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**THE IMPACT OF BIG DATA ON
HUMAN RESOURCES MANAGEMENT**

**L'IMPATTO DEI BIG DATA SULLA
GESTIONE DELLE RISORSE UMANE**

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TABLE OF CONTENTS

TABLE OF CONTENTS	1
INDEX OF GRAPHS	3
INDEX OF TABLES	3
INTRODUCTION	4
INTRODUZIONE	7
1. INDUSTRY 4.0	10
1.1. FROM THE LATE EIGHTEENTH CENTURY TO NOWADAYS: A HISTORICAL FRAMEWORK	10
1.2. THE EARLY STAGES OF A NEW ERA	14
1.3. THE ADVENT OF BIG DATA	20
1.3.1. Definition of Big Data	24
1.3.2. The three Vs and their evolution	26
1.3.3. Data quality as a top priority for competitiveness	31
1.3.4. Big Data analytics	35
1.3.4.1. Descriptive analytics	36
1.3.4.2. Predictive analytics	38
1.3.4.3. Prescriptive analytics	39
2. HOW BIG DATA CAN HELP HRM	41
2.1. DEFINITION OF PEOPLE ANALYTICS	41

2.1.1. HR Analytics tools	44
2.2. APPLICATIONS OF PEOPLE ANALYTICS	46
2.2.1. Talent acquisition processes	51
2.2.2. Motivation and engagement	60
2.2.3. Performance management	64
2.2.4. Alignment of HR strategy with business goals	68
2.3. NEW TRENDS IN HRM	72
2.4. THE CANDIDATE RELATIONSHIP MANAGEMENT	74
3. THE RIGHT BALANCE	88
3.1. WHICH ORGANISATIONS HAVE ALREADY BEEN ADOPTING BIG DATA IN HRM?	88
3.2. THE SCEPTICAL SIDE: THE NEO-LUDDITES	93
3.3. THE BALANCE BETWEEN MEN AND MACHINES	95
3.4. CHALLENGES IN THE RECRUITERS' SKILLS	98
3.4.1. Main obstacles to the application of HR analytics	99
3.4.2. New skills and roles	102
3.4.3. The design thinking approach	108
CONCLUSION	113
REFERENCES	115
SOURCES	123

INDEX OF GRAPHS

Graph 1.1. Number of internet users worldwide from 2009 to 2019, by region (in billions)	21
Graph 1.2. Internet of Things connected devices installed base worldwide from 2015 to 2025 (in billions)	22
Graph 2.1. Interest in HR Analytics (Blue) and People Analytics (Green)	42
Graph 2.2. Top reasons organisations are struggling to hire suitable candidates	52
Graph 2.3. Top uses for data in talent acquisition	53
Graph 2.4. Management of HR data risk levers	85
Graph 3.1. Percentage of companies applying analytics in HR by industry in EMEA	91

INDEX OF TABLES

Table 1.1. Key technologies in Industry 4.0	16
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INTRODUCTION

The Covid-19 emergency has made it more evident than ever that society has by now entered the Fourth Industrial Revolution, characterised by the emergence of new revolutionary technologies. Because of Artificial Intelligence, Internet of Things and the numerous connections linking the devices we use every day, the amount of data daily generated is enormous: this led to the birth of the phenomenon of Big Data.

Companies are starting to understand the importance of this tool, especially with regard to the countless benefits that its analysis can bring about, in order to make effective decisions. The application of Big Data analysis does not stop at corporate departments such as Marketing and Finance, but it goes further and enters the field of Human Resources Management too: therefore, leading to People Analytics or HR Analytics.

The purpose of this thesis is to investigate the impact that Big Data has and could have on the management of human resources, starting from the fields of application, up to the consequences in terms of business changes and the skills necessary to properly manage such tool.

To achieve the research goal, a qualitative research method, combined with various case studies and numerical data from statistical databases, such as Statista and World Bank Open Data, has mainly been used. The information was collected

from numerous secondary sources, including: specialised books on the topic of Big Data; papers written by the scientific community, mostly taken from electronic databases such as IDEAS, ResearchGate and Scopus; articles from specialised journals, such as MIT Sloan Management Review and Harvard Business Review; reports from some of the leading global consulting and IT companies, such as Deloitte and IBM, as well as reports from experts and communities related to Human Resources, such as Academy to Innovate Human Resources (AIHR) and Society for Human Resources Management (SHRM).

The paper, after a brief historical framework, which acts as an introduction to the theme of Industry 4.0, provides for the discussion of the topic of Big Data, giving a definition, examining the main characteristics and deepening the analysis possibilities that such amount of data can offer.

Subsequently, in the second chapter, People Analytics is introduced and, with respect to the soft aspect of human resources management, the organisational processes, in which it is applied, are indicated: from the selection of personnel, to the involvement of the workforce, to the control of employees' performance, to the alignment of human capital management with the corporate strategy. The advantages and risks associated with this tool are examined, and new trends, that are characterising the management of human resources in recent times, as well as the management of relations with candidates, have also been exposed.

Afterwards, in the third chapter, light is shed on the current state of adoption of People Analytics within companies. The reasons for a higher degree of hostility towards the application of such tools and the difficulties that could prevent the inclusion of People Analytics in a business context are then analysed. Lastly, the needs for new skills of HR professionals are exposed and an effective method to facilitate the adoption of People Analytics in the company is proposed.

INTRODUZIONE

L'emergenza Covid-19 ha reso evidente, più che mai, il fatto che la società sia ormai entrata nella Quarta Rivoluzione Industriale, caratterizzata dall'emergere di nuove tecnologie rivoluzionarie. Tra Intelligenza Artificiale, Internet delle Cose e le numerose connessioni che collegano i dispositivi che utilizziamo quotidianamente, la mole di dati generata ogni giorno è enorme: ciò ha portato alla nascita del fenomeno dei Big Data.

Le aziende stanno iniziando a comprendere l'importanza di tale strumento, soprattutto per quanto riguarda gli innumerevoli vantaggi che può portare la loro analisi, al fine di prendere decisioni efficaci. L'applicazione dell'analisi dei Big Data non si ferma a dipartimenti aziendali quali Marketing e Finanza, ma va oltre ed entra anche nel campo della Gestione delle Risorse Umane: arrivando quindi alla People Analytics o HR Analytics.

Lo scopo di questa tesi è quello di investigare quale sia l'impatto che i Big Data hanno e potrebbero avere sulla gestione delle risorse umane, a partire dai campi di applicazione fino ad arrivare alle conseguenze sul piano dei cambiamenti aziendali e delle competenze necessarie per utilizzare con dimestichezza tale strumento.

Per raggiungere l'obiettivo della ricerca, l'autrice ha adoperato principalmente un metodo di ricerca di tipo qualitativo, combinato a vari casi studio e dati numerici

provenienti da database statistici, quali Statista e World Bank Open Data. Le informazioni sono state raccolte da numerose fonti secondarie, tra cui: libri specializzati sull'argomento dei Big Data; paper scritti dalla comunità scientifica, per la maggior parte presi da database elettronici come IDEAS, ResearchGate e Scopus; articoli di riviste specializzate, come MIT Sloan Management Review e Harvard Business Review; report di alcune delle principali aziende di consulenza e di informatica a livello globale, quali Deloitte e IBM, e anche relazioni di esperti del settore e comunità legate alle Risorse Umane, come la Academy to Innovate Human Resources (AIHR) e la Society for Human Resource Management (SHRM).

L'elaborato, dopo una breve cornice storica, che fa da introduzione al tema dell'Industria 4.0, prevede la trattazione dell'argomento dei Big Data, dandone una definizione, esaminandone le caratteristiche principali e approfondendo le possibilità di analisi che tale mole di dati può offrire.

Successivamente, nel secondo capitolo, viene introdotta la People Analytics e vengono indicati i processi, relativi all'aspetto soft della gestione delle risorse umane, in cui essa trova applicazione all'interno dell'azienda: dalla selezione del personale, al coinvolgimento della forza lavoro, al controllo della performance dei lavoratori, all'allineamento della gestione del capitale umano con la strategia aziendale. Vengono esaminati vantaggi e rischi legati a tale strumento e vengono anche esposte nuove tendenze che stanno caratterizzando negli ultimi tempi la

gestione delle risorse umane, come anche la gestione delle relazioni con i candidati.

Infine, nel terzo capitolo, viene fatta luce sull'attuale stato di adozione della People Analytics all'interno delle aziende. Si analizzano poi i motivi sottesi a una maggiore ostilità all'applicazione di tali strumenti e alle difficoltà che potrebbero impedire l'inserimento della People Analytics in un contesto aziendale. Per ultimo, si espongono le necessità di nuove competenze da parte dei professionisti che si occupano della gestione delle risorse umane e viene proposto un metodo efficace per facilitare l'adozione della People Analytics in azienda.

1. INDUSTRY 4.0

1.1. FROM THE LATE EIGHTEENTH CENTURY TO NOWADAYS: A HISTORICAL FRAMEWORK

It was the late eighteenth century when the First Industrial Revolution occurred. Precisely, in 1760 the steam engine was invented and twenty-four years later the power loom was firstly applied to the British manufactures, leading to a first step of mechanisation of the production process (Cipolla, 1965). Steam power was defined as “the hub through which the spokes of coal, iron and cotton were linked” (Rosen, 2010). Indeed, the industrial sectors which definitely saw a dramatic development were those related to cotton, coal and iron, such as the textile. The railways industry played a key role too, at that time, given that trains were the main means of transportation for both people and goods. However, a different technological regime does not only bring about new products and new production processes, but has far-reaching social repercussions on the way people live, work and organise themselves, as well as effects on life expectancy, on the characteristics of the family, on the business organisation and financial system (Zamagni, 1999). When it comes to the First Industrial Revolution, several transformations took place with regard to the organisation of work: even if the emergence of Work 1.0 (Tohanian and Toma, 2018) did not require high levels of

education, being based on a simple and widely known science, the division of labour and the use of specialised machinery started to take place in the factories.

Almost a century later, there was another step forward from the technological point of view, with the advent of the Second Industrial Revolution. Starting from the second half of 1800, inventions multiplied rapidly, leading to a new phase for the industry, primarily founded on the combination of electrical energy and mass production. With the invention of the internal combustion engine, based on the use of oil, a new era was inaugurated in 1900, also called the “Age of Steel”, characterised by rapid industrialisation and a faster growth in productivity. Such innovations triggered further changes in social terms, starting from the fact that higher levels of knowledge and education were required to manage the new tools present in the companies: Work 2.0 was born (Tohanian and Toma, 2018), featuring a highly specialised, and organised along assembly lines, production.

With the appearance of the first programmable logic controller, PLC, in the late sixties of the last century, and the application of computers, electronics, web-based interconnectivity and Information and Communication Technology (ICT), not only was the automation of production processes made possible, but also the remote coordination of business logistics was enabled: the world was witnessing the beginning of the Third Industrial Revolution. Due to the fact that this era was especially based on knowledge progress and to the fast development of Information Technology, it was named the “Information Age”. The IT transition

affected various industrial sectors. In particular, on the one hand companies were able to streamline processes to reduce labour input, they became less vertically and more horizontally integrated, also fragmenting their production processes to enhance specialisation by deploying global supply chains, therefore leading to a further global economy. On the other hand, the industrial revolution that began around the middle of the 1900s and continued until a few years ago, ensured a closer relationship between science and technology: indeed, it was based on nuclear energy, artificial materials, biochemistry and electronics. With regard to the effects upon labour, the increasing use of computers in the workplace, the consolidation of the welfare state and of the workers' rights made possible the emergence of Work 3.0 (Tohanean and Toma, 2018), with the proliferation of employment in services.

Nowadays, the technological innovation process speeded up: after less than fifty years from the beginning of the Third Industrial Revolution, we are already talking about a Fourth Industrial Revolution. In the wake of the Third one, the Fourth Industrial Revolution is characterised by the fusion and integration of exponential technologies, such as nano-materials, biotechnologies and artificial intelligence, which thinning more and more the demarcation between physical and digital, have led to the existence of the digital enterprise, as well as to the digitalisation of the global economy. With regard to those who question if the Fourth Industrial Revolution is a revolution apart from the Third one, there are

three elements that make a significant distinction between the two revolutions, therefore implying that Industry 4.0 is not a mere extension of the “Information Age”: velocity, scope and systems impact. Indeed, new breakthroughs are taking place much faster than in the past and appear to have an exponential, rather than linear, trend, in terms of speed. Furthermore, the extent of the impact it is having is as prominent as to involve almost all sectors worldwide. Not to mention the depth of these changes, that are likely to provoke disruption in the business world, leading to the transformation of entire systems of production, management and governance (Schwab, 2016). Other elements that stress the difference between Industry 3.0 and Industry 4.0 can be found in the digitalisation and vertical integration of the processes throughout the organisation, as well as the horizontal integration of several value chains. With regard to the first characteristic, today all data on operational processes are available in real time in a single information space, that usually is a business platform. As for the second one, it refers to integrated planning tools that are used in order to quickly adjust plans according to suppliers, customers and partners through the value chain. Moreover, digitalisation covers products and services, especially through the use of intelligent sensors and communication devices that are compatible with data analysis tools. Dissimilarities can be seen also in the new business models that aim at obtaining additional revenue from digital solutions, optimising customer interaction and improving customer access (Tarasov, 2018). Differently from the

Third Industrial Revolution, in the current one, change is driven by the deep connection of products and processes via the Internet, that enables human and mechanical actors in the value chain to exchange relevant information with each other, in order to organise in an autonomous way and to arrange processes and deadlines co-ordinately. From digitalisation and digital transformation, new forms of communication, collaboration and value creation are emerging and influencing the way of doing business.

1.2. THE EARLY STAGES OF A NEW ERA

If someone was not completely aware of it until some time ago, with the emergency situation caused by Covid-19 the impact of the Fourth Industrial Revolution on today's society is now clear: billions of people worldwide have the possibility to stay connected by mobile devices, equipped with unprecedented processing power, storage capacity, and to access to knowledge. We are just in the early stages of this new powerful technological shift, that will multiply the extension of its impact by emerging technology breakthroughs in a wide range of fields. In 2015, at the World Economic Forum, numerous hypothesis concerning the forthcoming future have been formulated by a group of 800 high-tech experts and executives, including: implantable cell phones by 2025, 10% of people wearing internet-connected clothes by 2022, one trillion sensors connected to the

internet by 2022, 3D printed cars by 2022, 10% of reading glasses connected to the internet by 2023, over 50% of internet traffic directed to homes and appliances by 2024, transplants of 3D printed organs by 2024, and driverless cars comprising 10% of all cars in the United States by 2026.

Essentially, three are the features that characterise the Fourth Industrial Revolution: ubiquity, availability, and interaction at a global level, since almost everybody all over the world is able to have access to a new level of knowledge and new technologies, that in turn can connect, communicate and interact with each other, exist. These elements have contributed to building a widespread network over time, in which an infinite number of devices, related both to business and domestic areas, are connected. Moreover, at present, it is possible to collect, store and process huge amounts of data, with a capacity that goes beyond human capabilities. We are also witness of new technological tools and systems that facilitate our daily life, such as translation programs, virtual assistance, software for trading and investment promotion, drones and, soon, automated vehicles. All these things are possible thanks to those revolutionary technologies that represent the three milestones of Industry 4.0: Internet of Things, Big Data, and Artificial Intelligence. Together with other technologies, some of which are explained in Table 1.1., such as 3D printing, machine learning, cloud computing systems, sensors, robotics, nanotechnology, genetic engineering and quantum computing, they are able to quickly deliver a great variety of products and

services at low costs and provoke significant modifications in the production processes. Indeed, Industry 4.0 is based on the use of cyber-physical production systems (CPS), which merge the physical and the virtual worlds by the adoption of Information and Communication Technologies, heterogeneous data and knowledge integration.

Table 1.1. Key technologies in Industry 4.0

Technology	Description	Example of application
Internet of Things	The IoT is a technology architecture connecting via Internet smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire, without requiring human intervention.	IoT sensors placed throughout a factory can determine when machines require maintenance or alert plant managers if temperature or humidity levels are too high for sensitive processes such as painting or mixing ingredients.
Big Data	Big Data is a huge amount of data characterised by big volume, velocity and variety.	Marketing uses Big Data coming from Social Networks to understand consumers' behaviour.
Artificial Intelligence	Artificial Intelligence concerns the ability of a digital computer or a computer-controlled robot to perform tasks commonly associated with intelligent beings.	Artificial Intelligence is used by digital translators to provide not only a translation of written or spoken words, but also of the meaning of the message.
Machine Learning	Machine learning is an application of AI, that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.	One of the most common uses of machine learning is image recognition.

Cloud Computing	Cloud Computing is a tool that allows users to remotely access and use services: SASS (Software-as-a-service), PASS (Platform-as-a-service), IASS (Infrastructure-as-a-service).	Online streaming sites use Cloud Computing to provide the same quality performance offline, and online.
3D Printing	3D printing or additive manufacturing is a process of building three dimensional solid objects from a digital file, using additive processes.	3D printing is used by automotive companies to produce spare parts, tools, jigs and fixtures, leading to lower stock levels and has shortened design and production cycles.
Quantum Computing	Quantum computers are machines that use the properties of quantum physics to store data and perform computations.	Quantum computers are used by the chemical industry to understand molecular structure and chemical reactions and processes.

Source: author's elaboration.

With regard to companies, Industry 4.0 is leading to new organisational business models that are characterised by shorter operations cycle times, quick delivery times, faster time to market of new products and services, improved quality, product and service customisation, stronger consumer involvement and loyalty.

Nevertheless, this process is still in its early stages and there is a relevant need for long-term investments to take full advantage of all the new opportunities that it offers, including an improvement of working conditions and a higher environmental friendliness of production.

In order to overcome several barriers for its successful implementation, investments will be definitely needed with regard to human skills, that are a

double-edged sword, representing both a bottleneck on this path and one of the key parameters of a flourishing technological transformation: the introduction of tools, related to Artificial Intelligence and other revolutionary technologies, will lead to the creation of new, safer and better paid jobs, typical of Work 4.0 (Tohanian and Toma, 2018), but at the same time it will contribute to the elimination of others, requiring a lower skill set, according to a process of creative destruction. Indeed, areas such as logistics, paralegal contract law, patent law tasks, accountancy, transport, manufacturing work, housekeeping, healthcare are likely to see a high automation and substitution of human workforce (Pérez Alonso et al., 2017). Moreover, according to a report conducted in 2016 by the United Nations Conference on Trade And Development and World Bank, there is a high likelihood that who will suffer most the losses of jobs are developing countries, that are predicted to lose almost two thirds of total jobs, as in the initial phase the robots will replace low and medium skilled jobs, who represent the majority in those territories.

As widely discussed at the World Economic Forum in 2019, by institutes of learning and business leadership, the Fourth Industrial Revolution will bring about several changes in the requirements concerning education and the workplace: in particular, a reskilling, primarily based on digital competences, will be necessary in the labour world (Gerhardus Beukes, 2019). Several analyses have chosen Big Data as a qualifying factor of the digital transformation of work, together with the

diffusion of the Internet and smartphones (Degryse, 2016), and it is not surprising that companies are allocating more and more resources to data analytics, in order to use the resulting information to make decisions in the various areas of operation, from business policies to organisational and personnel management aspects. We have also witnessed some of such transformations in the last months, due to the Covid-19 emergency, that implied the “forced” adoption of smart working in numerous companies, especially when it comes to mobile internet and cloud technologies.

On the whole, with regard to the impact of Industry 4.0 on labour, there have been numerous debates, but, essentially, experts are divided into two opposite positions: on the one hand, some of them think that this industrial revolution will dramatically affect the labour market and generally the human role in the economic process; on the other hand, the remaining part thinks that probably the development of the Fourth Industrial Revolution will be similar to those of the three previous ones, without provoking relevant or long-term disruptions on the labour market (Bonciu, 2017), as, for example, many occupations being in demand today did not even exist some years ago. According to this latter point of view, the labour market will not be subjected to narrowing, but will solely change its structure, leading to an overall new business model paradigm in which competences and abilities of people will represent the key resources to achieve a competitive advantage for companies.

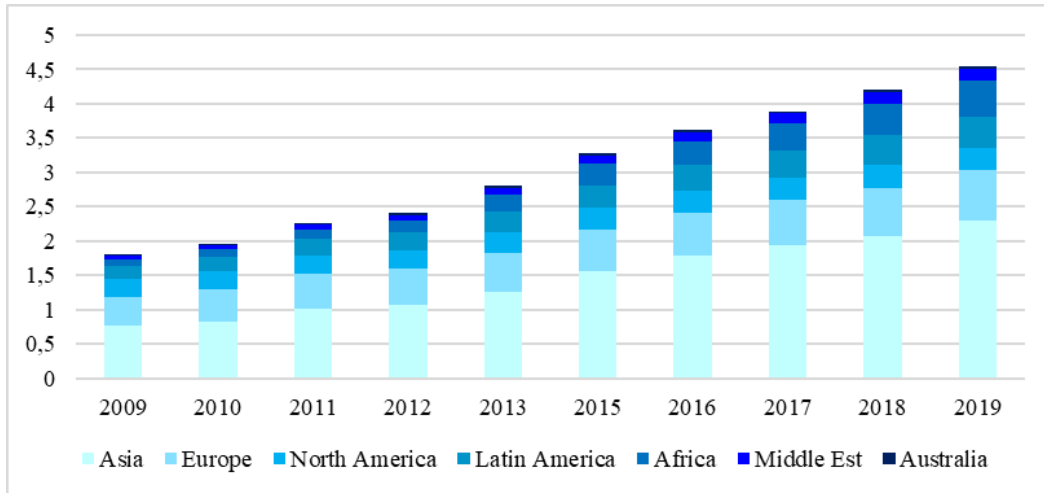
In the end, the Fourth Industrial Revolution can be summarised in advanced digitalisation and integration of industrial manufacturing and logistics processes, and the use of internet and smart objects (Fonseca, 2018), able to exchange huge amounts of data and important information with machines and people, in online networks, and capable of building production with a reduced number of errors, interacting with produced goods and adapting to the new needs of customers.

1.3. THE ADVENT OF BIG DATA

In the last ten years, there has been a sharp increase in Internet utilisation by people all around the world, especially in Asia, as shown by the following chart. In 2009, there were only 1.8 billion people who had access to the Internet, but in just six years 3.2 billion internet users were reached. This phenomenon continued to grow without interruption and in April 2020 it was registered that almost 4.57 billion people out of 7.6 billion were connected to the Internet, representing 59% of the global population¹.

¹ <https://www.statista.com/statistics/617136/digital-population-worldwide/>, URL visited on 08/05/2020.

Graph 1.1. Number of internet users worldwide from 2009 to 2019, by region (in billions)

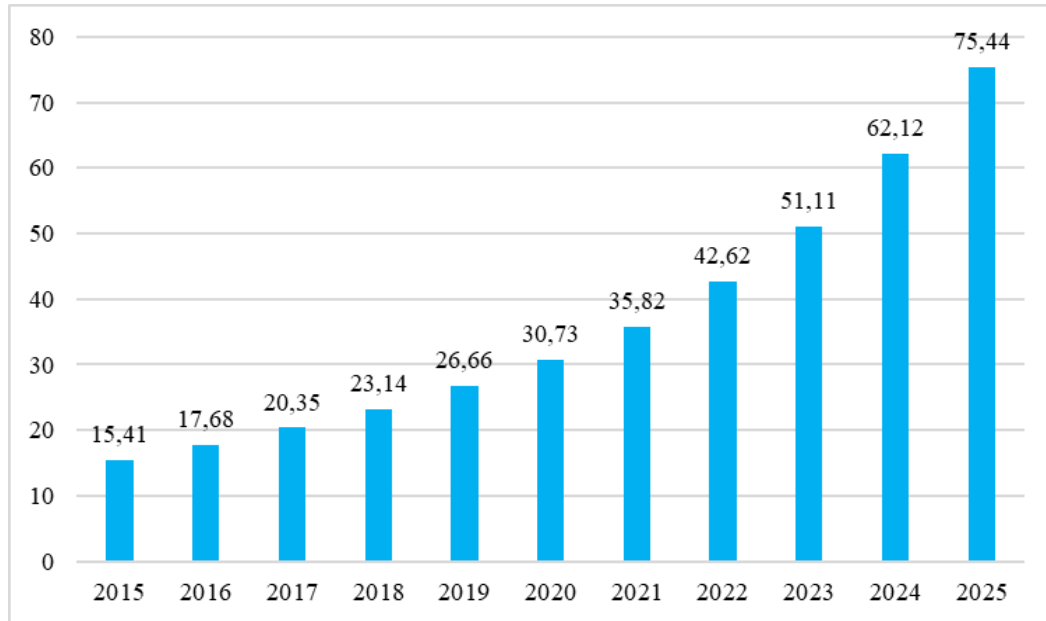


Source: Statista², <https://www.statista.com/statistics/265147/number-of-worldwide-internet-users-by-region/>, URL visited on 08/05/2020.

Together with the use of mobile phones, tablets, PCs, laptops and fixed phones by common people, also the use of IoT devices is expected to grow, leading to a huge number of connections worldwide. As shown by Graph 1.2., globally, the number of IoT connected devices doubled in five years, passing from 15.41 billion in 2015 to 30.73 billion in 2020, but the growth for the following period is expected to be exponential: it is forecasted that in 2025 there will be 75.44 billion of connected devices worldwide.

² 2014-year data were not available.

Graph 1.2. Internet of Things connected devices installed base worldwide from 2015 to 2025 (in billions)



Source: Statista, <https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/>, URL visited on 08/05/2020.

According to Cisco (2020), the number of devices connected to IP networks will be more than three times the global population by 2023, in particular there will be 29.3 billion networked devices by that year, up from 18.4 billion in 2018. More connections mean more Internet traffic and more data generated: IoT connected devices are expected to reach, on their own, 79.4 zettabytes³ (ZB) by 2025, in terms of total data volume. Every two years the growth of data has doubled and every second the Internet creates more data than it was stored in the entire Internet

³ One zettabyte (ZB) equals 10^{21} bytes, meaning 10^{12} gigabytes GB.

just 20 years ago (Brynjolfsson and McAfee, 2012): precisely 92,107 GB of Internet traffic⁴. The use of devices and the Internet brought about a sharp increase in the volume, variety and velocity of data, especially thanks to optic fibre and wireless networks: Big Data is continuously produced worldwide and it is important to understand its characteristics, before managing it in different contexts.

Such overwhelming data flow implicates challenges and competences related to processing, analysing and storing the huge data sets to improve decision making and to ameliorate the exploration and the manipulation, rapidly and cost-effectively. Demanding more sophisticated computational platforms than the usually used to leverage normal data and needing specific data storage are typical features of Big Data.

From the economic perspective, Big Data represents a noteworthy revolution in the 21st century: it has become critical for business success and it introduced a new era of data-driven approaches to organisations, fundamental to take decisions and, consequently, to increase profit. Companies started to understand the importance of Big Data in the business environment, when they looked at the large amount of data that social networks and mobile communications generate: both structured and unstructured data can be used to improve current transactions,

⁴ <https://www.internetlivestats.com/one-second/#traffic-band>, URL visited on 08/05/2020.

to develop new business models, to provide a real image of the supply and demand and, thereby, to create market advantages. The vast amount of data is crucial when it comes to the possible correlations that can be found: it could not be possible using common tools, based on smaller and separate sets. It goes without saying that there exist numerous technical challenges connected to the use of Big Data, but it has already entered diverse business processes and, even if it is in its infancy stage, the relevant impact on economic and social sectors is already observable.

1.3.1. Definition of Big Data

Despite the fact that the term “Big Data” is approximately ubiquitous, from IT researches and practitioners to other fields such as economics, management, information science, sociology, medicine and biology, it still lacks a formal definition. Often “implicit” definitions are adopted by scholars, through anecdotes, success stories, characteristics, technological features, trends or its impact on society, firms and business processes (De Mauro et al., 2016). The term “Big Data” appeared for the first time in the computing world in 2005, when Roger Magoulas from O’Reilly media used it to define a great amount of data that traditional data management techniques cannot manage and process due to its

particular complexity and size⁵. However, it was present in research already in 1970s and it has been included in publications in 2008.

According to a study published by MIT Technology Review in 2013, two researchers of the University of St. Andrews in Scotland founded out that there are different definitions provided by influential organisations. Oracle defines Big Data as the derivation of value from traditional relational database-driven business decision making, augmented with new sources of unstructured data. Microsoft states: “Big data is the term increasingly used to describe the process of applying serious computing power – the latest in machine learning and artificial intelligence – to seriously massive and often highly complex sets of information”. The National Institute of Standards and Technology argues that Big Data is data which “exceed(s) the capacity or capability of current or conventional methods and systems”. For Intel, Big Data exists when there is a generation of 300 terabytes of data a week. On the other hand, the Method for an Integrated Knowledge Environment open-source project argues that Big Data is not a function of the size of a dataset but its complexity. According to Edd Wilder-James, chair at the O’Reilly Strata Conference, Big Data can be described as “data that exceeds the processing capacity of conventional database systems. The data is

⁵ <https://www.researchtrends.com/issue-30-september-2012/the-evolution-of-big-data-as-a-research-and-scientific-topic-overview-of-the-literature/>, URL visited on 24/04/2020.

too big, moves too fast, or does not fit the structures of your database architectures. To gain value from this data, you must choose an alternative way to process it". Also McKinsey defines Big Data as "the datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyse". Finally, Gartner provides a definition that is based on the "three Vs", describing Big Data as the "high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making"⁶. This last definition is the most frequently used in analyst and academia communities for research and development of Big Data as a computing, science and technology. To conclude, "Big Data is the Information asset characterised by such a High Volume, Velocity and Variety to require specific Technology and Analytical Methods for its transformation into Value" (De Mauro et al., 2016).

1.3.2. The three Vs and their evolution

Generally, Big Data is defined through its characteristics, the 3 Vs, representing volume, velocity and variety.

⁶ <https://www.gartner.com/en/information-technology/glossary/big-data>, URL visited on 24/04/2020.

Fundamentally, these three features mark the border between Big Data and normal data.

Volume refers to the amount of data that are generated by both unstructured sources and traditional databases belonging to science and education, business and human interaction fields, such as Internet of Things, social media, banking transactions and movements in financial markets. The big volume of Big Data reflects the size of the data set, which is typically in exabytes⁷ (EB) or zettabyte (ZB). Nowadays, companies are awash with ever-growing data of all types, easily amassing terabytes, even petabytes, of information on a daily basis. For instance, Google processes over 20 PB⁸ of data every day⁹, whereas Walmart gathers about 2.5 PB of unstructured data from its customers hourly¹⁰. Data volume has a relevant impact on storage and processing. Currently, Big Data repositories exceed EB and they are increasing rapidly in size. Nevertheless, the challenges concerning the storage capacity are less problematic than those posed by processing, thanks to the numerous storage solutions and cloud technologies that allow enterprises to deposit data in an efficient way. The greater problem has to

⁷ One exabyte (EB) equals 10^{18} bytes, meaning 10^9 gigabytes (GB).

⁸ One petabyte (PB) equals 10^{15} bytes, meaning 10^6 gigabytes (GB).

⁹ <https://www.heshmore.com/how-much-data-does-google-handle/>, URL visited on 25/04/2020.

¹⁰ <https://www.dezyre.com/article/how-big-data-analysis-helped-increase-walmarts-sales-turnover/109>, URL visited on 25/04/2020.

do with the computational power of processing systems: in this case, it is useful to utilise massively parallel computing platforms, such as Hadoop, because they distribute the workload across many processors.

The second V stays for velocity, which indicates the speed at which data is produced. This measure is composed by two features: throughput and latency of data. The former denotes the elevated speed at which data flow into and out of networked systems in real time. The latter concerns the time it takes for data packets to be stored or retrieved. Data can be imported in two different ways: either all at once, as it happens with batch data, or continuously, as it occurs with streaming data, which are also processed at the same time that they are generated. The second method is crucial when it comes to the choice of a Big Data analysis platform, especially because some time-sensitive processes, such as catching fraud, require almost instant analytics results that lead to the maximisation of the value of information that the company comes across with. An example of real time and interactive analysis is Apace Spark, whereas Hadoop is a good representation with respect to the batch model.

The third V refers to the variety of data that can differ in terms of formats, sources and structures. Big Data can be classified into three types: structured, semi-structured, and unstructured at a higher level. Structured data have a high degree of organisation, include a unified data format and can be easily leveraged with database systems like Oracle. Conversely, unstructured data lack such

organisation and make up 80% of the world's data. They are those data that are available on the web, such as blogs and tweets on social media, that are absorbed in a multi-language and multi-ethnic environment. Semi-structured data are in-between: they are a kind of structured data that do not comply with the formal structure of data models associated with relational databases, but still contain some elements that enable a separation within them and the creation of hierarchies of records and fields, such as tags. Doubtlessly, the last two typologies of data make the storage, mining, as well as the analysis, further complicated. Semi-structured and unstructured data require more advanced infrastructures for processing than the Relational Data Base Management System (RDBMS), that has been used by traditional data analysis systems and that can be only applied to structured data. The heterogeneity of Big Data demands the capacity of platforms of handling data from multiple sources, such as e-mail, mobile devices, sensors, web pages, social networks, which in turn use different formats that go from text, to images, videos, audio and other multimedia contents. Variety therefore concerns the combination of all kinds of formats that data can display and the challenges that incompatible data type, non-aligned data structures and inconsistent data semantics imply. A useful tool to cope with demand tasks related to variety of data is represented by NoSQL databases, which are more than 225 in the market.

Subsequently, these three Vs has been extended to four, with the addition of veracity: it concerns data quality and accuracy, particularly when it comes to the trustworthiness and truthfulness that guide important decisions through the use of collected data. With regard to Big Data, there is always a high degree of vagueness, uncertainty, ambiguity, discrepancy, inconsistency, incompleteness, deception and approximation, that leads to the classification of data into good, bad or undefined. In order to increase the accuracy and reliability of Big Data, effective technologies, methods and techniques have to address the incertitude and the incompleteness of data.

Recently, also a fifth V has been added: value. It is one of the most important factors in Big Data and refers to data relevance in decision-making. Big Data value can be recognised in several fields, from business, to science, technology and society. Value plays a key role on business profits, since it impacts the ROI and can be the driver of competitiveness of a company: it might increase productivity, efficiency and revenues, lowering costs and decreasing risk in business and management. Moreover, Big Data are valuable when it comes to medical research to find new effective solutions. Also, in society some modifications due to Big Data can be seen. For instance, the education method has been the protagonist of a revolutionary change: from books, library and paper newspapers, to online search.

1.3.3. Data quality as a top priority for competitiveness

Data quality represents an important challenge when it comes to the usage of Big Data: without this crucial characteristic it is difficult to begin to correctly work with it. Data are ceaselessly changing and they quickly become obsolete, so they have to be always monitored and new data have to be incorporated into databases. This is especially true with respect to a large database and the big volume of data on the Web, even if many people could think that a great amount of data can reduce inconsistency. Unfortunately, there is not a data quality rule that can be applied in each case: due to the high degree of variety and the wide range of sources from which data can come from, there is a greater difficulty in discovering the semantics of data and correctly understanding the correlations between attributes.

Whenever a quality-related business case takes place, it is fundamental to calculate the costs and estimate the risks related to poor data quality. In particular, low-quality data can cost a business up to 600 billion dollars annually¹¹. Inaccurate data lead companies to the inability of making good decisions based on a careful understanding of the internal and external environment, and to the use of intuition, therefore undermining strategic plans or projects. Indeed, in addition to

¹¹ The Data Warehousing Institute (TDWI), Survey, 2002.

untruthful insights and missed opportunities, imprecise data can damage the reputation, mislead resources and decelerate the data recovery. Typically, there are two very frequent problems that are also interrelated: extra time required to reconcile data and loss of credibility in the system or application. It is important to track the origin of data through meta data, because trust is generated from source systems firstly, and secondly from the accuracy of a data warehouse.

Other problems concern the redundancy and duplication of data, data entry mistakes, as well as system migrations and software errors: this is the reason why many companies are increasingly investing in managing and improving data quality through data warehousing projects, where a key role is played by data cleaning.

The Global Data Quality Tools market is expected to grow up to \$2.35 billion by 2025, at a compound annual growth rate of 18.2%¹²: this demonstrates the importance that companies give to the development of data quality management systems and, consequently, the increasing demand in industries that can help organisations effectively detect and correct errors in the data, as well as add accuracy and value to business processes.

Comprehensively, data quality can be described as an essential feature that ascertains the reliability of data for making decisions: it involves the continuous

¹² <https://www.marketresearchengine.com/data-quality-tools-market>, URL visited on 27/04/2020.

maintenance of changing data. In particular, the Data Management Body of Knowledge defines it as “the planning, implementation, and control of activities that apply quality management techniques to data, in order to assure it is fit for consumption and meet the needs of data consumers”. Data quality helps companies to identify revenue opportunities, meet regulatory compliance requirements and respond to customer issues in a timely manner, thus is a top priority that drives the competitiveness of a business, especially in a digital landscape.

Data quality can be determined by several metrics that are useful to benchmark their accuracy, helping organisations to differentiate between high-quality data and low-quality data. Key factors to examine data quality are: accuracy, absence of duplication, availability, completeness, consistency, integrity, timeliness, validity.

Accuracy is about the compliance with real values, that is, correctness of the values themselves. The starting point for the accuracy of data lies in their integrity and it focuses on the adherence of data to a given reality of interest.

Absence of duplication means that fields, records or tables must be present only once, avoiding duplications in the same system or in different systems. In addition to the need for double maintenance, duplication of data has a negative impact on quality, as a lack of synchronisation between copies of data is possible.

Availability means that required data have to be accessible on demand.

Completeness concerns the presence, in a specific dataset, of all those relevant data, such as accounts, addresses and relationships, necessary to describe an entity, a transaction or an event.

Consistency refers to the absence of contradictions in data and to the maintenance of synchronicity between different databases. It is linked to the concept of data equivalence, for instance, in a bank, the sum of the previous month-end balance of a current account with the active and passive movements, must be equal to the current month-end balance.

Integrity particularly concerns relational databases, that guarantee that data respect some constraints: for instance, that in a column there are only data of the same type. This is especially important when it comes to data stored in multiple systems.

Timeliness reflects the accuracy of data at a specific point in time, so it regards up-to-date information to support decisions.

Validity is about the data conformity to the required value attributes, that can be a specific format.

Useful metrics that help to ensure the presence of such characteristics could be: the ratio of data to errors; the number of empty values, that is missing information; the data transformation error rate, which concerns the process of converting stored data into different formats; the amounts of dark data, that is data that cannot be used effectively; the time needed to derive results from a given data

set, known as time-to-value, and so on. As mentioned before, there is not a general rule that can be always applied, notwithstanding the circumstances: metrics have to be developed according to the context in which a company operates and to its specific needs, when it comes to data profiling.

1.3.4. Big Data analytics

The term “analytics” has become more popular as Big Data started to play a more relevant role in the business world. It has been used very often as a synonym of Big Data, but actually the two terms refer to very distinct elements: analytics concerns the methodologies that allow to analyse Big Data stored in databases. Big Data analytics can be defined as the process of collecting, organising and analysing Big Data to discover, visualise and communicate meaningful patterns, knowledge, and intelligence as well as other information within the Big Data to support decision-making. It relies on the simultaneous application of statistics, computer programming and operations research to quantify performance. Using Big Data properly can be a challenging process, but with the appropriate tools powerful and valuable insights can be gained. Data analysis concerns inspecting, cleansing, transforming and modelling data in order to obtain useful information that can be used to suggest conclusions and guide decisions. Analytics encompasses a growing field of data science capabilities, amongst which there can

be found mathematics, statistics, data mining, artificial intelligence, machine learning, cognitive computing and predictive modelling. Moreover, it can be applied to different sectors, from business, to science and society.

The three main components of Big Data analytics are descriptive analytics, predictive analytics and prescriptive analytics. Each of them answers different questions and offers a different kind of insight, so they can be used in a combined way to take the best advantage from them.

1.3.4.1. Descriptive analytics

Descriptive analytics is the most basic form of analytics. It examines historical data and information to determine the current situation, addressing issues such as what happened and what is happening. An example of Big Data descriptive analytics is the web analytics for pay-per-click data or the number of people that visited the company's website over the past few months. It utilises statistical analysis, categorising them, filtering them, aggregating them and applying purely descriptive mathematical functions, such as sums, averages and variances, to understand the development and patterns. Therefore, it also provides a clear recap and visualisation of data, producing both standard and ad hoc report, as well as alerts, that are readable at a glance. It is very useful when it comes to gaining insights from past behaviours and understanding what their influence on future

outcomes can be, in order to better inform future decisions. In particular, companies should use descriptive analytics when they want to have a clear idea of what is happening in their organisation at an aggregate level and to understand the relationships between a variety of areas, such as the link between customers and products.

With regard to Business Intelligence, On-Line Analytical Processing (OLAP) software techniques enable companies to perform an interactive and fast analysis of large amounts of data, through slicing, dicing, drill down, roll-up, drill-through and pivoting operations. Drill-down operations allow you to move from a level of greater aggregation to a level of lesser aggregation. The roll-up is the opposite operation to the drill-down: through it, the degree of aggregation increases. Slicing concerns the operation to reduce the dimensionality, or the number of elements of the same size, in the result of a multidimensional query. Instead, the term dicing means filtering data by defining a criterion. Through pivoting, the attributes on the rows are exchanged for those on the columns, or the order of display is changed, obtaining a different shape of the result. The pivoting operation helps the analyst to present the result in different ways, giving greater or lesser emphasis to the descriptive attributes, or to arrange the data according to a visualisation more suited to the purpose of the analysis. Drill-through allows you to get the maximum detail of the data that generated a certain aggregate.

1.3.4.2. Predictive analytics

Predictive analytics comprises a set of techniques that can be used to predict possible future trends and outcomes based on historical data sets and prior patterns. A synonym of predictive analysis is data mining, a term used for many years to indicate the discovery, in the available data, of hidden patterns applicable to the future. It addresses issues such as what is going to happen in the near future and in the remote one, what is likely to happen and the reason why it will happen. Therefore, it is able to provide estimates of the likelihood of a future outcome, even though there does not exist any statistical algorithm that can forecast future events with total accuracy: predictive analytics works on the grounds of probabilities obtained from data and provide actionable insights based on it. The greater the availability of data, the more precise the results and the predictions of the analysis will be. The predictive model is nothing more than a set of parameters, taken from the data of the past, and such as to provide a representation of the relationship between the characteristics of the phenomenon analysed, called the input variable and the value of the phenomenon itself, called output variable. In doing such a type of analysis, machine learning, AI processes, algorithms, regression techniques and forecasting models play a key role. Typically, predictive analytics produces a credit score to determine the likelihood of events. It is used by companies to identify risks and opportunities and, thus, to

plan and act accordingly. For instance, with regard to a bar that sells hot chocolate, predictive analytics can show on a macro level that hot chocolate sales are likely to increase during autumn and winter and decrease when temperatures rise. On a micro level, predictive analytics can display that sales are likely to decrease on sunny and hot days and increase on rainy and cold days.

1.3.4.3. Prescriptive analytics

Prescriptive analytics prescribes a specific course of action based on a descriptive or typically predictive analysis. It refers to modelling alternative scenarios and their impact on business outcomes, through optimisation, simulation, as well as randomised testing and heuristics-based techniques. It uses a combination of data to assess what could potentially happen if certain parameters change. Therefore, it addresses issues such as what should be done, why it should be done and what should happen in the best hypothesis. Beyond providing information, prescriptive analytics goes even one step further: it enables users to consider different possible actions to take and it provides advices that guide them towards a solution, by trying to quantify the effect of future decisions before they are actually implemented. Instead of simply predicting what will happen, prescriptive analysis tweaks certain variables to achieve the best possible outcome, and then prescribes that course of action. This can be relatively simple or complex, depending on the

data sets involved, but anyway prescriptive analytics, whether correctly applied, enhances the effectiveness and the efficiency of organisations because it enables companies to gain a better understanding of their operations and how to optimise them. Prescriptive analytics is the last and most valuable level of analytics, since it allows you to answer specific questions. An example of the application of prescriptive analytics could be, with regard to the health care sector, the calculation of how many patients show obesity problems, then the addition of filters for factors such as diabetes and cholesterol levels to identify where it is better to focus the medical therapy.

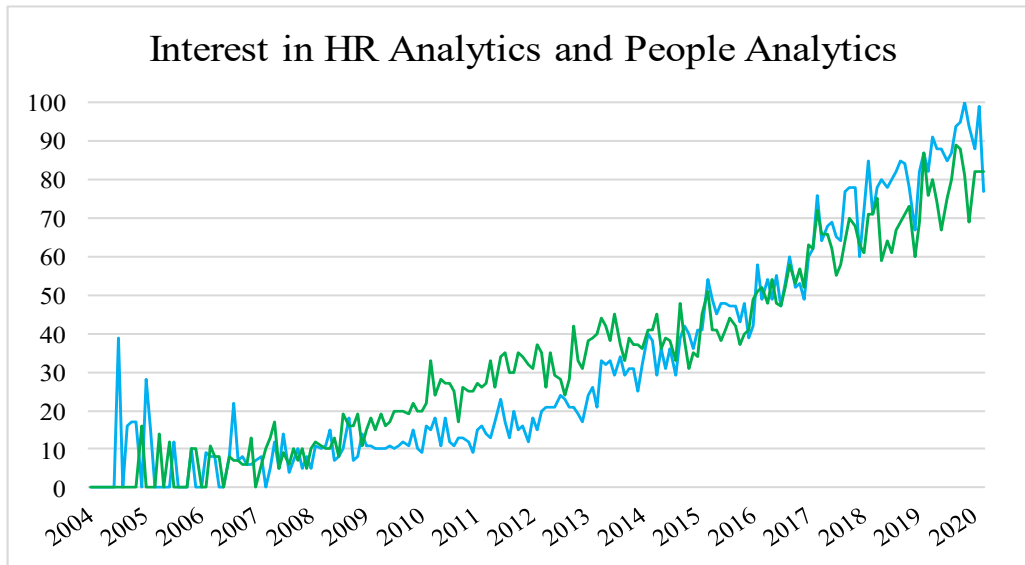
2. HOW BIG DATA CAN HELP HRM

2.1. DEFINITION OF PEOPLE ANALYTICS

With the arrival of Industry 4.0 and the increasingly fast changing external environment, companies find themselves dealing with several challenges affecting human capital management. The need of new skills, job complexity, the enlargement of recruiting channels, the lack of talented workers and candidate diversity are only some of the difficulties that the Human Resources department has to cope with in the digital era. It goes without saying that enterprises have perceived the need to invest in the latest sophisticated Big Data technologies, able to organise and process large volumes of heterogeneous, unstructured and rapid data, in order to improve functions related to the HR: those solutions are named either Human Resources Analytics or People Analytics.

In the last five years, the exponential growth in the usage of HR Analytics has been evident. Generally, looking at the online researches, all over the world, regarding the terms “HR Analytics” and “People Analytics”, the interest in such subjects registered a sharp increase starting from 2013, as reported in the following chart.

Graph 2.1. Interest in HR Analytics (Blue) and People Analytics (Green)



Source: Google Trends (2020).

From a report of IBM (2016), it can be seen as the usage of predictive analytics to make more informed workforce decisions had increased almost by 22% between 2013 and 2015. However, according to the Global Human Capital Trends report (Deloitte, 2016), even if companies had understood the importance of such tools and 32% of the respondents was ready to start using People Analytics, they also still exhibited significant gaps in their competences. Moreover, only a few enterprises claimed that HR Analytics was prominent in their organisation.

Recently, the intense application of analytics in other business functions, such as marketing, to create value, the availability of new software to collect and process data, the rise in the use of metrics in the HRM and the development of new skills made a relevant contribution to the spread of interest in People Analytics. As a

result, in 2019, in a survey carried out by OrgVue¹³ (2019), 89% of the respondent organisations, located in the UK and in the US, stated that HR Analytics was already part of their planning process.

Together with HR Analytics and People Analytics, other nouns are used with regard to Big Data in the HR field: Workforce Analytics and Talent Analytics. Nonetheless, they have more specific connotations: indeed, the former usually refers to workforce planning, whereas the latter to talent research.

As for Human Resources Analytics, even if it is a pretty novel topic in the scientific literature and there are several definitions of it, the analyses themselves are not new, as they consist of behavioural modelling, predictive modelling, impact analysis, cost-benefit analysis and ROI.

According to Academy to Innovate HR, the best-known scientific definition of the topic is the one given by Heuvel and Bondarouk (2017): HR Analytics is the systematic identification and quantification of the people drivers of business outcomes.

Previously, another meaning was provided by Lawler and his colleagues (2004) who stated that HR Analytics represents statistical techniques and experimental approaches that can be used to show the impact of HR activities. They were

¹³ OrgVue is the leading fast-growth SaaS company with award-winning software product, that provides workforce analysis and modeling software solution.

focused on underlying the difference from HR metrics, which are described as measures of key human resources management outcomes: they are useful to assess the effectiveness of existing processes, but HR Analytics aims at identifying patterns in order to predict alternative possibilities to take strategic decisions.

Similarly, Bassi (2012) defines HR Analytics as an evidence-based approach for making better decisions on the people side of the business: it consists of an array of tools and technologies, ranging from simple reporting of HR metrics all the way up to predictive modelling.

2.1.1. HR Analytics tools

Nowadays, Human Resources analytics tools play a key role in understanding a wide range of activities related to the human capital management of a company: from the selection process, to performance monitoring, passing through hiring, payrolling and promotions. Currently there are many well-known companies like IBM, Workday, Oracle, SAP, Talent Analytics, Saba and Cornerstone who are specialised in the delivery of effective HR analytics software. These tools help Human Resources Management to extract relevant information from the large amount of data that circulates, on a daily basis, in their software.

Only if it is transformed into information, data acquires value, and it requires a complex procedure, given the volume, the variety and the interrelations that characterise HR data.

For the HRM it is crucial firstly to determine specific key performance indicators and secondly to monitor them, in order to identify trends inside the company. In this sense, HR dashboards are tools that turn to be very helpful, on the grounds that they allow Human Resources managers to graphically visualise, in real time, which direction their business is taking. Through charts and other graphic representations, performance can be monitored and areas for improvement can be identified. HR dashboards are usually created using tools such as: R, Python, Excel, Power BI, Tableau, Visier, Qlik, SPSS, CPLEX Optimiser.

In addition to dashboards and scorecards, typical data-based activities conducted by HR functions include benchmarking and data mining.

On a upper level there are behavioural modelling and predictive modelling, which differ in the fact that the former one has a backward-looking approach, taking available data, and it identifies the causal factors that led to the outcomes that occurred, whereas the latter one has a forward-looking approach, as it predicts future outcomes. Moreover, behavioural modelling is a necessary step to build predictive modelling.

Going upper there are impact analysis, cost-benefit analysis and ROI analysis, which represent the ultimate objectives of the two aforementioned modelling (Levenson, 2005).

2.2. APPLICATIONS OF PEOPLE ANALYTICS

Data-driven HR practices are becoming ordinary among business leaders, but many of them still do not have a clear understanding of the capabilities that the application of such tools can have. Human Resources Analytics does not only refer to reporting backward-looking HR data, such as those regarding percentages of absenteeism in a company, but rather it goes beyond mere statistical facts. As stated by Boudreau and Ramstad (2004), HR Analytics does not only include statistics and research design, but it also regards the identification and the expression of significant questions, the acquisition of suitable data from both within and outside the Human Resources department and their correct use. Moreover, HR Analytics is about setting proper standards in order to make sure that a certain degree of rigor and significance are respected, as well as the crucial improvement of analytical abilities and competencies of Human Resources professionals.

Thus, even though data systems represent the basis for doing complex analysis, People Analytics tries to offer predictive solutions, starting from the accurate

examination of existing evidence, therefore eliminating “gut feelings” from decisions: they can help identify which potential measures should be adopted in order to reach a certain organisational objective, meanwhile assessing the future impact on another variable.

If more than fifteen years ago, Lawler, Levenson and Boudreau (2004) identified in the lack of analytic models able to show the relationship between HR practices, as well as the effectiveness of the organisation, and in the absence of the right metrics and of data-based decision-making capability needed to influence business strategy, the main cause of Human Resources inability of being a strategic partner, despite its importance within the organisation, nowadays, thanks to People Analytics, the HR function has a much greater likelihood of getting that role.

According to the Principal Associate at the Institute for Employment Studies¹⁴, Peter Reilly (2016), by taking into account the various interrelations in which different areas of a firm are engaged, such as problems regarding people and sales targets, organisational culture and performance, or locations and the best workforce conditions, predictive analytics can be used by Human Resources Management to solve critical issues affecting the business. For instance, if the

¹⁴ The Institute for Employment Studies (IES) is a leading independent centre for research and evidence-based consultancy, that provides insights on employment and human resource management topics to help improve policy and practice.

application of People Analytics in a company leads to the identification of a positive causal relationship between training expenditure and profitability, there is a great likelihood the enterprise should better create a strategy based on further training the workforce.

The continuous evolution of HRM, also resulting from cutting-edge technology, has led to the discipline having a more strategic role: by interacting with other departments within the organisation, HR divisions are able to create synergies across the company, thanks to the alignment of their objectives with the ones of the enterprise. This is the meaning of Strategic Human Resource Management. For instance, collecting data coming from the Human Resources department and the Finance division, respectively regarding employee engagement and financial performance, thanks to People Analytics, Human Resources professionals are enabled to measure the impact that the former has on the latter: simple data is processed and transformed into relevant information, which in turn will lead to noteworthy insights, useful to know the impact of HR policies and interventions on the overall business strategy.

Moreover, thanks to People Analytics, now HRM is able to combine multiple data coming from various streams: data can originate from both internal and external sources, including demographic employee data, recruitment data, absenteeism data, performance data, training data, payroll data, engagement and satisfaction

data, career progression data, social network data, population data, labour market data and others.

HR professionals can use such information to make better decisions, make appropriate interventions and test their effectiveness, understand the real business impact of people, improve the efficiency and the efficacy of HR processes, enhance the wellbeing at work, therefore turning their initial operational function into a tactical or even strategic one. HR data are precious because they can have a strong impact on the achievement of the strategic goals of an organisation. All state-of-the-art technologies such as, sensors, analytics, machine learning and artificial intelligence, allows data-driven people management. For instance, wearables, such as FitBit, Google Glass or Apple Watches, can allow employers to collect more data on their workers. Nevertheless, technology is supposed to be able to help measure, predict and manage employees' performance also in jobs concerning more creative and complex roles, than those in the manufacturing industry.

A data-driven approach enhances the quality of decisions made, as they will be based on data analysis, prediction and experimental research and no longer on anecdotal experience.

According to a study published in 2018 by Harvard Business Review, involving several companies belonging to the Fortune 500 group, enterprises were using People Analytics to drive their transformational efforts, mainly in: core functional

or process transformation initiatives, to evaluate activities and discover embedded expertise; in bottom-up cultural transformation initiatives, through feedback loops and storytelling, to explain how things are done; top-down strategic transformation, to measure resources, boundaries, capacity, time use, networks, skill sets, performance, and find mindsets that can help discover where modifications are possible and can provide an evaluation of the consequences of a certain action related to them.

Generally, every time that HR data are used to make better decisions, enhance the happiness of employees and improve organisational processes, they add value to the enterprise.

On the whole, HR Analytics can be used by HRM in its wide range of functions, as a help to face challenges related to recruitment, retention, monitoring, predicting, better decision-making, such as the identification of new recruiting channels and of suitable candidates, the improvement of review reports, the recognition of workforce requirements, the identification of skill gaps, the enhancement of training activities, the classification of performance of workers, the betterment of productivity, the measurement of engagement and motivation of employees, the classification of employer branding activities in terms of effectiveness, the identification of areas of improvement, the recognition both of star performers and of who is most likely to leave the enterprise, due to disengagement, testing the effectiveness of reward practices, tracking of turnover

and the reduction of hiring costs. All the techniques applied to People Analytics are a reliable tool to look at and analyse big amounts of data in order to find incongruences, models and redundant expenses.

2.2.1. Talent acquisition processes

Big Data, analytics technologies and Artificial Intelligence are bringing about numerous changes in the recruitment and in the selection processes: particularly they are helping organisations discover high-potential talent in a more precise manner. The role of such innovations is crucial when it comes to an era characterised by an increasing globalisation of the job market and a growing competition among companies: according to a study conducted by SHRM in 2019, 83% of respondents found difficulties in recruiting suitable candidates in the previous year. As shown by the following chart, more than one-third of the interviewed companies had troubles in finding candidates with the right technical skill set, while 30% strived for finding adequate soft skills in their applicants: this is a symptom of an accelerating shortage of skilful workforce. Moreover, 33% of HR professionals declared that there is lack of interest in their organisation by the applicant, which is probably due to a low impact employer branding.

Graph 2.2. Top reasons organisations are struggling to hire suitable candidates



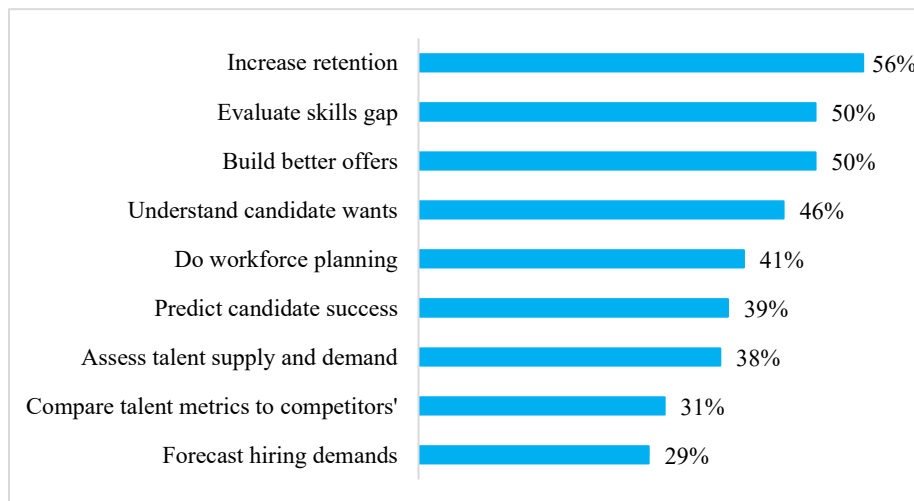
Source: Society for Human Resource Management¹⁵ (2019)

New tools, such as online platforms like LinkedIn and Glassdoor can provide companies with access to valuable information on applicants. Moreover, they can lead to new talent acquisition techniques, based on Big Data, that allow to solve many issues related to traditional hiring, like difficulties in assessing soft skills, the presence of bias due to interviewers, the duration of the entire process, complications in understanding candidate weaknesses and in finding the right questions to answer during an interview.

¹⁵ The Society for Human Resource Management (SHRM) is the foremost expert, convener and thought leader on issues impacting today's evolving workplaces.

Currently, a great amount of information referring to supply and demand in the labour market is stored electronically as curriculum vitae in the form of text databases, but it goes without saying that only scanning resumes of candidates, which present subjective heterogeneous information, for keywords, is an obsolete technique that cannot provide sufficient success metrics: Big Data-based tools enable companies to capture a greater volume of data, analyse them rapidly and, especially, to predict hiring outcomes, not just track them. As shown by graph 2.3., when it comes to recruitment, data are used not only to assess talent supply and demand, but also to understand what the candidate's needs and expectations are, to build better offers and evaluate the skills gap.

Graph 2.3. Top uses for data in talent acquisition



Source: LinkedIn (2018).

People Analytics can be used by Human Resources professionals to identify potential pools of candidates, by automatically acquiring information about applicants from different sources: it enables recruiters to find a broader range of candidates that they would not find using traditional searching methods. In particular, portals and recruitment sites provide semi-structured data, whereas from social networks, personal web pages, collaborative academic platforms and specialised forums organisations can extract unstructured data. A curious example is provided by Walmart, that in order to find data analysts, set a challenge on a crowdsourced analytics competition platform where people show their skills solving analytical problems submitted by companies. The senior recruiter for Walmart's Technology division declared that various people, that would not have been considered on the basis of their review, have been hired thanks to this peculiar method (Marr, 2018).

The introduction of multiple and heterogeneous data sources has to be enabled by a complex architecture, possibly developed through Cloud Computing, including elaborate models of analysis. In this process, the difficulty lies in choosing and implementing the right algorithms for data mining and text mining, in order to build a platform able to process and analyse parallel data and extract timely information, therefore to compare and classify documents according to the importance associated to specific metrics identified by the HR team.

By using algorithms, such as decision trees, association rules or clustering, data analysis applied to recruitment can remove unconscious bias due to complexities of nature and human behaviour, isolating objective traits and identifying candidates with appropriate backgrounds. This is crucial when it comes to companies that try to recruit candidates from unusual backgrounds, different from what they are used to: a broader set of indicators on capacities and performance can help firms to find the best match. Therefore, in addition to the reduction of bias, analytics tools can promote diversity inside the corporate environment, finding workers with adequate skills, but with atypical backgrounds and work experiences. With regard to the use of algorithms to find appropriate workers, an example is provided by IBM, which using a tool called “Blue Matching” is able to match the skills of individuals with internal job opportunities and development programs. The system not only advises an employee when internal opportunities, corresponding to their skills and preferences, arise, but it is also able to spot opportunities that individuals may have not noticed or think they had not the right skill set to perform. In a few words, the algorithm is able to make suggestions about parallel career paths that require the same skills but concerns another part of the business. Up to 2019, 1,500 IBM employees shifted to new jobs internally and

the company estimates that “Blue Matching”, together with other People Analytics tools, led to a saving of more than \$100 million in 2018¹⁶.

Statistical models provide a holistic evaluation of the candidate since they take into account semantic analytics of structured and unstructured data and they can extract crucial information related to metrics such as job titles, skills, experiences, certifications, companies and industries. Then, they compare them to job descriptions provided by companies, on the grounds of features like past hiring data, preferences on the successful candidate, salary levels and other organisational metrics. From this comparison a match arises and candidates are classified according to the scores they are given. For instance, with regard to the suitability of tests which applicants have to undergo, in order to recognise which candidates can make a higher contribution to performance once they are hired, by taking into account other functions belonging to HRM, such as performance monitoring, it is possible to determine the main drivers of performance in an organisation and, therefore, base future hiring decisions on the assessment of abilities positively related to the identified KPIs. Something similar to this has been done by the British company Rentokil Initial, that developed a project to increase efficiency in the recruitment process, in which it analysed the behaviours

¹⁶ <https://www.shrm.org/resourcesandtools/hr-topics/technology/pages/ibm-transforms-human-resources-ai.aspx>, URL visited on 11/05/2020.

of its highest performing sales professionals, in order to identify their characteristic attributes. Then, those data were used to develop six selection tests, that successfully predicted such qualities, to select future candidates. By doing so, the firm saw a rise in sales of 40% and a return on investment in the project of more than 300% (Levenson and Pillans, 2017).

Thanks to machine learning, such assessments can be deployed automatically by machines, which are now able to make smarter recruiting decisions for you, by continuously learning from feedbacks of recruiters and key influencers, as well as systematically improving future candidate search and match, not to mention the capability of substituting Human Resources employees in repetitive tasks, thus leading to a reduction in time. Similarly, predictive analytics can be used to measure the likelihood of fitting well a certain role in an organisation based on the candidates' responses to interview questions. Potential candidates can be also evaluated against a list of predictors from the current employee data to know if they would accept the offer.

The acceleration of research times and the increasing accuracy in the selection process allow the development of a talent intelligence strategy, which favours the reduction of the mismatch between job demand and offer and, above all, a better positioning of new hiring within the company, based on compliance between roles and identified skills: this represents a fundamental step to increase a company's competitiveness. From this point of view, Google was a pioneer: by deploying

People Analytics in the assessment process, the company was able to shorten the duration of the entire procedure. It passed from 15-25 interviews to just 4, as its analysis showed to be the optimal amount, reducing the median time to hire from 90-180 days to 47 and cutting the amount of time Google employees spent on hiring by 75%. In addition to it, the US giant makes use of an Applicant Tracking System that compares candidates' curriculums with the curriculums of existing employees: when overlaps are found, such as attending the same university, the system puts in contact with the Google worker to gather more information about the applicant (Levenson and Pillans, 2017).

Furthermore, HR Analytics can allow companies to re-engage a targeted group of candidates and discover if they are interested in applying for another position that became available in the same organisation. Tools, such as an Applicant Tracking System, can also play an important role in helping firms to stay up to date on either employees or candidates' progressions, like the assumption of new roles, recent work experiences or fresh competencies that they might have acquired since the last time they have been in contact with the company or since they were hired.

All in all, the application of People Analytics in the recruitment process brings about several advantages, amongst which there are the easiness in accessing relevant information to take hiring decisions, the minimisation of time spent in the selection process, the rise in efficiency since HR professionals can focus their

attention on the best recruitment channels, once they have recognised the ones with the highest return on investment, and therefore reduce costs. Moreover, the implementation of such systems provides a competitive advantage as they can identify and assess talent, finding the best match between a candidate and a required skill set, taking into consideration qualifications, experiences, culture and personality attributes, eliminating the bias that often characterises the selection process and prevent organisation from building up a heterogeneous environment. Predictive analytics might also represent a valid ally to acquire information on the future job market, starting from the analysis of the historical demand, of the market growth and of the current situation. According to such information, companies may better develop future plans regarding their workforce and the overall allocation of budget, enhancing their capacity to be flexible and quickly adapt to unexpected changes in organisational needs.

There are consequences also in economic, social and environmental terms, respectively: by using a Cloud Computing architecture the organisation of activities related to human resources recruitment can be easier; there is a facilitation regarding the put in contact between HRM and candidates; the environmental impact is minimised as with Cloud Computing, enterprises will no longer invest in their own hardware, cutting down on acquisition costs and energy consumption.

2.2.2. Motivation and engagement

Typically, a sharp productivity in organisations is positively associated to a highly engaged and motivated workforce. According to the Society for Human Resources Management, this relationship is demonstrated by the research, that indicates that a 5% increase in employee engagement is linked to a 3% growth in revenues in the following year (SHRM, 2018).

On the contrary, when employees present a scarce motivation and are not engaged enough in what they are doing, there is a great likelihood that companies register high rates of absenteeism, which often turn into an elevated turnover rate. Moreover, when an employee decides to leave the company, it brings about several negative financial consequences for the company, as a new recruitment process has to be opened and, in the meantime, there are no profits from the production point of view.

Since the impact on the bottom line produced by the employees' performance can be relevant, understanding the factors that lead to such events plays a crucial role in assessing the health of corporate environments, especially when it comes to the identification of possible actions to take to solve problems related to absenteeism and turnover.

Organisations have to catch the signals and predict the future moves. People Analytics can be a valid ally to develop behavioural predictive models, both for

absenteeism and for staff turnover. Enterprises should constantly monitor absenteeism, also comparing their situation with the rest of the market.

Companies can then conduct sentiment analysis aimed at testing the attitude of employees, collecting data from feedbacks and annual engagement and well-being surveys, and connecting them to public data, like those coming from posts on internal social media platforms. For instance, firms can also study digital traces coming from the language used by employees in internal email communications, to measure the influence that organisational culture has on their thoughts and behaviour at work. Bank of America is a witness of such innovative methods, since it is currently using electronic badges, developed by the company Humanyze, that are able to identify social dynamics at work, such as conversations, including the length of the speech and the tone of voice. By doing this, the bank discovered that its more productive workers were those who take their breaks together, in which they let off steam and shared tips about dealing with difficult customers. Consequently, the organisation implemented group break policies and saw a growth in performance of 23%, together with a drop in stress levels of 19%¹⁷.

¹⁷ <https://www.ft.com/content/d56004b0-9581-11e3-9fd6-00144feab7de?mhq5j=e3>, URL visited on 11/05/2020.

Indeed, factors like well-being, satisfaction, work engagement, organisational commitment are decisive when it comes to absenteeism and can signal potential causes of the phenomenon. After collecting both absenteeism and relevant survey data, companies have to identify causal relationships, for instance, someone might find that highly variable and unequal compensation levels drive high rates of attrition, that in turn leads to a higher dissatisfaction in the workplace and therefore to a higher probability of absenteeism.

Once companies have identified the cause that lies behind absenteeism, they are able to consider resolute actions to lower it. They should always bear in mind that different causes require different solutions, so conflicts among employees or between an employee and a superior should be treated in a different way with respect to work stress. Furthermore, companies can implement solutions to improve the involvement of staff within the organisation: there is a wide range of solutions concerning it, from employee engagement software to continuous education and training, employee recognition, career development. Tracking employees' absence was the reason why the German energy company E.ON decided to adopt People Analytics. Since absenteeism had risen above benchmark, the firm built up a team in order to identify the causes of this phenomenon: it formulated 55 hypotheses, tested 21 and validated 11 of them. One of the findings was that selling back untaken holidays did not increase absenteeism, whereas

taking only one long holiday a year increased the likelihood of sickness. This led to managers changing holiday approval policies (Van Vulpen, 2018).

Moreover, firms can be able to proactively prevent absenteeism, as well as turnover, by identifying which workers have a higher probability of leaving the company. It can be done by applying machine learning to a set of benchmark data from employees who previously left the company. By matching the characteristics and the responses to surveys that current employees give with those of past workers, organisations can classify them on a risk score list. Then, to try to increase the retention rate, motivation and engagement inside the company, they can build retention plans on the basis of what they have previously found. One of the first examples of proactive prevention in terms of turnover was given by Credit Suisse, that calculating which employees were likely to quit and why, decided to offer them new career roles. The Global Head of Talent Acquisition and Development of the company stated that this method left employees astonished with respect to the fact that the organisation is always trying to find something interesting for them, even if they did not care about the proposal. Credit Suisse also trained managers to retain the best performing workers who showed a high risk of leaving the company, leading to a saving of \$70,000,000 per year (Van Vulpen, 2018).

The HRM can also increase retention by hiring candidates who present core values and believes that align most with those of current employees, but this represents a risk in terms of little diversity inside the company.

2.2.3. Performance management

Reviewing workforce performance annually, as many enterprises do, does not allow immediate action by the HR department with regard to risky situations. Continuous monitoring and regular reporting are fundamental for the Human Resources department to control organisational proceeding, by tracking key workforce metrics.

Through performance analytics, companies have real-time information that allows them to be able to recognise new emerging patterns and to discover hindering issues affecting the performance of workers, both on an individual and on a team basis. In particular, this represents a way to track key problem areas by screening all key execution pointers, and consequently to take timely decisions and drive improvements.

By convincing the workforce to wear devices embedded in their clothes or gadgets such as FitBit, companies might be able to monitor employees' productivity and performance, as well as the health and safety of their workers. For example, in Ohio, the company North Star BlueScope Steel implemented a

safety program that includes the use of cognitive computing power and sensors in wrist bands and helmets, able to understand if a worker is suffering from exertion of heat stress, by gathering data about his moving, heart rate and temperature, and to advise the employee to take a break or a supervisor to control the situation (Marr, 2018).

Such devices are able to send signals and produce a great amount of data, that through Big Data analysis can also be used to identify potential mistakes and defects in work, which turns to be very useful in tasks, such as retail ones, where there is exigency to examine daily execution. For instance the company UPS has equipped its drivers with handheld computers that helps their employees to make effective decisions in order to save time in their deliveries, by suggesting the most efficient route on the basis of the packages that need to be delivered. Also, each truck contains more than 200 sensors that are able to understand things like if the driver is wearing a seatbelt. By monitoring their employees and providing feedback and training if needed, UPS has been able to reduce by 8.5 million the gallons of fuel and by 85 million the number of miles per year. Moreover, the company saw a rise of 20% in the number of parcels that are delivered: from 100 stops, now its drivers are able to make 120 of them (Marr, 2018).

Indeed, the role of HR Analytics is not limited to mere reporting, but it goes further: on the grounds of historical and real-time data, it can help companies to predict employees' performance. Therefore, the type of analysis is not only

retrospective, but also forward-looking. Moreover, thanks to the application of the right algorithms, HR professionals can gain objective insights into employees' work preferences and which factors most influence their performance. For instance, HR can firstly obtain relevant information about the real effectiveness of engagement activities on workforce performance, secondly direct investments towards the most successful initiatives and thirdly define new measurable metrics that show interdependencies between engagement and performance. This kind of study has been developed by the shoe company Clarks, that used People Analytics to analyse the relationship between engagement and financial performance: statisticians took into consideration 450 business performance data points and discovered that every 1% improvement in engagement, lead to an improvement of 0.4% in business performance. They also analysed the characteristics of the 100 best performing stores and found that two crucial roles were determined by the size of the team and the frequency with which store managers where changed (Van Dijk, 2018).

Monitoring performance can be furthermore useful to assess the return on investment with regard to training activities, through the comparison between past and new data.

Another benefit deriving from the possibility to measure employee performance through analytics is represented by the increased easiness of succession planning, with regard to promotions, transfers and firings. Consequently, forecasts about

workforce requirements can be made, as well as working in order to fill the open positions.

In this sense, HR dashboards are useful tools to analyse performance and identify areas for improvement in an organisation, as they enable HR professional to have a dynamic overview of the most significant HR metrics in one place: especially they allow to keep workforce performance aligned with organisational objectives. HR dashboards, together with HR reports, play a key role in managing Human Resources, because they provide insights that represents the basis to make informed decisions. The new HR dashboards are more advanced, since they can enable HR department to predict the future through the application of machine learning algorithms. This way, from insights related to operational activities, it enhances the role of HRM up to a strategic level.

Starting from the analysis of qualitative data and data coming from internal social media, People Analytics can be helpful to identify the major contributors to performance, such as hidden networks within the organisation, and, therefore, to take actions to strengthen connections among staff members and support collaboration among teams, for instance creating inner communities.

Case studies provided evidence on the relationship between HR analytics and performance: for instance, according to a research developed by Aral et al. in 2012, People Analytics is positively associated with improved performance because it allows HR department to monitor workforce behaviour and to align the

incentives of managers and employees. From the study, it appeared that some resources have to be combined with HR analytics, such as Information and Communication Technologies and performance-related pay, in order to motivate and support the staff.

Organisations already have considerable amounts of data on employees that can be used to build performance management systems, in order to link employee recompense to their individual performance. In particular, through HR Analytics it is possible to find the causal relationship that exists between compensation and individual performance, map and connect organisational performance to single employees. Therefore, HR professionals can manage the rewarding system in order to enhance the performance.

This is another demonstration of the fact that, undoubtedly, HR Analytics represents a powerful data-drive tool for companies when it comes to both the anticipation of performance outcomes and the development of proactive strategies for workforce management.

2.2.4. Alignment of HR strategy with business goals

One of the main benefits brought about HR Analytics is the elimination of “gut feelings” when it comes to decision-making. Indeed, decisions have become more and more accurate and precise, also thanks to the presence of figures such as data

scientists, statistician and analysts inside Human Resources teams, who are able to create defined analytics to increase the organisation's performance. Without the presence of a proper HR analytics tool, data circulating in the HR department would be useless: the relevance of People Analytics lies in the fact that it is able to interpret those data and transform them into statistics, in order to identify patterns and give suggestions to HR about what actions should be taken.

According to a research carried out by McAfee and Brynjolfsson, published by the Harvard Business Review in 2012, companies that use Big Data to inform their planning and decision-making functions perform better than those which do not: they were on average 5% more productive than their competitors in the same sector.

HR Analytics provides transparency with regard to how employees are really working. Thus, it acquires a greater value when collecting data before and after the implementation of certain actions, that is People Analytics plays a key role in evaluating the effectiveness of new policies inside the organisation. For instance, if the organisational objective is to innovate, the company has to develop and manage its human capital accordingly. HR professionals therefore play an increasingly important role in helping the organisation build its capacity to deal with change, which in turn is critical for improving its performance.

Nowadays, HR metrics can deliver business-critical insights and can be used to improve the leadership's decision-making in people-related matters, increase the

efficiency and the effectiveness of HR processes and operations and improve the overall wellbeing of the employees within the organisation.

HR data can be a supplement both to ROI and cost-benefit analysis in order to take decisions. Indeed, on the one hand ROI, by collapsing different costs and benefits into one number, throws out information that may be critical for decision-making. It is important to contextualise numbers and to take into account underlying assumptions, otherwise there is the risk to fall into incorrect decisions. Moreover, given the numerous possible outcomes of an organisational initiative, especially with regard to people-related procedures, ROI can be difficult to calculate: there can be consequences on teamwork, innovation, cycle time, customer satisfaction, organisational learning and knowledge management. On the other hand, cost-benefit analysis, though including a higher level of details, by focusing on readily-quantifiable monetary values, regarding each potential benefit and costs, can likely ignore benefits deriving from process improvements, such as innovation, customer satisfaction, knowledge management and organisational learning (Levenson, 2005).

Through the application of People Analytics, from Talent Acquisition Process, to Retention and Performance Management, HR teams can build behavioural models to find the causal links between individual motivation, group dynamics, and the incentives and behaviours that produce organisational outcomes.

HR Analytics can help managers create a productive work culture, starting from a proactive HR strategy. People Analytics projects that aim at enhancing the organisation's performance require a good understanding of the connections between business performance and individual employee performance. Moreover, the company has to be considered as a system in which the drivers of performance are clear, as well as the channels that can positively impact it. Without an interdepartmental collaboration, the likelihood of a growth in the company's performance is very low. If there is fragmentation inside the organisational reality, Human Resources analytic experts will remain focused on mainly functionally oriented HR topics, such as matters related to the verification of skills enhancement or actions aimed at verifying the effectiveness of recruiting decisions. Even if they are able to find meaningful insights regarding the drivers of workers' behaviour, such information is likely to fail in correctly identifying a cause-effect relationship that also takes into account important process improvements. The same issue may take place when it comes to other departments, such as marketing, where analytic experts can be very good at developing the right analytics to handle organisation concerns about product lines, but they cannot go further and understand either employee-related problems or overall cultural questions. Cooperation at a departmental level, as well as working in the same direction, is crucial to understand how specific issues related to Human Resources drive organisational outcomes like productivity growth. Once

identified this and set the main business objectives that are to be achieved, companies have to understand which HR elements to leverage, in order to enhance performance.

2.3. NEW TRENDS IN HRM

In addition to the previously described data-related solutions, other technological trends such as gamification and social recruitment are affecting HR, in promoting employee engagement, widening diversification and enhancing the organisational well-being.

With regard to the recruitment process, companies are promoting themselves as “places for talents” by using marketing techniques in order to make the enterprise more appealing: not only do they involve users on social media, but they also take care of their online reputation and push people to visit the corporate website. In this way users are more encouraged to apply to become part of the company. Already in 2015, 84% of HR professionals had understood the fundamental role of social media in recruitment, especially through LinkedIn, Facebook, Instagram and specific websites (SHRM, 2016). According to a research of Adecco (2019), the use of social networks by companies also pursues different purposes: from verifying the candidate’s curriculum vitae, as stated by the 72% of the respondents, to employer branding, in addition to a more in-depth investigation of

the profile and published content by the candidate, that raised from 26% in 2015 to 48.1% in 2019. Digital reputation therefore becomes crucial in the initial skimming of competitors with an open profile, so much that 44.1% of the recruiters interviewed admitted having excluded candidates because of an image on the web deemed non-compliant.

Moreover, thanks to specific applications, such as Hi-Q Labs, candidate's LinkedIn profile can be connected with his Twitter followers and used this type of analysis to understand if the person is willing to change his job. The algorithms used by Hi-Q Lab and other HR software also evaluate the way people communicate: they judge their writing skills to see if they are capable of performing at a high level.

Another important trend in the field of HR is represented by chatbots, which are an application of artificial intelligence to provide answers to employee questions, related to payments, holidays, social benefits and legal rights. In this way, repetitive HR tasks are automated and Human Resources professionals can dedicate themselves to more complex issues and top-priority matters.

An additional tool that is used to attract, select and also train the workforce corresponds to gamification. For instance, Deloitte used gamification techniques to strengthen their leadership training programme. The average time taken to complete the training programme dropped by 50%, and daily users of the website

increased by 46.6% (Azpiral, 2017). Compared to serious or business games, gamification can reduce costs and development times.

As for performance monitoring, there is a new type of analysis, called “relational analytics”, which aims at understanding the relationships of workers with other employees. In this way, HR professionals can estimate the likelihood that an employee, a team or an entire organisation will achieve a performance goal.

A further trend regards an operational task carried out by the HR department: payroll systems with blockchain technology. Nevertheless, experts and researchers are divided between those who believe that this technology is emerging, and those who argue that the use of these systems is only a possibility for now.

2.4. THE CANDIDATE RELATIONSHIP MANAGEMENT

People Analytics can also help companies avoid a poor candidate experience: the wrong management of applicants, that have not been selected, can lead to a damage to the organisation’s reputation and to the employer brand, influencing also the likelihood of becoming a client in the future. According to a study carried out by CareerBuilder in 2015, on more than 5,000 American employees, 69% of respondents said that they were less prone to buy from a certain company after an uncomfortable and bad interview experience. In 2019, a Deloitte survey identified

in the need to improve the employee experience, one of the biggest challenges firms had to face: 28% of respondents rated it urgent, while 84% said it was a crucial issue. Indeed, less than half respondents thought that their employees were satisfied with their job design. With regard to the satisfaction according to daily work practices, work-related tools and technology, and decision-making autonomy, percentages decrease: respectively 42%, 38% and 38%.

The concept of employee experience originated as a parallel to the customer experience: just like consumers, candidates expect companies to relate to them on the most favourable terms. It refers to putting emphasis on the workforce engagement, thus providing employees with meaningful careers and a sense of purpose, not just jobs or roles: as long as it is possible, work should be rewarding and fun, colleagues should be friends, and work-life balance should be replaced by work-life integration. In order to differentiate themselves and to attract and retain ideal candidates, recruiting and HR methods must become similar to marketing processes, creating relevant and captivating experiences.

There is a parallelism in the way in which human resources and marketing approach respectively with employees and consumers. For instance, when it comes to marketing, the term customer experience refers to the creation of value through the care and attention for the customer journey, both online and in-store. On the one hand, analytics are able to provide a quick understanding of the customer, that allows companies to make agile and rapid actions. On the other

hand, clients expect firms to offer a purchase path on digital platforms and, above all, to provide them with a social and emotional high-valuable experience. This path is promoted not only through word of mouth, but also through online reviews that describe the experiences with the brand and that allow companies to monitor their reputation.

In parallel, the candidate experience, therefore, was born in response to certain business needs in order to avoid that rejected candidates remain dissatisfied, and to ensure that they positively remember the selection experience, also influencing their decision to propose themselves for another position in the same company or to “become” potential customers of the same in the future. Indeed, if the selection process is all that the aspiring candidate will bring with him once finished, employers have every interest in making it as positive as possible and consistent with the values that the corporate brand communicates. With so many talents who are now looking for job occupations, the talent shoppers who browse the different company job stores to see their offers are increasing. In the era of online experience, HR professionals should interpret talent acquisition as something holistic: in fact, the candidate experience is a kind of product, a final result that the candidate will bring with him at the end of the experience and that should, at least, repay the time and effort he has dedicated to the company.

Nonetheless, there are also significant differences between employees and customers that should not be forgotten: the former ones have a long-lasting

relationship with their employers, whereas the latter ones can stop buying a firm's products anytime. Moreover, the employee experience includes social relationships with colleagues that go beyond the individual customer's needs.

By integrating HR technologies with AI, companies can also improve the experience of their employees. Through the structured recruiting process based on Big Data, they manage to monitor more in depth the initial stages of the process, from the first contact of the candidate to the potential hiring, thus avoiding losing the most talented candidates. The constant monitoring and the possibility of corrective actions during the process allow to prevent possible exit of talents from the system: with an approach supported by real time data, it is therefore possible to understand what the factors of the selection process that increase or reduce the probability that the candidate renounces his application are, and this represents a competitive advantage for the company.

Artificial Intelligence is able to improve the entire life cycle of the employee: AI technology can help companies treat their candidates and employees as if they were loyal customers. It improves the employee experience, increases involvement and enhances corporate culture. The pillars are the online channels, content and transparency; the latter define what is called candidate relationship management (CRM). Transparency is based on the desire to make manifest what are the values that distinguish the corporate culture, through clear communication. Moreover, applying Artificial Intelligence to machine learning, companies can

reduce the amount of human energy needed to perform a job quickly and effectively and improve response time and access to information. Another application of AI can be on Applicants Tracking Systems, which make easier the process of application analysis and can be used to reduce prejudice too.

Employee experience is a bottom-up concept, in which processes, places, and workflow are designed around employees' pre-existing tendencies: in order for companies to implement the candidate experience process, attention must be paid to people and their experience, understood as a set of sensations, emotions and reactions.

In the end, a step forward the employee experience can be found in the "human experience" at work: while the employee experience journey may start with a focus on the workplace, perks, and rewards, it must focus on the more human elements of the work itself to truly create meaning. A true human experience embeds meaning into work and enables every employee to contribute in the most positive, supportive, and personal way, not only in the organisation, but also in society.

2.5. BENEFITS

Overall, the advantages brought about by the application of HR Analytics are:

- combine multiple data coming from various streams

- help organisations discover high-potential talent in a more precise manner
- easiness in accessing relevant information to take hiring decisions
- remove unconscious bias
- promote diversity inside the corporate environment
- reduction of the mismatch between job demand and offer
- better positioning of new hiring within the company
- re-engage a targeted group of candidates
- minimisation of time spent in the selection process
- rise in efficiency since HR professionals can focus their attention on the best recruitment channels
- develop behavioural predictive models, both for absenteeism and for staff turnover, able to proactively prevent these phenomena
- build effective retention plans
- enhance the happiness of employees and improve organisational processes
- real-time information to recognise new emerging patterns and to discover hindering issues affecting the performance of workers, both on an individual and team basis.
- recognise potential errors and imperfections in work
- identify skill gaps
- develop learning and training activities

- create a high-performing culture and motivate top-performing employees.
- gain objective insights into employees' work preferences and which factors most influence their performance.
- assess the return on investment with regard to training activities
- increased easiness of succession planning
- manage the rewarding system in order to enhance the performance.
- anticipation of performance outcomes and the development of proactive strategies for workforce management
- HR more strategic role
- eliminate “gut feelings” from decisions
- increase the efficiency and the effectiveness of HR processes and operations
- improve the overall wellbeing of the employees within the organisation.
- HR teams can build behavioural models to find the causal links between individual motivation, group dynamics, and the incentives and behaviours that produce organisational outcomes.
- avoid a poor candidate experience
- improve the entire life cycle of the employee

2.6. RISKS

On the other hand, the application of HR Analytics is not exempt from cons that might limit the speed of adoption. There are some risks linked to technical, ethical and legal aspects that need to be taken into consideration when adopting Big Data in people-related matters.

Starting from technical issues, one problem is related to analytical capabilities, especially to the wrong interpretation by untrained recruiters who over-rely on algorithms. This is why HR Analytics should be used together with already existing methodologies. When employers look at HR analytics, they may get lost in the small details and focus on the wrong things. Indeed, before starting collecting data, HR professionals should have a hypothesis and understand the reason why they need those data. They ought to have a tangible plan for which data is being sought, think of what changes will be made based on the findings and determine how to measure them. An example of hypothesis may be: “find correlations between HR Analytics metrics and business outcome of the financial department”. Moreover, they need to determine what metrics they want to focus on and start to work on it, following a reverse-engineer process.

Apart from analytical capabilities, Human Resources teams need to have sufficient and reliable data. If the quality of data is not appropriate, there is a great likelihood that companies are not able to conduct significant People Analytics

projects: in particular, when it comes to the most relevant categories, data are often mediocre. Moreover, with regard to small enterprises, they could probably lack of high-quality HR data and analytical capabilities to adapt techniques designed for Big Data to areas where the volume of data is quite minute.

Another category of problems concerns developing and programming the right algorithms. For instance, sometimes the recruitment selection algorithm can give too importance to factors that are irrelevant and a low weight to crucial elements. This risk is more likely to occur when the system utilises “kill” questions that immediately exclude candidates on the basis of a single data item. Similarly, algorithm-based systems may fail in capturing the subtle connections between people which often command business behaviour, by being over-rational. Furthermore, systems may be manipulated by professionals in order to suit their needs, especially if they do not provide the expected results. Users might also enter false data in order to lead the system to certain outcomes.

An additional matter is related to the system design of machine learning. It is a double-edged sword: if on the one hand an advantage of its application is given by the elimination of gut feelings and the reduction of bias due to human behaviour, on the other hand there is the risk that, because of an improper programming, it might be responsible for the creation of unconscious bias. Indeed, building the algorithm in order to hire the best candidates on the basis of similarities with workers already present in the company can lead to discrimination.

With regard to gender discrimination, the experiment of the Toronto Symphony Orchestra, that had a staff composed mainly of men until the blind test was introduced, in which the selectors chose the best candidates by hearing them play without seeing them, was emblematic. At that point, the percentage of selected women rose to 50%.

Similarly, when it comes to promotions and the identification of best performers on the grounds of previous employees, the algorithm may ignore contextual assumptions, such as the team that accompanied a certain worker in developing a specific project. This is what is called “fundamental attribution error” in social psychology: the over-attribution of explanations for the causes of behaviour to “the person” and the under-attribution of the causes of behaviour to “the situation”. In careers and in the workplace, this means that credit or blame for performance is likely to be assigned to an individual more based on his or her perceived character, personality, intentions or efforts, rather than on the situation, context, opportunities or constraints within which that individual is working. This is the reason why HR teams must ensure that their algorithms are designed in order to reflect principles such as equality, transparency and confidentiality and that they are not discriminating against anyone, especially minority employees, and they take into account that, given the economic growth, competition and arrival of new technologies, candidates are constantly in an evolutionary state.

When it comes to ethical and legal problems, organisations must take into account that with more data, it comes more data-responsibility. Firms' reputation can be affected by the wrong management of employee data to improve productivity, if their privacy is underestimated.

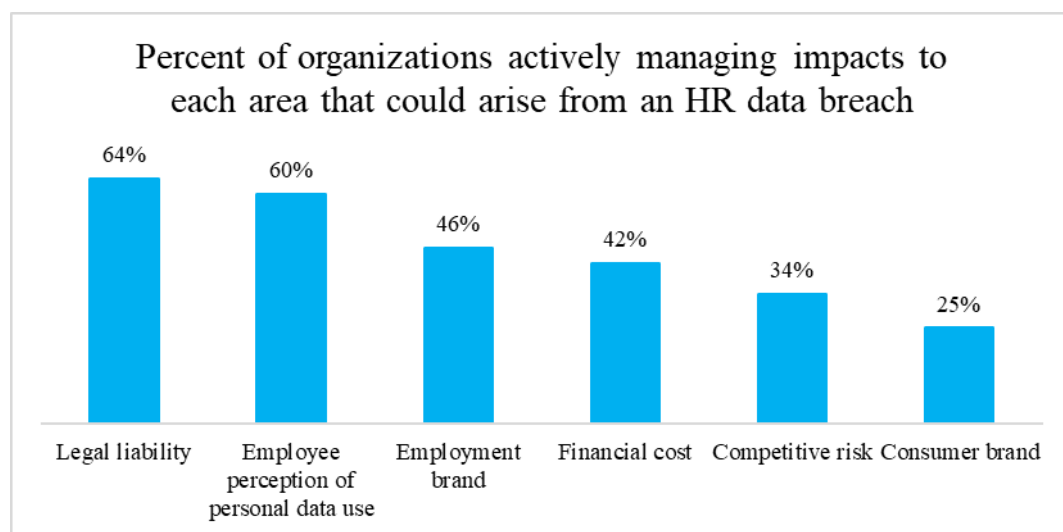
Analytics initiatives are not the place for satisfying personal curiosity: the organisation should collect only what is needed and take requisite steps to secure it, by encrypting it and regularly updating the solution to remain immune to the latest hacking techniques. Moreover, when it comes to sensitive data, access should be restricted only to specific professionals in charge of HR analysis. There should also be a system of checks that registers all the accesses. An option could be the one of using a third party in order to do data cleansing and aggregation, to remove the risk of privacy violations.

Furthermore, to protect workers' privacy, organisations should anonymise data, in order to avoid drilling down to a single employee's data and snooping. Analysts should bear in mind that personal matters should be handled by managers.

From a survey conducted by Deloitte (2018), it resulted that two years ago, 75% of respondent companies had understood the need for data security, but only a little part, corresponding to 22%, had already implemented excellent precautionary measures to protect workforce data. Instead, among those organisations that did not consider employees data worth the exposure to data risk, 30% did not have any strong data governance structures.

The following chart shows which risky aspects related to employees' data, companies are actively managing: the major part focuses on legal liability, followed by the employee's perception of personal data use and by the employment brand. Instead, the impact of such risks on their competitiveness is taken into account just by little more than one-third of the respondents. However, the aspect that resulted to have the least consideration was the consumer brand, with only 25% of the interviewed organisations declaring to take actions to control the impact of risks concerning workforce data.

Graph 2.4. Management of HR data risk levers



Source: Deloitte, Global Human Capital Trends survey, 2018.

In case of impossibility of making employees' data anonymous, companies have to let them choose how their data can be used, by asking permissions before

gathering the data. This can be done using an opt-out mechanism, sending workers a notification by email to inform them about a study on their data and including the possibility to explicitly accept the conditions to carry on it. Another option is represented by opt-in mechanisms, which imply an action by the employee in order to be included in the study. Sometimes to incentivise people to take part in such studies and increase their interest, HR teams can provide employees with confidential reports in which their data are compared to organisational benchmarks.

In any case, to ensure complete data security, organisations must adhere to the legal requirements and compliances, since employees have a human right to personal privacy, in addition to relevant legal rights that vary according to the country. This may well constrain Human Resources Analytics and limit the impact of AI on the work of the HR function. For instance, with regard to the personal data protection regulation in the European Union, on 24th May 2016 the General Data Protection Regulation (GDPR) entered into force, whereas in the U.S. it is in force the Health Insurance Portability and Accountability Act of 1996. In the end, ethical conflicts can arise when it comes to sacrificing employee privacy for profit. Especially, employees can feel as they are under surveillance and many fears that the numbers could be used against them: wide-open workspaces and copious real-time data on how individuals spend their time can leave employees feeling exposed and vulnerable, leading them to changing their

usual conduct, even if they do not have anything bad to hide. Although the data may be used with the best of intentions, employees may question what the information is really being used for and whether employers are acting unethically. Ethical issues also affect data-driven hiring, with regard to up to what point it is correct to use non-professional data, extracted from a Facebook or an Instagram profile, as an excuse not to hire certain applicants, or at least as an element to judge a candidate.

All the aforementioned questions should lead organisations to considering the use of Big Data in Human Resources as a risk management technique. Companies that ignore or violate limitations regarding employees' privacy might become vulnerable, both from a legal and a financial point of view, but especially with regard to firm's reputation. It is important that companies make a cultural shift and focus on respect for workers' personal information. Moreover, the employer should establish a trustful relationship with his employees, assuring that their data is in good hands.

3. THE RIGHT BALANCE

3.1. WHICH ORGANISATIONS HAVE ALREADY BEEN ADOPTING BIG DATA IN HRM?

With respect to a few years ago, the usage of HR Analytics is now better known and there are also more case studies to understand how it is used within organisations. However, despite the promising future for People Analytics, some companies are still struggling to make it an organisational reality.

According to The Rise of Analytics in HR report (LinkedIn, 2018), the adoption of specialised HR Analytics in Europe, Middle East, and Africa has been strong in the last five years.

A global study conducted in 2018 by Deloitte among more than 11,000 businesses, showed that 84% of respondents considered People Analytics as an “important” or “very important” matter, making it the second highest ranked trend. Furthermore, 69% of them were building integrated systems to analyse worker-related data to improve decision-making, and 17% already had real-time dashboards to utilise the great amount of numbers in original ways.

In addition to it, 90% of empowering and anticipatory companies¹⁸ had accurate, timely data, and 95% had data security policies in place. They were already monitoring people data from many sources, including social media (17%), surveys (76%), and integrating data from Human Resources and financial systems (87%) to provide insights about the entire employee experience, as well as data on job progression, career mobility, and performance (Deloitte, 2018).

Notwithstanding the strong interest in better data management, from the 2019 Deloitte global report (Deloitte, 2019), it resulted that only 26% of respondents were effectively using technology and analytics and only 6% believed their HR technology was excellent, whereas 65% of the 10,000 respondents reported that their technology was “inadequate” or “only fair” at achieving its overall objectives.

¹⁸ According to Bersin’s High-Impact Learning Organisation Maturity Model, there are four levels of maturity in which organisations can be classified: episodic or programmatic; responsive or contextualised; continuous or empowering; anticipatory or flow. Programmatic companies try to make work more productive through subsidiary and tactical training. Responsive companies focus on training excellence and have a centralised Learning and Development team in charge of governance and instructional design. Empowering firms concentrate on organisational performance, considering talent development one of the main competencies of management in the enterprise and measuring KPIs. Anticipatory companies are the most mature ones and they are learning organisations with an agile corporate structure, using strategic tools for Learning and Development.

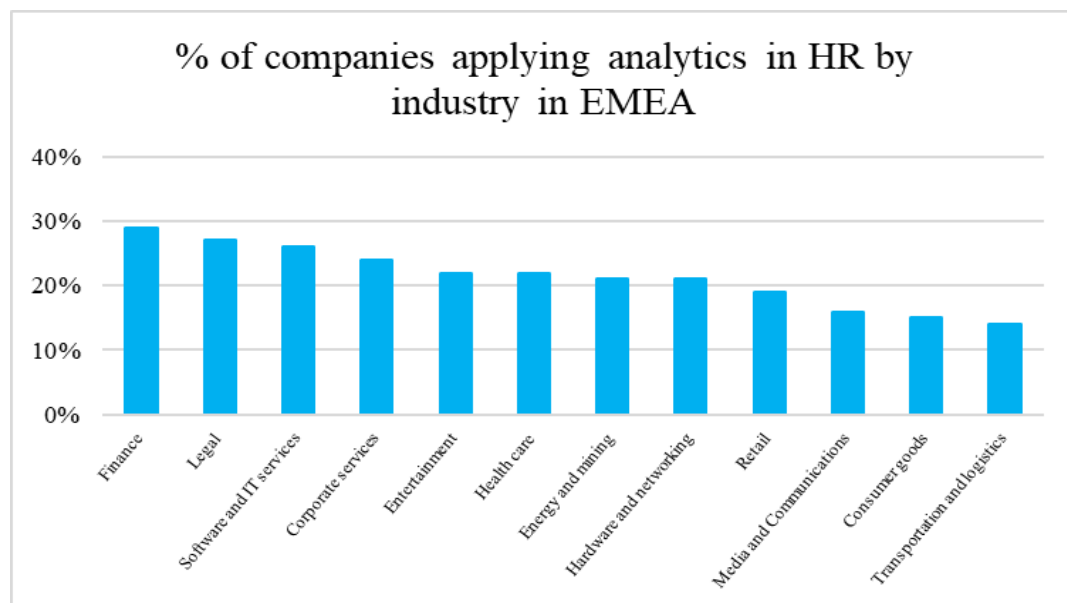
(<https://www.panopto.com/blog/the-evolution-of-the-high-impact-learning-organisation/>)

From another survey carried out by Visier in 2018, advanced organisations that used People Analytics resulted to outperform the emerging organisations on profit margins, which were 56% higher, and on return on assets, that were 22% higher. Advanced organisations stand out for a more sophisticated role of data in decision-making: they use it to analyse employee proactively, make predictions and create and monitor overall workforce plans. In addition to using HR Analytics to improve HR effectiveness, they count on it to improve business outcomes, even though it is still not a common accomplishment. Moreover, with respect to other types of organisations, advanced businesses have 24% more user types, so there is a greater variety of people using data to drive decision making, that goes from executives to people managers. They also use the double of data sources than emerging organisations, integrating talent management, employee engagement and financial data to correlate business outcomes with workforce data. Additionally, advanced organisations are characterised by the establishment of an analytics Centre of Excellence that supports HR business partners, people leaders, and other HR centres of excellence for talent acquisition, development, and retention, while freeing the analytics team to focus on more sophisticated analysis. On the other hand, emerging organisations distinguish themselves for frequently basing decisions on operational reports and using data only in case of critical matters regarding the workforce.

Generally, high-tech organisations and very large organisations, with more than 3,000 employees, are those belonging to advanced businesses group.

Even if firms are investing a lot in programs that will allow them to use data for workforce planning, talent management and operational advancement, this investment is concentrated in certain industries, and the overall adoption rates of HR focused analytics teams remain low. With regard to sectors, finance and legal are the ones with the highest degree of adoption of People Analytics, as stated by LinkedIn's report and showed by graph 3.1. Differently, industries such as media and communications, consumer goods, transportation and logistics result to be positioned at the bottom in terms of usage of HR Analytics.

Graph 3.1. Percentage of companies applying analytics in HR by industry in EMEA



Source: The Rise of Analytics in HR, LinkedIn, 2018.

Overall, 19% of companies in Europe, Middle East and Africa have adopted HR analytics, and 12% have dedicated HR analytics roles. Moreover, based on information listed on the LinkedIn profiles of professionals using HR analytics, talent development and employee engagement are the top use cases across all countries included: it is evident the focus on employee satisfaction and career development. These two areas are followed by employee retention and talent acquisition: keeping a focus on talent development and employee engagement may mean that less attention needs to be given to retaining and hiring talent (LinkedIn, 2018).

As for small enterprises, one could think that they often might not have the right resources that are necessary to gather information on the workforce, but there are cases that show how they may as benefit from HR Analytics as large companies. One interesting example is provided by a company with less than 100 employees, Intracorp, that working on specific objectives and tracking them in a smart way, improved its productivity by 10%. In particular, the organisation started from a complex situation which showed disbanded teams and communication problems which were bringing about numerous misunderstandings and errors. Intracorp, selected the highest priority development areas in order to train its teams and leaders within the flow of their workday. The firm took track of each process and progress and made more visible the performance of the employees. This led to a decrease in the cost of lost productivity: for each \$1 spent on training, \$3.20 were

recovered in lost productivity. The company used People Analytics, through virtual content sessions, also to increase the retention level, reaching a rise of 128% (AIHR, 2019).

This is emblematic to understand that organisations that are willing to start adopting People Analytics should firstly prioritise key business areas: implementing an analytical approach, to address business problems affecting the most important areas, will lead to a stronger outcome than applying analytics across the board. However, the most important action to take is to create a culture and a mindset that enhance data-driven thinking and where change is delivered from the top. Indeed, according to Visier (2018), “the question for HR professionals and business leaders is not whether or not to adopt people analytics, but rather, how they can mature their organisation’s people analytics to achieve improved outcomes”.

3.2. THE SCEPTICAL SIDE: THE NEO-LUDDITES

The use of Big Data, as well as that of Artificial Intelligence and Machine Learning, is seen as a disruptive invention and some categories of people are worried about them. One of these groups is represented by the neo-luddites, who claim that Human Resources Management is able to work in a professional way, even without using an intensively data-driven approach.

Essentially, neo-luddites are individuals who oppose the use of technology for ethical, moral, or philosophical reasons¹⁹. The term “luddite” appeared for the first time during the early 1800, when the Industrial Revolution began to replace human labour with machinery: in Great Britain, textile workers started to protest the introduction of such machines, that threatened to make their jobs obsolete, giving rise to the anti-technological-progress movement called Luddism. The same anxiety and fear to the unknown, which in the past characterised such workmen, with regard to steam-powered industry and mechanised textile machines, nowadays affects workers with respect to Artificial Intelligence.

As for Human Resources Management, neo-luddites accuse Big Data of annihilating the basic mission of HR, in which the “H” stays for “human”: they charge Big Data with “dehumanizing human resources” (Cukier, 2013), since, according to them, by outsourcing to such technologies decisions and processes, there is a great likelihood that people will be only considered as mere resources in the future, without taking into account the human side.

Basing decisions exclusively on the grounds of a computer would translate into the thoughtlessness of the importance of emotional intelligence, since to date there still does not exist a software able to assess, judge or comprehend it.

¹⁹ Definition from <https://www.merriam-webster.com/dictionary/Luddite>.

Moreover, they are sceptical about up to what point behaviours and actions of employees can be gathered and transformed into data. In addition to this, they question the likelihood that such data might lead to appropriate decisions. As for data collection, neo-luddites also go against the fact that the employees' privacy is not completely respected, building up resistance towards the use of Big Data and reinforcing the HR-IT barrier. They see Big Data as a form of workplace surveillance, that is meant to have a detrimental effect on the relationship between employees and Human Resources Management.

Anyway, whether Big Data is good or evil is debatable, but it is here and it is shaping our daily reality, especially with regard to working life.

3.3. THE BALANCE BETWEEN MEN AND MACHINES

Despite the ongoing debate between people who are pro and con the utilisation of Big Data in Human Resources Management, it is important to underline that, to date, Artificial Intelligence is not utterly prepared to definitely substitute the work done by human beings. Indeed, HR professionals' contribution will remain strong, since there are neither robots nor computers able to carry out strategic and complex tasks that go beyond analytical exercise.

Nevertheless, it is common knowledge that the activities conducted by HRM may be positively affected and, thus improved, by the application of Big Data and

Artificial Intelligence. Managers and employees will most likely welcome faster and more accurate HR processes, but applicants could think of it in a different way. Indeed, with regard to recruitment, even if technology may be useful to attract talent, almost two-thirds of job candidates would find preferable a face-to-face interview than digital recruitment methods (Brown, 2018). There is a high rate of scepticism towards algorithms among applicants: 76% of Americans prefer not to apply for jobs that use a computer program to make hiring decisions. This is part of a phenomenon called “algorithm aversion”, according to which people are more likely to opt for relying on gut-feeling-based human conjectures than data-driven predictions (HBR, 2018).

Also among Human Resources employees there are some doubts with regard the perfect substitutability between men and algorithms in the recruitment phase. According to a recent survey conducted by Monster.it, the Italian division of the online recruitment multinational Monster Worldwide, one person in two says they are convinced that it will never be an algorithm to evaluate the suitability of a candidate: 45% of respondents stated that a robot can never evaluate a candidate better than a human being, but 33% declared to be very open to technological innovation as a tool to facilitate the first contact between applicants and companies. Interestingly, 23% of participants think that, even if an algorithm is not adequate to evaluate the suitability of a candidate, it can become an increasingly valuable ally in the service of the human resources area, especially in

the evaluation phase of the curriculum received, particularly in large organisations (Il Sole 24 ore, 2018).

Therefore, it seems that there is room for a collaboration between human beings and AI in the HR function, with the latter supporting the work of the former. Undoubtedly, men's decision can be augmented by Big Data and the result would be superior to either one working alone. On the one hand, AI capabilities that can understand context, concept and meanings faster, can help employees to generate large amounts of data and enhance the expertise of human beings; on the other hand, HR professionals can provide more of their own input for training, quality control, and fine-tuning of AI outcomes. Firstly, machines can enhance efficiency by eliminating the repetitive work, thus letting HR teams to focus on high value-added activities. Moreover, algorithms can be used in people-related decisions to improve consistency, reduce bias, and cast a broader net.

Since People Analytics can give HR the information needed to make better decisions, it should be applied as a complement to human judgement, not as a substitute for it. HR professionals should bear in mind that people are unpredictable and outcomes can be always influenced by volatile factors. This especially counts when it comes to decisions related to firing: HR professionals must be careful, because taking decisions only on the basis of what an algorithm says that it is likely to happen, rather than what employees are actually doing, can be a sign of imprudence and have a significant negative impact on the enterprise,

particularly in terms of reputation and with respect to relationships in the workplace.

In order to take full advantage of the new possibilities coming from Artificial Intelligence, companies will have to allocate their technology spending and to redesign knowledge-work processes and jobs. It is crucial to prepare organisations for the AI revolution, starting from making the workforce understand the functioning of new technologies and their importance: Big Data augments and support people within organisations in making better decisions, but it does not make people redundant in the process of decision-making.

3.4. CHALLENGES IN THE RECRUITERS' SKILLS

Preparing for the adoption of Human Resources Analytics means that organisations have to make sure that the workforce is “change-ready” and willing to embrace new technology. A special effort should be therefore made by managers in spreading the knowledge and the right attitude within the business. A vital step, with regard to the introduction of an innovation such as People Analytics, consists in the recognition of the role of the resistance to changes, which is in conflict with the abandonment of the predominant role of intuition in managerial decision-making. In addition to it, there is a multitude of different challenges that companies have to cope with. One of them implies a reskilling of

the HR department, which will lead to the acquisition of new roles by the people-related function. Doubtlessly, in the process regarding the shift towards a 4.0 era there exist several difficulties. Nevertheless, organisations can successfully address them by adopting a design thinking approach, which represents an extremely valid ally in such a context.

3.4.1. Main obstacles to the application of HR analytics

A research carried out in 2017, by HR Tech World and the IBM Smarter Workforce Institute, shows that, in Europe, HR professionals are less prepared to deliver People Analytics projects, successfully, than their colleagues in the rest of the world, despite the sporadic presence of excellence in workforce analytics in the continent. The main cause of such a gap regards the lack of the right combination of skills: indeed, it results that in Europe only 27% of HR professionals have the proper expertise, whilst in the rest of the world the percentage is 49%. Within the Asia Pacific, the adoption of HR Analytics is higher in countries like India, Singapore, Hong Kong. In particular, in India, according to a LinkedIn report published in 2017, from 2012 to 2017 there has been an increase of 77% in specialised analytics professionals in Human Resources, with job titles that vary from Data Scientist, to Talent Analytics Director and to Diversity Analytics Specialist. The difference can be explained by

varied interpretations of what constitutes workforce analytics and possible divergences in the demands of HR practitioners between Europe and the rest of the world.

Some of the employee related issues regard: the absence in the department of technical skills and expertise, that can be reduced by hiring more internal consultants, data scientists, and IT specialists; the lack of versatility to Human Resources Analytics; the need of specific personnel in charge of analytics; the redundancy of operative and administrative workload which has no value added; numerous areas for improvement, that need more coaching, selling and prioritizing (Keerthi and Reddy, 2018). Providing training and orientation to Human Resources professionals, with respect to how People Analytics works and how to use it, is crucial: they have to be able to understand what the insights provided by Big Data mean and how they might provoke changes in their activities, even if human intervention is rarely required by such tools. HR teams should take into account that analytics expertise means that they have to ask the right question, prioritise ever-competing demands with tight budgets, make the correct hypothesis to take advantage from data and, also, be able to tell a clear and cohesive story with the data that drive action. Therefore, it is crucial for HR professionals to be equipped with analytical skills, related to innovative technology and computational social science, in addition to knowledge about organisational psychology. An interesting fact, found by the Innovation

Generation (Thomsons, 2019) report, was that 32% of companies have plans to upskill their HR teams to develop People Analytics skills, whereas 17% indicated that they would hire external talent for their requirements.

Other challenges concern management, such as the need of a change in management's view and the understanding of how to act. Usually there is also a sharp fear of change that frightens HR employees: they can consider automation as an implication of job loss. But top managers must try to convince HR departments for People Analytics adoption and make them understand the importance of decision-making process based on HR data, in addition to the fact that it can help HRM streamline its work. It can also happen that, despite the managers' capacity of understanding how to benefit from Big Data and the employees' willingness to adopt innovative tools, there is still a gap between what companies should do and what they would do, due to organisational policies and cultural issues. Additionally, there might be issues with respect to: lack of a mentor to guide and promote analytics; the connection to the business; time consuming process (Keerthi and Reddy, 2018). Furthermore, the financial aspect should be taken into account: sometimes companies may lack of the necessary resources to pay for large scale implementations. The adaptation to advanced technologies, such as Artificial Intelligence and Machine Learning implies a high cost, that goes from the acquisition of technical tools to upskilling the existing workforce and hiring of especially skilled employees.

Bottleneck in implementing People Analytics can also be data-related, in particular with regard to disaggregated data sources, availability, accuracy, quality, integrity, non-structured databases, inconsistencies in data governance, data literacy in Human Resources. Therefore, it is essential to have a HR team, composed both by analysts and HR professionals, dedicated to cleaning and properly managing such data.

3.4.2. New skills and roles

Not only are Big Data a relevant technological phenomenon, but they also have a strong potential impact on people within organisations and at a social level. In particular, they represent a critical resource for organisations and an opportunity for Human Resources Management to take one step forward towards the 4.0 mindset, enhancing its position and improving how it is perceived in terms of organisational activity: it can be seen as a high-value deliver function and HR professionals can boost their careers, adding further skills, roles and opportunities. So far, technology has been used by the Human Resources department to enhance the efficiency in their administrative activities, especially through Human Resources Information Systems, which enabled HR professionals to streamline essentially quite straightforward processes, related to basic record keeping, including tracking applicants, conducting open enrolments, making payroll

payments, monitoring time and attendance. However, nowadays technology can further enhance the HR function, going beyond solely administrative tasks. HR professionals might be able to establish connections with both candidates and employees, but in order to do so, they should have the ability to leverage social networking technologies. They should understand mobile technology and how to use it into the organisations, especially when it comes to the amount of data that tools like wearables can generate about workers. They have to be able to analyse the right data, recognise insights and extract relevant information for decision-making. Despite the fact that managing in an advanced way HR technology to improve the company's strategy can be very challenging for someone, for those who are not be able to do so, there is a great likelihood of losing an opportunity in terms of exciting progress in their field (SHRM, 2016).

On the one hand 4.0 technologies lead to new, cheaper and more strategic electronic Human Resources Management solutions, but, on the other hand, they require an effort by the HR department, in terms of new HR practices and a new organisational mindset at different levels: indeed, both supervisors and workers have to participate in the adoption, co-design and implementation of the new procedures.

In order to cope with the challenges underlined in the previous paragraph, with regard to the lack of expertise limiting Human Resources professionals, they can react by starting to educate themselves towards non-static capabilities that to date

they considered as a foreign skill set: they should increase their abilities by reading manuals, taking training courses, talking with experts in order to learn as much as they can about People Analytics. In this way, they can tear down the barrier that for them is represented by the perceived complexity of data and analytics. Moreover, they ought to be sure to have clear in mind the different analytic approaches, from descriptive, to prescriptive and to predictive analysis. In 2019, according to a report of myHRfuture Academy regarding HR skills for the future, People Analytics resulted to be the most sought-after skill that Human Resources professionals wanted to know. Basic data analysis, intermediate data analysis, basic multivariate models, advanced multivariate models, data preparation, root cause analysis, research design, survey design, and quantitative data collection and analysis are some of the peculiar analytical competencies that are required to effectively manage Human Resources Analytics (Levenson, 2011). They should additionally integrate their knowledge with that of colleagues belonging to the IT department, in order to collect suggestions and have a guidance for better reaching their goals. It is also crucial that they understand which analytics tools are used within the organisation, the data architecture and the strategies: having a definite comprehension of the analytics ecosystem of the company is useful in order to have an authentic perception HR's role. Besides, they have to create the infrastructure with the right HR professionals skilled in data-related activities and build the data repository.

Nonetheless, the imperative skills to successfully deal with People Analytics are not merely technical and related only to gathering, structuring, storing and manipulating data. Indeed, they belong to a mix which includes also commercial and interpersonal abilities: an essential component is given by the ability to correctly translate organisational problems into data analysis questions and, then, to precisely and compellingly communicate the results back with the business, especially in terms of visualisation and storytelling. Maybe it is for this reason that at Google, Human Resources teams are composed by one-third HR people, one-third business consultants and one-third high-powered analysts (IES, 2014).

By being equipped with new skills and by learning to effectively manage Big Data-related tools, the Human Resources department will drastically enhance its role within the company thanks to the ability to drive business value. Specifically, in 2012 Ulrich D., Brockbank, Younger and Ulrich M. identified six roles in which Human Resources professionals have to effectively demonstrate competence.

The first role is the one of the credible activist, which regards the ability to build trustful relationships, to shape HR professional credibility and to have a clear vision about their responsibility and about how the business should operate more successfully. Therefore, with regard to People Analytics, the role of the HR department aims at remaining credible about Big Data use and at engendering trust concerning such a usage within the organisation. According to Scholz Tobias

M. (2017), this role can be also called “canon keeper” since HR professionals have to maintain the integrity and consistency of Big Data, which need to fit with the canons of organisations, through managing questions about orderliness, story integrity, continuity, internal consistency, and overall coherence.

The second role is that of the strategic positioner, which concerns understanding the business and placing it in contexts and with stakeholder for future success. It includes a wide range of capacities, such as interacting with the company, cooperating in the creation of an organisational strategy, adjusting organisational activities to meet stakeholders’ needs, being aware of the business environment. Similarly to the credible activist, Scholz named this role “HR konstruktor” on the grounds that thanks to Big Data, Artificial Intelligence and Machine Learning, the HR department can contribute to the strategy of an organisation and understand the relational network in which firms are embedded. Moreover, connecting human and machines, in addition to controlling the workforce, it acquires an integral function.

The third role is the one of the capability builder, who is able to align the company’s culture with its strategy, after having identified, diagnosed and meliorate individual and, therefore, organisation capabilities. When it comes to Big Data, the HR function is supposed to be able to discover the hidden capabilities both at the individual and organisational level, by looking at data and analysing them. In this case, the name proposed by Scholz is “theory crafter”,

which derives from video games and defines the search for the optimal strategy starting from mathematical and statistical analysis. Theory crafters have the capacity of crunching the numbers and applying them to the contextual situation within companies, thus HR professionals do not only have the responsibility of mining data, but they should also be able to understand the data and make sense out of them, in addition to transform insights into organisational measures.

The fourth role is the change champion, which regards triggering and sustaining organisational change at different levels. In this sense, the HR function is useful to recognise emerging trends and to win out any opposition, and therefore to support changes. Big data will thus be a tool to help enhancing the capacity of organisations to change. This role can be called the “built-in Schumpeter” since it is trying to continuously conduct creative destruction in order to improve the enterprise.

The fifth role is given by HR innovators and integrators who in addition to developing talent, driving performance and creating new practices in communication and work, also ensure their complete integration. They have the ability to develop new solutions regarding the organisation, starting from their knowledge of new trends and tools. With respect to Big Data, HR professionals are a sort of data maker since they give birth to new ideas and innovations. Big Data within organisations are strongly linked to a thinking-outside-the-box approach, because they are not able to think on their own.

The sixth role is the one of the technology proponent which refers to the use of technology to increase organisational efficiency and to build relationships and share information among people in social media contexts. The appropriate name for this category is “data geeks”, as HR professionals should search for new ways and innovative ideas to make analysis of the collected data and they are continuously seeking original sources of data.

Notwithstanding the thriving literature on the strategic role of the Human Resources function and the wide range of innovative opportunities that concern this department, HR professional still struggle to be considered as strategic and relevant. Moreover, there is an ongoing debate on how to definitely describe its multifaceted role, attributable to several reasons.

Anyhow, what it is crucial is to understand that a tech-savvy HR function is critical in view of the fact that it enables HR professionals to drive and measure employees’ productivity and aid the company. It plays a key role because HRM shape the behaviour that organisations will need from all workers, when technology is likely to re-establish the real nature of work.

3.4.3. The design thinking approach

Companies that are willing to get started with Human Resources Analytics have to be aware that it is important to drive the whole organisation, not just one area,

through the paradigm shift brought about by the 4th industrial revolution. This does not only imply improving analytics and Information Technology expertise within the HR department and the whole organisation, but a transformation in the overall attitude. Since there are interconnections among all the enterprise's functions and processes, it is crucial to bring about a change in the organisational culture, leading to the adoption of a data-driven mindset. These circumstances make the HR called for playing the fourth role attributed by Ulrich et al. (2012): the change champion role.

There should be a continuous collaboration and collective effort: the workforce has to be as flexible, responsive, qualified and innovative as possible. This is an objective that can be successfully reached only if leaders foster a corporate culture of learning. It is common and understandable that there may be some fear about the speed and scope of technological transition: this anxiety lead to an aversion of employees against experimenting and push them to protect themselves.

Behaviours such as expressing a persistent disapprobation are strongly detrimental for innovation, therefore leaders have the responsibility of enabling a switchover, from the assessment of the correctness, the knowledge of answers or the implementation of top-down changes, to the evaluation of dissent and debate, asking good questions, and iterating to learn. Experiment-and-learn approaches are not scarce of occasions for failure, mistakes and disputes, notwithstanding, it

is indispensable to abandon the traditional plan-and-implement approach to triumphantly handle new technologies.

The design thinking approach is considered as a multi-disciplinary, non-linear methodology to deal with business challenges from a fresh perspective. It has had a strong success in product design, technology and marketing, but is also being applied in broader functions, such as Human Resources. It is an innovative approach that will change the way Human Resources teams deliver value, organise work and find solutions, transforming it from a traditional process-oriented model to a people-oriented model, in which tailor-made solutions for employees are possible.

Moreover, it represents an invaluable ally in bettering the culture of those organisations that want to step into Industry 4.0. Companies can benefit from this kind of approach in terms of dealing effectively with the general intricacy, uncertainty, and vague issues that affect organisations: they should focus on developing a deep empathy for the employees. The design thinking approach is also in accordance with the integrity and holistic vision that is necessary to have in order to face the increasing difficulty brought about by the paradigm shift of 4.0 era, especially characterising the HR department: the involvement in the design process of people belonging to different business units and functions delivers a new perspective to problem-solving.

The distinctive features that belong to the design thinking approach consist of exploration and reflective iteration, a human-centred approach, observation, visualisation and prototyping (Cantoni and Mangia, 2018). It leverages the creative processes related to design and it is acknowledged to be a successful methodology when it comes to empower innovation. It is based on understanding and comparing the problems, testing diverse kinds of solutions and developing a co-evolving process that includes iterations to elucidate the issue. Generally, it is helpful to use prototypes and flowcharts in order to transform the problem in a tangible object and then focus on it to elaborate new ideas and knowledge. Subsequently, those thoughts are translated one more time into observable objects that enable the development of critical thinking, as well as feedbacks, in order to find the most suitable solution for the beneficiary's expectations.

Therefore, when it comes to the innovation process, it should be based on a scrutinised knowledge of the context which is calling for a solution and where it will be implemented. The point of view of all the subjects involved has to be considered in order to have a clear idea of the necessities of each user. This is the reason why it is fundamental the contribution of each employee, especially with regard to the wide range of competences that they can cover within the organisation: this enables a more effective reflection on which opportunities, offered by innovative technologies, is better to take advantage from.

Allowing a non-judgmental observation of a situation and facilitating dialogue among multiple employees with different points of view, the design thinking approach can give birth to a virtuous circle, since it helps the Human Resources function to abandon preconceived notions about the motivations underlying people's behaviour and demonstrate the very openness that they seek to build in the organisation. It can be used to answer human-centred questions and challenge assumptions, developing an in-depth understanding of people for whom solutions are designed for and include them in the process to widen the range of ideas. The HR team can take advantage from the design thinking approach to build a culture of ideation and experimentation, that is necessary to give rise to innovative organisations characterised by a new mindset, new attitudes and capabilities.

CONCLUSION

To conclude, the work provides a general view of the effects in the short term, mostly positive, that the application of Big Data in Human Resources Management can have at the microeconomic level, that is within the company.

Several business case studies show a greater precision in discovering high-potential talent, a reduction in the mismatch between job demand and offer, the possibility to develop behavioural predictive models able to proactively prevent absenteeism and turnover, the access to real-time information to recognise new emerging patterns and to discover hindering issues affecting the performance of workers, both on an individual and team basis, and a help to create a high-performing culture and motivate top-performing employees.

To obtain such results, it is essential to be supported by specific competences that will have to be acquired by Human Resources professionals and by business strategies able to allow a correct integration of People Analytics within the organisation.

Nevertheless, the subject matters addressed are based on a relatively recent literature. This is due to the fact that the application of Big Data in Human Resources Management, as underlined in the text, is a phenomenon that has developed in the latest years and it is still in its state of infancy.

Surely, when the use of People Analytics will no longer be in the introductory phase, but it will move on to the growth phase and, subsequently, to the maturity one, further data will be available: they might thus demonstrate the effects in the long run of such a tool, and, therefore, confirm or invalidate the short-term impacts.

A topic that will undoubtedly acquire more and more importance and which will require further study, for a wide-ranging application of People Analytics, will be that of privacy and cybersecurity.

Moreover, it could be very meaningful to detect and deeply analyse the long-term effects on the corporate performance of individuals subjected to specific techniques, such those utilised by Bank of America, to study the impact also from the physical and mental point of view of the human being, given that for some people they could represent a source of stress and consequently of burnout.

Furthermore, it would be beneficial if future research could focus on the macroeconomic effects that the application of such technologies to personnel might have on the productivity of entire nations, if the use was extended over most of the territory, and on understanding if those tools could be used as a vehicle for even greater digitalisation and robotisation of the company reality.

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