

Big data and human resource management: paving the way toward sustainability

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Abstract

Purpose – This paper aims to examine the influence of big data (BD) on human resource management (HRM). It defines how these data can be a useful tool in the decision-making process of companies' human resources to obtain a sustainable competitive advantage.

Design/methodology/approach – This paper emphasizes the need to develop a holistic approach to emphasize these relations. Starting from these observations, the document proposes empirical research employing Eurostat data to test the benefits of BD in HRM decisions that optimize the relationship between training, productivity, and well-being.

Findings – The findings estimate HRM decisions and their impact in a broader macroeconomic and microeconomic perspective.

Originality/value – BD research is emerging as a crucial discipline in human resources. To overcome this problem, the paper develops an analysis of the literature on cleaner production and sustainability context; it creates a conceptual framework to clarify whether the existing studies consider the growing intensity of BD on human resources.

Keywords HRM, Big data, Sustainability, Well-being, Productivity

Paper type Research paper

1. Introduction

The power of big data (BD) is growing within organizations. It is transforming the landscape of economic value creation (Blazquez and Domenech, 2018) while opening new and fascinating scenarios in human resource management (HRM) processes that are the highest value for any organization and a rare, inimitable and irreplaceable mine of production factors (Purcell *et al.*, 2003; Pfeffer, 1994; Prahalad, 1983; Ratner, 2020).

The potentialities and benefits that these huge amounts of data originated are enormous (Wamba *et al.*, 2017; Resch *et al.*, 2021). Making good use of tetra-bite information requires



enormous cultural efforts within the organization that only human resources, the driving force of the company's individual, interpersonal and organizational change, can support.

Nevertheless, few types of research have tackled the impact of BD in HRM and its various applications in organizations. Thus, exploratory empirical literature on the topic remains at a rudimentary state (Gupta and George, 2016; Wamba *et al.*, 2017), reducing BD's application strategic potential in HRM (McAfee *et al.*, 2012; Mikalef *et al.*, 2018). Effectively, one of the most significant corporate applications of BD consists of contributing to a better understanding of changes and the making of predictions (Jun *et al.*, 2018) within a multidimensional framework including "IT infrastructure, operational, organizational, managerial and strategic aspects" (Wang *et al.*, 2016, 2020).

Throughout tools such as data mining and business analytics, techniques that use algorithms to analyze enormous quantities of data such as information on "employment history, skills and competencies, formal educational qualifications, and demographic information" (Angrave *et al.*, 2016; Alaimo and Kallinikos, 2021), career and salary, BD are relevant in the transformational processes of companies, which aim to plan and create value. It is a new value that produces a responsible and sustainable competitive advantage.

However, also research on the impact of BD on sustainability (in terms of sustainable performance) is discontinuous (Dubey *et al.*, 2017) and limited, leaving a largely uncharted territory of research, even if it is critical to grasp better how to use BD to render it an HRM's competitive advantage for managing structures, processes and organizational cultures.

Therefore, this paper intends to find out when and how the integration of BD technologies and HRM practices (in terms of training) enhances firms' operational and sustainable performance.

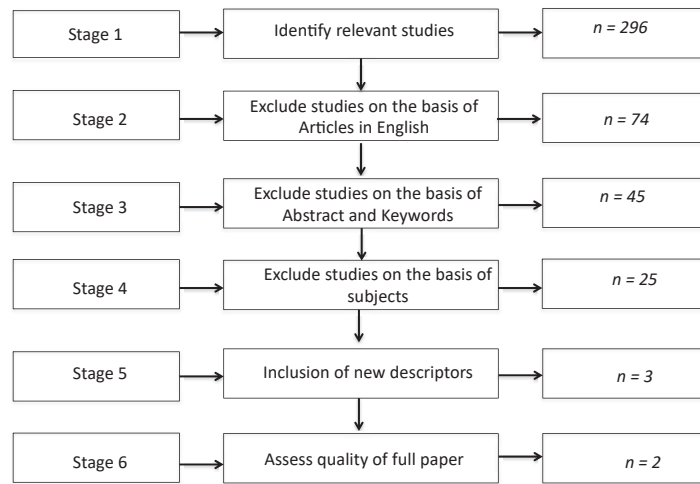
The conceptual idea of the paper starts from the Triple Bottom Line (TBL) model, which considers three components: the natural environment, society and economic performance (Elkington, 1994, 2004). According to this model, the sustainable advantage, which translates into economic, social and environmental benefits, considers employees as stakeholders and adopts an integrated vision of HRM with long-term strategic planning.

The primary purposes of this study are three: (1) describe and explain the existing scientific research, develop a systematic literature review to bring to light the ability of companies to integrate and improve HRM with BD technologies, as well as their influence on sustainable performance; (2) using the findings of the review for identifying a conceptual holistic research model; (3) testing empirically the model with a study: through a holistic approach, the document proposes empirical research employing Eurostat data to test the benefits of BD in HRM decisions that optimize the relationship between training, productivity and well-being.

In order to achieve this, the paper is structured in seven sections. After the introduction (Section 1), Section 2 describes the main steps adopted to conduct a systematic literature review. Section 3 offers the data sources and search strategy from which it is possible to deduce the main research areas observed by literature studies on BD and HRM. Section 4 develops empirical research on the VAR model's relationship between training, productivity and well-being. Section 5 shows the results of empirical research, while Section 6 discusses the results of systematic literature review and empirical research, as well as identifying avenues for further research. Lastly, Section 7 serves as the conclusion.

2. Review background

In this paper, we have used the methodology by Ngai and Wat (2002), Kitchenham (2004), Brereton *et al.* (2007), Kitchenham *et al.* (2009), for a systematic literature review. First, a revision protocol followed; then, the inclusion and exclusion criteria were established to reveal significant research for the analyzed topic. This was followed by the critical evaluation, the extraction of the data and the synthesis of the results. The following figure describes in detail the process (Figure 1).



Source(s): Author’s own work

Figure 1.
Stages of the study selection process

3. Data sources and search strategy

3.1 Description of the review process: data collection

A systematic literature analysis was developed in the Web of Science (WOS) and SCOPUS databases. The descriptors carefully chosen to examine the scientific production were “Big Data,” “Human management,” “Human resources management” and “Talent management.”

3.2 Description of the inclusion criteria

Investigation showed that scientific production started in 2013 and has 296 papers. Those written in “English” were 74 (70 in Journals and 3 in Trade Publication), all published between 2013 and 2020 (see Table 1).

3.3 Description of the sample analysis

Chinese, American and English authors (see Table 2 and Figure 2) mainly focused on research areas such as Engineering, Computer Science and Business, Management and Accounting, even though other regions were concerned (see Table 3) (see Figures 3–8).

Selected journals and highly cited articles are in the following Tables 4 and 5:

In the following figures are visible the maps of the citation by countries, citations by authors and coauthorships:

Year	Frequency	% (N = 74)
2020	3	4%
2019	30	40%
2018	18	24%
2017	9	12%
2016	5	7%
2015	8	11%
2014	1	1%
Total	74	100%

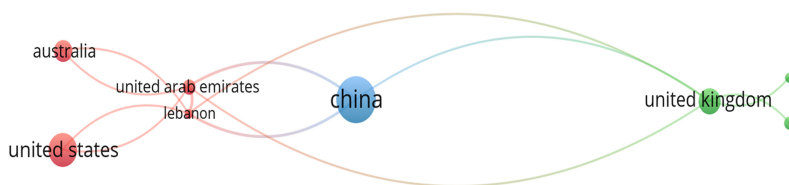
Table 1.
Scientific production for the year

Source(s): Author’s own creation

Country	Frequency	% (N = 108)
China	26	27.66
United States	15	15.96
United Kingdom	10	10.64
Australia	7	7.45
Canada	4	4.26
Germany	4	4.26
India	4	4.26
Russian Federation	4	4.26
United Arab Emirates	4	4.26
Italy	3	3.19
Spain	3	3.19
Finland	2	2.13
Lebanon	2	2.13
Pakistan	2	2.13
Slovenia	2	2.13
Taiwan	2	2.13
Total	94	100

Source(s): Author’s own creation

Table 2.
Top 15 countries contributed to the publications



Source(s): Author’s own work

Figure 2.
Top 15 countries contributed to the publications

Following this classification, all papers were examined, and those out of our study’s scope were excluded. This second screening process was based on the analysis of “Abstract and Keywords,” and the result gave 45 relevant articles (Figures 9 and 10) using a combination of the following keywords: “Big Data,” “Human Management,” “Information Management,” “Data Analytics,” “Big Data Analytics,” “Decision Making,” “Human Resources Management,” “Human,” “Resource Management,” “Human Resource,” “Machine Learning,” “Personnel,” “Sustainable Development,” “Artificial Intelligence,” “Innovation,” “Internet Of Things,” “Managers,” “Natural Resources Management,” “Performance Assessment,” “Big Data Era,” “Employee,” “Employment,” “Enterprise Human Resource,” “Environmental Management,” “Green Innovations,” “HR Analytics,” “Industry 4.0,” “Information Management Systems,” “Information Systems,” “Management,” “Organizational Performance,” “Performance Management,” “Quality Management,” “Talent Management,” “AI,” “Environmental and Organizational Performance,” “Behavioral Research,” “Big Data Analysis,” “Big Data Analytics (BDA),” “Big Data

Table 3.
Distribution of
research areas

Authors	Research areas															
	ENGR	CS	BMA	SS	DS	M	C	MS	P	ABS	EEF	E	ES	M	N	
1. Angrave <i>et al.</i> (2016)			X													
2. Bageot <i>et al.</i> (2020)				X							X		X			
3. Bleich (2018)			X													
4. Bisco <i>et al.</i> (2017)		X							X							X
5. Calvard and Jeske (2018)			X													
6. Campion <i>et al.</i> (2018)			X						X							
7. Caputo <i>et al.</i> (2019)	X	X	X		X						X					
8. Chang, Y.H. and Yeh, (2018)			X								X					
9. Chen Lv., Song (2019)		X	X						X							
10. Cheng and Hackert (2019)			X													
11. Cheng <i>et al.</i> (2018)	X	X	X													
12. Cotes and Ugarte (2021)			X													
13. Dahlboom <i>et al.</i> (2020)			X		X											
14. De Mauro <i>et al.</i> (2018)	X	X	X		X											
15. Deng and Cao (2018)				X					X							
16. Dessureault (2019)	X															
17. Dutta, D. and Bose (2015)	X	X	X		X						X					
18. ElKassar and Singh, (2019)			X						X							
19. Evans-Pughe (2014)	X		X													
20. Farrington and Alizadeh (2017)	X		X		X											
21. Fathi <i>et al.</i> (2020)	X	X	X													
22. Fathian <i>et al.</i> (2017)	X		X													
23. García-Arroyo Oseca (2021)			X													
24. Gu <i>et al.</i> (2019)	X	X	X													
25. Hamilton and Sodemam (2020)	X	X	X													
26. Ivaschenko <i>et al.</i> (2015)	X		X													
27. Ivaschenko <i>et al.</i> (2015)	X		X													
28. Ivaschenko <i>et al.</i> (2015)	X		X													
29. Jiang, C. and Li (2019)	X	X	X													
30. Johnson <i>et al.</i> (2016)	X		X													
31. Ke (2017)	X		X													
32. Kim <i>et al.</i> (2016)	X	X	X													
33. Li (2014)	X		X													
34. Ling Alii (2018)			X													
35. Liu <i>et al.</i> (2019)		X	X													
36. Luo, T. (2019)		X	X													
37. Martin-Rosset <i>et al.</i> (2017)			X													
38. McHale and Reiton, S. (2018)			X		X											
39. Meilo and Martins (2019)			X													
40. Min (2018)		X	X													

(continued)

Authors	Research areas									
41. Nair (2019)	X									
42. Nocker and Sena (2019)		X								
43. Oswald <i>et al.</i> (2020)		X								
44. Osuszek <i>et al.</i> (2016)		X								
45. Palpanas (2015)		X								
46. Pejić-Bach <i>et al.</i> (2020)		X								
47. Pfander <i>et al.</i> (2019)		X								
48. Polyviyany <i>et al.</i> (2019)		X								
49. Popovic <i>et al.</i> (2018)		X								
50. Qiu and Zhao (2018)				X						
51. Ragimi <i>et al.</i> (2018)										
52. Rialti <i>et al.</i> (2019)										
53. Rodriguez-Sánchez <i>et al.</i> (2019)										
54. Roifman <i>et al.</i> (2018)										
55. Suberi <i>et al.</i> (2019)										
56. Scilitto and Hawking (2015)										
57. Shamim <i>et al.</i> (2019)										
58. Singh <i>et al.</i> (2019)										
59. Song <i>et al.</i> (2017)										
60. Sun <i>et al.</i> (2018)										
61. Tsou <i>et al.</i> (2019)										
62. ur Rehman <i>et al.</i> (2016)										
63. Wang and Cotton (2018)										
64. Waurzyniak (2016)										
65. Wu <i>et al.</i> (2020)										
66. Xie <i>et al.</i> (2019)										
67. Yang (2017)										
68. Zhang, Y. (2017)										
69. Yu <i>et al.</i> (2019)										
70. Yuan <i>et al.</i> (2015)										
71. Zhang, G. (2017)										
72. Zhang <i>et al.</i> (2019)										
73. Zhang <i>et al.</i> (2018)										

Note(s): Legend: ENGR: Engineering CS; Computer Science BMA: Business, Management and Accounting
SS: Social Sciences DS; Decision Sciences M: Mathematics
C: Chemistry MS; Materials Science P: Psychology
ABS: Agricultural and Biological Sciences EEF: Economics, Econometrics and Finance
E: Energy ES: Environmental Science M: Medicine
N: Nursing
Source(s): Author's own creation

Table 3.

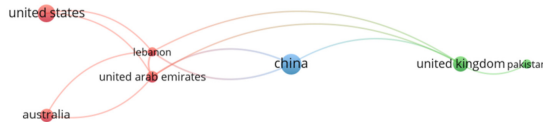
Applications,” “*Big Data Decision-making Capability*,” “*Blockchain*,” “*Business Intelligence*,” “*Artificial Intelligence and Talent Management*.”

The third phase of the process, assessed based on subjects, consisted in identifying relevant articles that allowed focus only on 25 papers, classifying them by research approach into seven categories: Conceptual, Review, Data Analysis, Survey, Experimental, Case Study and Developmental (see [Table 6](#)).

3.4 Synthesis of findings

Our investigation revealed that BD usage could benefit different categories of HRM (see [Table 7](#)).

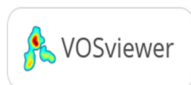
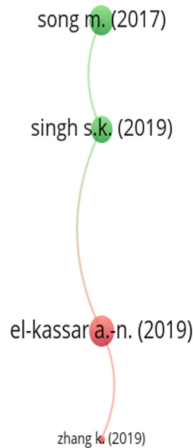
At the fourth step of our investigation, it became necessary to introduce new descriptors, such as “sustainability,” “environmental management” and “Triple Bottom Line.” From this further evaluation, only four papers appeared (3 articles and 1 article in press) and were published between 2016 and 2018 in the following journals: “*Human Development and Interaction in the Age of Ubiquitous Technology*,” “*International Journal of Information Management*,” “*Journal of Cleaner Production*” and “*Technological Forecasting and Social Change*.”



Note(s): Minimum number of documents of an author = 1
Minimum number of citations of an author = 5

Source(s): Author’s own work

Figure 3.
Network visualization map of the citation by countries.



Note(s): Minimum number of citations of a document = 5

Source(s): Author’s own work

Figure 4.
Network visualization map of the by countries citation by documents

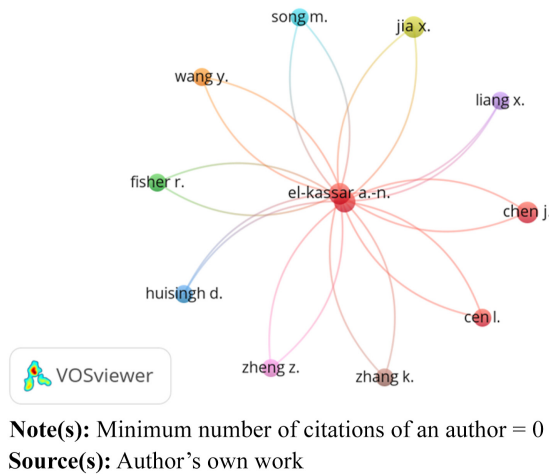


Figure 5. Network visualization map of the citation by authors

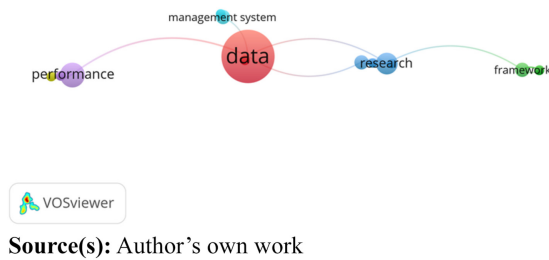


Figure 6. VOSviewer visualization of a term co-occurrence network based on title fields (binary counting)

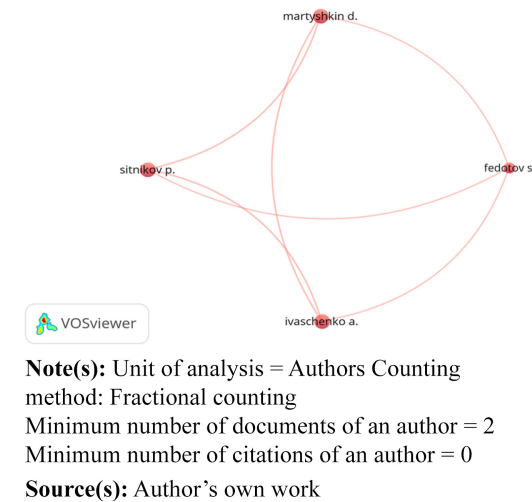
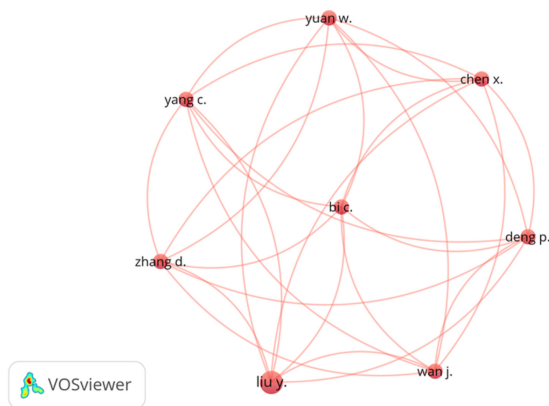


Figure 7. Network visualization map of the co-authorship. Unit of analysis = authors counting method: fractional counting

Following their classification by research areas, two main categories were identified: Business, Management and Accounting, and Computer Science, even though other regions were treated, as demonstrated in [Table 8](#).



Note(s): Unit of analysis = Authors Counting method :
 Fractional counting
 Minimum number of documents of an author = 1
 Minimum number of citations of an author = 5
Source(s): Author's own work

Figure 8.
 Network visualization
 map of the
 co-authorship

At the final phase of the process, the four selected papers were crossed with the other previously analyzed documents. Two papers were finally excluded because they were out of the scope of our study. In the end, only two articles were in line with the research topic (El-Kassar and Singh, 2019; Singh and El-Kassar, 2019). Both papers highlight the links between HRM, sustainability, BD and performance (as shown in Table 9).

This paper has developed a literature review of BD, HRM and sustainability in the largest abstract and citation database of peer-reviewed publications called SCOPUS. The literature review found 25 relevant articles published on these topics. The analysis of the related papers shows that since 2013, new literature has continued to emerge, highlighting how BD are being applied to revolutionize HRM, indicating that the transformation is underway. However, there has been little indication (only two papers) on the impact of environmental sustainability on BD and HRM and vice versa, even if the “green economy” is imposing a profound rethinking of the HRM.

Findings indicate that, at varying levels, scholars from all research areas who are particularly interested in Engineering, Computer Science and Business, Management and Accounting fields are demonstrating a growing interest in BD and HRM, especially those from China, the USA and the UK. BD research is emerging as an essential discipline in the HRM field. Virtually all HRM subareas deserve special attention, including the following: people resourcing, learning and development, career, employee relations, performance and awards and a flexible work system. Investigations are mainly conducted through case studies and conceptual papers, meaning an increasing need to develop an integrated and standardized method for managing human resources in organizations.

4. Conceptual framework and empirical research hypotheses

For the conceptual framework, this paper draws upon the dynamic capabilities (DC) approach, such as in Singh and El-Kassar's (2019) studies put in light of the literature review. According to this theoretical lens, companies need to constantly develop resources able to integrate and/or reconfigure competencies internally and externally (Teece *et al.*, 1997). Moreover, in this perspective, the company's ability to renew its skills needs to be in tune with

Source title	No. of documents	%
<i>Agro Food Industry Hi-Tech</i>	2	2.70
<i>Algorithms</i>	1	1.35
<i>Baltic Journal of Management</i>	1	1.35
<i>BMJ Open</i>	1	1.35
<i>Boletín Técnico Technical Bulletin</i>	2	2.70
<i>Business Horizons</i>	1	1.35
<i>Development and Learning in Organizations</i>	1	1.35
<i>Engineering and Technology</i>	1	1.35
<i>Eurasip Journal on Wireless Communications and Networking</i>	1	1.35
<i>European Journal of Operational Research</i>	1	1.35
<i>Expert Systems with Applications</i>	1	1.35
<i>Future Generation Computer Systems</i>	2	2.70
<i>Human Resource Management</i>	1	1.35
<i>Human Resource Management Review</i>	2	2.70
<i>IEEE Access</i>	3	4.05
<i>IEEE Engineering Management Review</i>	1	1.35
<i>IEEE Transactions on Computational Social Systems</i>	1	1.35
<i>IEEE Transactions on Engineering Management</i>	1	1.35
<i>Industrial and Organizational Psychology</i>	1	1.35
<i>Information and Management</i>	1	1.35
<i>Information Processing and Management</i>	2	2.70
<i>Information Systems Frontiers</i>	1	1.35
<i>International Journal of Applied Engineering Research</i>	3	4.05
<i>International Journal of Computer Integrated Manufacturing</i>	1	1.35
<i>International Journal of Enterprise Information Systems</i>	1	1.35
<i>International Journal of Human Resource Management</i>	1	1.35
<i>International Journal of Information Management</i>	4	5.46
<i>International Journal of Product Development</i>	1	1.35
<i>Journal of Advanced Oxidation Technologies</i>	3	4.05
<i>Journal of Cleaner Production</i>	2	2.70
<i>Management Decision</i>	2	2.70
<i>Technological Forecasting and Social Change</i>	2	2.70
<i>Annual Review of Organizational Psychology and Organizational Behavior</i>	1	1.35
Total	74	100

Source(s): Author's own creation

Table 4.
Most active source title

environmental changes. In this regard, several BD studies have demonstrated the applicability of the dynamic capabilities view, arguing that BD technologies are resources that support firms operating in turbulent contexts (Wamba *et al.*, 2017; Dubey *et al.*, 2017) and examining their influence on firm performance.

Considering the context of sustainability, dynamic capabilities can be referred to as the ways in which companies implement and reconfigure BD technologies and HRM practices to achieve sustainable performances (e.g. Eisenhardt and Martin, 2000; Teece *et al.*, 1997). It's evident, therefore, that a strong accent needs to be laid on human capital adapting to the company's new requirements.

Based on these observations, this paper develops a conceptual model that focuses on HRM decisions aiming to test the relationship between training, productivity and well-being. It consists of 6 factors, namely: education (E), IT training (ITT), IT personnel (ITP), productivity (P), well-being (WB) and social exclusion (SE).

Understanding the effects of these factors can support managerial strategies in effectively implementing sustainable HRM practices to perform better, be more competitive, and gain more market quotas, despite the turbulence. Adaptability theory proposes that organizations must possess the ability to adapt to changing circumstances to achieve sustainable success.

No.	Authors	Title	Year	Cites	Cites per year
1	Dutta D		2015	104	20.80
2	Rehman MH.U.		2016	87	21.75
3	Johnson AE.W.		2016	81	20.25
4	El-Kassar A.-N		2019	61	61.00
5	Song M		2017	52	17.33
6	Ragini JR.		2018	47	23.50
7	Popovi A		2018	35	17.50
8	De Mauro A		2018	32	16.00
9	Singh S.K.		2019	31	31.00
10	Palpanas T		2015	28	5.60
11	Bosco F.A.		2017	15	7.50
12	Kim H.-W		2016	13	3.25
13	Mchale IG.		2018	9	4.50
14	Calvard T.S.		2018	8	4.00
15	Martin-Rios C		2017	8	2.67
16	Rialti R		2019	6	6.00
17	Shamim S		2019	6	6.00
18	Yuan W		2015	6	1.20
19	Xie Z		2019	5	5.00
20	Fathian M		2017	5	1.67

Table 5.
Highly cited articles:
most influential papers **Source(s):** Author's own creation

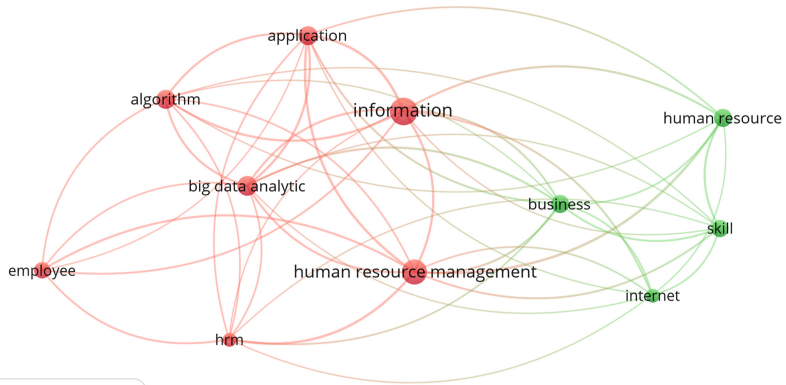


Figure 9.
VOSviewer
visualization of a term
co-occurrence network
based on title and
abstract fields (binary
counting)

Source(s): Author's own work

Integrating BD analytics (BDA) into HRM, practices offers a valuable tool for enhancing organizational adaptability and ultimately fostering sustainability. This article explores how BD and HRM can be combined using the lens of adaptability theory to pave the way toward sustainable practices. Adaptability theory provides a valuable framework for understanding the role of BDA in HRM and its influence on organizational sustainability. By integrating BDA into HRM practices, organizations can enhance their adaptability by improving environmental scanning, sense-making, flexibility, learning, employee empowerment and change management. This integration ultimately paves the way toward sustainable practices by enabling organizations to make data-driven decisions, respond to emerging trends and align HRM strategies with sustainability goals.

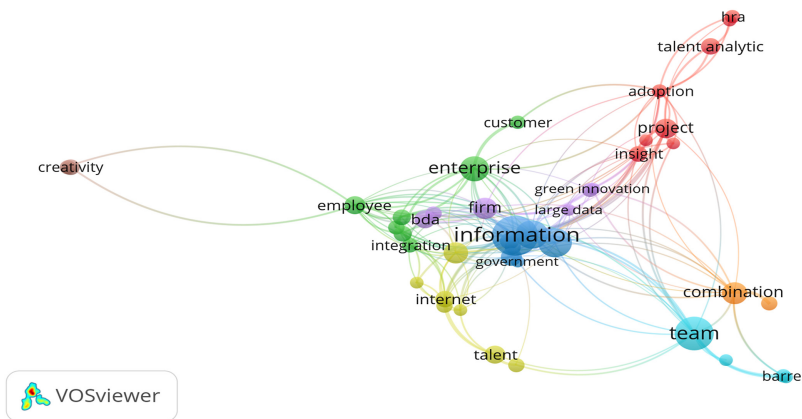


Figure 10.
VOSviewer
visualization of a term
co-occurrence network
based on title and
abstract fields (full
counting)

Source(s): Author's own work

The link between training, performance and wage is one of the most researched topics in the field of economics (Bartel, 1995). However, the implications of these variables are far-reaching, with echoes in macroeconomic variables such as GDP per capita and social exclusion.

To estimate the impact of HRM decisions on employees' performance and observe the implication of these decisions in a larger picture from a macroeconomic point of view, we have considered both microeconomic and macroeconomic variables. Thus, having in mind the implications, both from macro and microeconomic points of view, and in order to test and contextualize these relationships, we have developed empirical research, implementing a VAR model and taking into consideration two variables that are responsible for BD generation: IT training offered by enterprises and IT personnel, focusing upon the HRM decisions that are aiming to optimize the relationship between training, productivity and well-being.

Our hypotheses are based on the augmented Solow neoclassical and the "new growth theories," and the role of education on productivity, well-being or social exclusion is almost axiomatic. Thus, human capital, as an extra input, directly influences productivity and hence well-being and social exclusion. According to Sianesi and Reenen (2003), a one-year increase in average education is found to raise the level of output per capita by between three and six percent according to augmented neoclassical specifications, while leading to an over one percentage point faster growth according to estimates from the new-growth theories.

Thus, starting from the findings of the literature review and the macro and microeconomic implications, we were able to formulate the following hypothesis:

- H1. Education (regarding both employees with tertiary and IT education) has a positive effect on productivity.
- H2. Education (regarding both employees with tertiary and IT education) has a positive impact on the well-being.
- H3. Education (regarding both employees with tertiary and IT education) has a negative impact on social exclusion.
- H4a. IT training in enterprises has a positive effect on employees (regarding both employees with tertiary and IT education).
- H4b. The need to implement IT training will decrease when more IT personnel are hired.

Hypotheses 4a and 4b are related to training and its impact on productivity. Training increases the marginal product of labor more than the wage, which creates incentives for the firm to invest in general training (Konings and Vanormelingen, 2015). In addition, taking into consideration the fact that the industry is full of 4.0 transformation, it makes sense the need to invest in IT&C

Research approach	No. of articles (%)	Authors, date	Topic
Conceptual	24%	Singh (2019)	Singh and El-Kassar analyze the influence of big data on business growth and in terms of sustainable performance
		Calvard <i>et al.</i> (2018)	Calvard and Jeske analyze the risks arising from the use of big data in HRM.
		Campion <i>et al.</i> (2018)	Campion <i>et al.</i> observe how big data can be used for Talent Management
		Cheng <i>et al.</i> (2018)	Cheng, Xu, and Cui discuss employee retention, which is generally based on organizational effectiveness and the effects of organizational support and career management on employee retention
		Hamilton and Sodeman <i>et al.</i> (2020)	Hamilton and Sodeman investigate HR and explore the impact of three new big data sources on strategic human resources
Review	8%	Angrave <i>et al.</i> (2016)	Angrave <i>et al.</i> define, with an overview of academic research, the concepts of data analytics and big data analyzing how they are related to HR.
		Cheng and Hackett (2019) Garcia-Arroyo and Osca (2021)	Cheng and Hackett produce a review of academic research on the use of algorithms in HRM. Garcia-Arroyo and Osca conduct a literature review to systematize the academic studies so far, identifying the importance of Big data for HRM.
Data Analysis	12%	Shamim <i>et al.</i> (2019) Wang and Cotton (2018)	Shamim <i>et al.</i> examine 108 Chinese firms and test the impact of big data on quality decision-making Wang and Cotton demonstrate the effects of organizational ties on team performance while highlighting that big data can add value to the workforce and firm strategy. However, a longitudinal dataset of 15,837 Major League Baseball players from all teams cast doubt on this result
		De Mauro <i>et al.</i> (2018) Zhang, Y. (2017)	De Mauro <i>et al.</i> list new skills necessary for family skills to use big data Yizhe examines 1245 Chinese enterprises, using a survey to demonstrate that career development, staff training project, and performance pay schemes (strategic HRM) positively impact enterprise performance
Survey	16%	El-Kassar <i>et al.</i> (2019)	El-Kassar and Singh analyze 215 organizations in the Middle East, North Africa, and Golf-Cooperation Countries, examining the effects of innovation practices and corporate environmental ethics on organizational and environmental performance
		Bag <i>et al.</i> (2020)	Bag <i>et al.</i> investigate how the workforce supports BDA in improving sustainable advantages
		Rialti <i>et al.</i> (2019)	Rialti <i>et al.</i> develop a survey in which they test the effects of organizational BDA capabilities on the firm's ambidexterity and agility and performance
Experimental	4%	Fathian <i>et al.</i> (2017)	Fathian, Saei-Shahi, and Makui develop a new model for simultaneously forming a team with three key factors: 1. Expert's skills; 2. Expert's collaboration network; 3. Expert's reliability

Table 6.
Classification of articles by research approach

(continued)

Research approach	No. of articles (%)	Authors, date	Topic
Case study	36%	<i>Dahlbom et al.</i> (2020)	<i>Dahlbom et al.</i> demonstrates the advantages of Big Data on the HR function. The paper focused on a group of the largest Finnish companies
		<i>Mello and Martins</i> (2019)	With two study cases, Mello and Martins investigate the potential of BDA to enhance Performance measurement systems
		<i>Nocker and Sena</i> (2019)	<i>Nocker and Sena</i> discuss several case studies that show the positive impact of talent analytics on organizational decision-making
		<i>Rodríguez-Sánchez et al.</i> (2019)	<i>Rodríguez-Sánchez, Montero-Navarro, and Gallego-Losada</i> carry out a case study in the mechanical engineering sector, evidence of the benefits of e-recruitment and selection
		<i>Yuan et al.</i> (2015)	<i>Yuan et al.</i> show a case study highlighting how big data are useful tools to evaluate the outdoor work performance of 1100 police officers in a medium-sized Chinese
		<i>Popović et al.</i> (2018)	<i>Popović et al.</i> demonstrate the effects of BDA on the empowerment of employees and how BDA can be integrated into organizations
		<i>Osuszek et al.</i> (2016)	<i>Osuszek et al.</i> show how Big Data analysis can extend the DSS part of Adaptive Case Management (ACM) systems, and they show how big data can be used by organizations to improve their business
		<i>Martin-Rios et al.</i> (2017)	<i>Martin-Rios et al.</i> (2017) examine a case study that matches the strategic dimensions of HRM with an empirical data analysis focused on HR analytics
		<i>Deng and Cao</i> (2018)	<i>Deng and Cao</i> study the problems of employees' education and training systems in large Chinese enterprises after introducing Big Data Technology
Total	100%		

Source(s): Author's own creation

Table 6.

personnel and the training by which they can transfer know-how and skills to other workers. However, IT&C personnel, considering their average salary, imply additional costs for the entity. Therefore, a cost-benefit analysis is required on this issue. In order to perform the case study, the following variables have been considered: GDP per capita, employees with tertiary education, employees in the IT field, real labor productivity per person, people at risk of poverty or social exclusion, enterprise-provided training to their personnel to develop their ICT skills.

For our case study, we have used an unrestricted panel VAR, one of the most flexible and versatile research instruments, as we can test different hypotheses. Thus, because of the interdependencies between the variables selected, and the bidirectional impact between them, we have concluded that a VAR panel model is the optimal type of research methodology. The model that we have opted for is original and, since the variables are integrals of different orders, is taking into consideration the recommendations of [Harvey \(1990\)](#). According to [Canova and Cicarelli \(2013\)](#), panel VAR models are best at determining the explicit microstructure present in DSGE models and, as their VAR counterparts, attempt to capture the dynamic interdependencies present in the data using a minimal set of restrictions.

Thus, because of the interdependencies that are common between our variables and the impact between them is mutual, we have opted for this unrestricted VAR Panel model, which because of its versatility, can be easily used for testing the hypothesized relationships between the variables considered. Thus, using the Eurostat database, we have taken 28 cross-sections regarding the European Union member states from 2012 until 2018.

Model:

Categorization of Zhang, Y. (2017)	Operational HRM	Strategic HRM
Learning and development	Training programs: Flexibly, new knowledge, creative approaches, motivation	Training programs: Flexibly, new knowledge, creative approaches, motivation
Career	Career development	Career development
Performance and awards	Work performance, motivation, salary	Work performance, motivation, salary
Flexible work system	Temporary employee management: contract workers, temporary workers	Flexibility
<i>Categorization of Nocker and Sena (2019)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Attendance, assessments, engagement	
Performance and benefits	Performance	
Career	Competencies, training, job status, job type	
Employee relations	Diversity	
<i>Categorization of Rodríguez-Sánchez, Montero-Navarro and Gallego-Losada (2019)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Recruitment and selection	
<i>Categorization of Garcia-Arroyo and Osca (2021)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Selection and hiring, rotation and retention	Knowledge, learning and decision-making
Career	Assessment and development	
<i>Categorization of Shamim et al. (2019)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Organizational culture	Organizational culture, knowledge and decision-making processes
Career	Talent management	Talent management
Employee relations	Leadership	
<i>Categorization of Singh and El-Kassar (2019)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
Learning and development	Training, employees' skills, knowledge and competencies	Knowledge
<i>Categorization of Hamilton and Sodeman (2020)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Evaluation and ethical problems	Exceptional knowledge, innovative ideas and skills to the organization
Performance and benefits		High individual and firm performance, training
Career		Appropriate career paths
Employee relations	Better relations between employer and employee	
<i>Categorization of Yuan et al. (2015)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Workforce planning: Employees working outdoors, work assignments, employee attendance management, parameters of work priorities	Workforce planning: Employees working outdoors, work assignments, employee attendance management, parameters of work priorities

Table 7.
Examples of research
on big data and HRM

(continued)

Categorization of Zhang, Y. (2017)	Operational HRM	Strategic HRM
Performance	Work performance measurement: Individual attendance data, location and trajectory information	Work performance measurement: individual attendance data, location and trajectory information
Flexible work system <i>Categorization of Wang and Cotton (2018)</i>	Temporary work assignment <i>Operational HRM</i>	Temporary work assignment <i>Strategic HRM</i>
People resourcing Career	Talent management Managers' career and creative approaches	Talent management Managers' career and creative approaches
Performance and awards	Team performance measures, individual performance, managers' career, awards	
Employee relations <i>Categorization of Calvard and Jeske (2018)</i>	Ties organizational experience <i>Operational HRM</i>	<i>Strategic HRM</i>
Risks for people resourcing	Inequalities (re) produced at work and in employment infringe employees' rights, manipulate employee voice	Decision-making process
Risks for recruitment Risks for career	Data screening Use of employee data	Flexible, new knowledge and creative approaches
Risks for performance and awards	Team performance measures, individual performance, managers' career, awards	
Risks for employee relations <i>Categorization of Champion et al. (2018)</i>	Participation in the workplace, social norms <i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing Recruitment	Talent management Selection process: Recruitment, scoring of essays, interviewing	
Career Performance and awards <i>Categorization of De Mauro et al. (2018)</i>	Job analysis Performance <i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	New professions	Strategies for the growth of the skills
Recruitment <i>Categorization of Popović, Hackney, Tassabehji and Castelli (2018)</i>	Job role, job skills <i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Talent management	Decision-making power shifts, empowering employees
Performance and awards <i>Categorization of Osuszek et al. (2016)</i>	Performance management <i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Talent management	Knowledge management, decision support
Performance and awards <i>Categorization of Cheng et al. (2018)</i>	Worker productivity <i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Talent management	Talent management

(continued)

Table 7.

Categorization of Zhang, Y. (2017)	Operational HRM	Strategic HRM
Career	Talent development, managers' career and creative approaches	Talent development, managers' career and creative approaches
Performance and awards	Team performance measures, individual performance, managers' career, awards	
<i>Categorization of Cheng and Hackett (2021)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
Learning and development	Training and development	
Performance and awards	Compensation	
Recruitment	Recruitment	
Career	Training and development	
<i>Categorization of Fathian et al. (2017)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Skills, personality traits, abilities	
Performance and awards	Team working performance	
Recruitment	Skills, personality traits, abilities	
Employee relations	Team	
<i>Categorization of Martin-Rios et al. (2017)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Employee retention, retirement age, end-of-work permit, pregnancy probability, absenteeism, rates and an assumed staff turnover rate based on seniority	Decision-making drivers
Learning and development	Training	
Career	Career	
Performance and awards	Performance management, salary, compensation and benefits packages	
Employee relations	Staff happiness	Staff happiness
<i>Categorization of El-Kassar and Singh (2019)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Organizational and technical infrastructure, organizational procedures, the employee review process, written employee manual, written job descriptions	Decision-making
Learning and development	Training: Introduction, intensification of training programs, in-house training	
<i>Categorization of Deng and Cao (2018)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
Learning and development	Training	
<i>Categorization of Dahlbom I (2020)</i>	<i>Operational HRM</i>	<i>Strategic HRM</i>
People resourcing	Employee retention, retirement age, end of work permit, pregnancy probability, absenteeism, rates and an assumed staff turnover rate based on seniority	Decision-making drivers
Learning and development	Training	
Career	Career	
Performance and awards	Performance management, salary, compensation and benefits packages	

Table 7.

(continued)

Categorization of Zhang, Y. (2017)	Operational HRM	Strategic HRM
Employee relations <i>Categorization of Angrave et al. (2016)</i>	Staff happiness <i>Operational HRM</i>	Staff happiness <i>Strategic HRM</i>
People resourcing <i>Categorization of Rialti et al. (2019)</i>	Talent management <i>Operational HRM</i>	Decision-making drivers <i>Strategic HRM</i>
Performance and awards <i>Categorization of Bag et al. (2020)</i>	Structure <i>Operational HRM</i>	Firm's performance <i>Strategic HRM</i>
Learning and development <i>Categorization of Mello and Martins (2019)</i>	Employee development, talent management <i>Operational HRM</i>	Innovation and learning <i>Strategic HRM</i>
Performance and awards <i>Categorization of Mello and Martins (2019)</i>	Learning <i>Operational HRM</i>	Performance management <i>Strategic HRM</i>
People resourcing	Performance management <i>Operational HRM</i>	The decision-making process became more efficient and effective thanks to BDA
Performance and awards	Performance	

Source(s): Author's own creation

Table 7.

$$GDP_{1,t} = \alpha_2 + \Delta \sum_{j=1}^j \beta_{1,j} GDP_{1,t-j} + \Delta \sum_{j=1}^j \delta_{1,j} employees_{3_{1,t-j}} + \Delta \sum_{k=1}^k \epsilon_{1,j} itemployees_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} productivity_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} exclusion_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} ittraining_{1,t-j} + u1_t$$

$$Employees_{3_{1,t}} = \alpha_2 + \Delta \sum_{j=1}^j \delta_{1,j} employees_{3_{1,t-j}} + \Delta \sum_{j=1}^j \beta_{1,j} GDP_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} itemployees_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} productivity_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} exclusion_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} ittraining_{1,t-j} + u1_t$$

$$itemployees_{1,t} = \alpha_2 + \Delta \sum_{k=1}^k \epsilon_{1,j} itemployees_{1,t-j} + \Delta \sum_{j=1}^j \beta_{1,j} GDP_{1,t-j} + \Delta \sum_{j=1}^j \delta_{1,j} employees_{3_{1,t-j}} + \Delta \sum_{k=1}^k \epsilon_{1,j} productivity_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} ittraining_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} exclusion_{1,t-j} + u1_t$$

$$productivity_{1,t} = \alpha_2 + \Delta \sum_{k=1}^k \epsilon_{1,j} productivity_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} itemployees_{1,t-j} + \Delta \sum_{j=1}^j \beta_{1,j} GDP_{1,t-j} + \Delta \sum_{j=1}^j \delta_{1,j} employees_{3_{1,t-j}} + \Delta \sum_{k=1}^k \epsilon_{1,j} exclusion_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} ittraining_{1,t-j} + u1_t$$

Research area	Title	Authors
Business, Management, and Accounting	Role of big data analytics in developing sustainable capabilities. <i>Journal of cleaner production</i> , 213, 1264–1273	Singh and El-Kassar (2019)
	Green innovation and organizational performance: the influence of big data and the moderating role of management commitment and HR practices. <i>Technological Forecasting and Social Change</i>	El-Kassar and Singh (2019)
Computer Science	How would big data support societal development and environmental sustainability? Insights and practices. <i>Journal of Cleaner Production</i> , 142, 489–500	Song et al. (2017)
	Big data reduction framework for value creation in sustainable enterprises. <i>International Journal of Information Management</i> , 36(6), 917–928	ur Rehman et al. (2016)
Psychology	Green innovation and organizational performance: the influence of big data and the moderating role of management commitment and HR practices. <i>Technological Forecasting and Social Change</i>	El-Kassar and Singh (2019)
Energy	How would big data support societal development and environmental sustainability? Insights and practices. <i>Journal of Cleaner Production</i> , 142, 489–500	Song et al. (2017)
	Role of big data analytics in developing sustainable capabilities. <i>Journal of cleaner production</i> , 213, 1264–1273	Singh and El-Kassar et al. (2019)
Environmental Science	How would big data support societal development and environmental sustainability? Insights and practices. <i>Journal of Cleaner Production</i> , 142, 489–500	Song et al. (2017)
	Role of big data analytics in developing sustainable capabilities. <i>Journal of cleaner production</i> , 213, 1264–1273	Singh and El-Kassar (2019)
Engineering	How would big data support societal development and environmental sustainability? Insights and practices. <i>Journal of Cleaner Production</i> , 142, 489–500	Song et al. (2017)
Social Sciences	Big data reduction framework for value creation in sustainable enterprises. <i>International Journal of Information Management</i> , 36(6), 917–928	ur Rehman et al. (2016)

Source(s): Author's own creation

Table 8.
Distribution of
research areas

$$\begin{aligned}
 ittraining_{1,t} = & \alpha_2 + \Delta \sum_{k=1}^k \epsilon_{1,j} ittraining_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} productivity_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} itemployees_{1,t-j} \\
 & + \Delta \sum_{j=1}^j \beta_{1,j} GDP_{1,t-j} + \Delta \sum_{k=1}^k \epsilon_{1,j} exclusion_{1,t-j} + \Delta \sum_{j=1}^j \delta_{1,j} employees3_{1,t-j} + u1_t
 \end{aligned}$$

LEGEND:

Variable	Explanation
GDP	GDP per capita
Employees3	Employees with tertiary education
Itemployees	Employees in the IT field
Productivity	Real labor productivity per person
Exclusion	People at risk of poverty or social exclusion
Ittraining	Enterprise provided training to their personnel to develop their ICT skills

After the estimation of the VAR, all the necessary tests were performed in order to continue further with the VAR methodology. As observed in Table 10, the number of lags is 1.

HRM	Sustainability	Big data	Performance
<p>El-Kassar and Singh (2019) Top Management Commitment in terms of strategy for</p> <ul style="list-style-type: none"> Decision-making Business benefits to the firm Supply chain collaboration Organizational information sharing Competitive advantage Organizational performance 	<p>Environmental Strategies in terms of</p> <ul style="list-style-type: none"> Environmental ethics <ul style="list-style-type: none"> environmental policies environmental investment or procurement environmental plan, vision, or mission Stakeholder View (SV) <ul style="list-style-type: none"> environmental reputation products and manufacturing for customers Market demand for green products <ul style="list-style-type: none"> price flexibility customer benefits and requirements, which affect the demand for green products 	<p>Big Data Adoption/ Acceptance in terms of</p> <ul style="list-style-type: none"> Job performance Organizational structure 	<p>Environmental performance</p>
<p>HRM in terms of:</p> <ul style="list-style-type: none"> Organizational and technical infrastructure Organizational procedures Employee review process Written employee manual Written job descriptions <p>Training practices in terms of:</p> <ul style="list-style-type: none"> Training for employees Introduction of formal training programs Intensification of existing training programs Formal in-house training by internal staff Formal in-house training by external staff 	<p>Green process innovation: manufacturing and production processes to follow environmental criteria</p> <p>Green product innovation</p>	<p>Big Data Routinization in terms of</p> <ul style="list-style-type: none"> Budget Organizational unit Technical support for organizational procedures Hiring and retaining qualified people Training <p>Big Data Assimilation in terms of</p> <ul style="list-style-type: none"> Decision-making The functional area of operation The functional area of management 	<p>Green process innovation:</p> <p>Organizational performance</p>
<p><i>HRM</i> Singh and El-Kassar (2019) Top Management Commitment in terms of strategy for</p> <ul style="list-style-type: none"> Decision-making Benefits to the firm Supply chain practices Knowledge sharing Competitive advantage Organizational performance 	<p><i>Sustainability</i> Environmental Strategies in terms of Implementation of environment-friendly practices</p> <ul style="list-style-type: none"> internal and external green SCM (facilitating green management, green technologies and green operations management, cooperation with customers) green technologies green innovation 	<p><i>Big data</i> Big Data Adoption/ Acceptance in terms of</p> <ul style="list-style-type: none"> Firm's value Organizational resources and practices (training, hiring) 	<p><i>Performance</i> Environmental performance in terms of social, environmental, and economic performance</p>

Source(s): Author's own creation

Table 9. Categories observed

Also, in Table 11, it can be observed that the VAR satisfies the stability condition after performing the stability test.

The VAR satisfies the autocorrelation condition, as presented in Table 12. For assuring the autocorrelation, it used the LM test, and it is possible to observe that for lag 1, the condition is satisfied.

Also, one can see in Table 13 that the VAR model respects the heteroskedasticity conditions, and therefore, it is possible to proceed forward with impulse response functions (see Table 14).

After performing the necessary tests for ensuring the VAR robustness, we have performed the impulse-response functions in order to observe the response of certain variables to the impact of others, according to our hypotheses. We have obtained a general overview that could be a starting point for HRM decisions with this approach.

Table 10.
Number of lags
selected

Lag	LogL	LR	FPE	AIC	SC	HQ
0	218.8114	NA	2.54e-10	-5.066937	-4.893307	-4.997139
1	372.5078	281.7769	1.54e-11	-7.869234	-6.653826*	-7.380650*
2	414.0964	70.30441*	1.37e-11*	-8.002294*	-5.745107	-7.094924
3	443.1952	45.03399	1.67e-11	-7.837982	-4.539016	-6.511826

Source(s): Author's own creation

Table 11.
VAR stability
condition

Root	Modulus
0.984729	0.984729
0.557812-0.178282i	0.585610
0.557812 + 0.178282i	0.585610
-0.051869-0.520226i	0.522805
-0.051869 + 0.520226i	0.522805
-0.389444-0.097122i	0.401372
-0.389444 + 0.097122i	0.401372
0.283742-0.096016i	0.299547
0.283742 + 0.096016i	0.299547
-0.198708	0.198708
-0.049992-0.149506i	0.157643
-0.049992 + 0.149506i	0.157643

No root lies outside the unit circle
VAR satisfies the stability condition
Source(s): Author's own creation

Table 12.
VAR residual serial
correlation

Lags	LM-Stat	Prob
1	55.43606	0.0202
2	39.25581	0.3261
3	29.73083	0.7602
4	36.73245	0.4348
5	44.20634	0.1637
6	33.35731	0.5949

Probs from chi-square with 36 df
Source(s): Author's own creation

5. Results of empirical research

5.1 The response to productivity

By looking at Figure 11 (a and b), it is possible to validate hypothesis H1, as the impact of the employees with tertiary education and IT education is having a positive effect on productivity. This makes perfect sense-being in line with mainstream literature stating a positive impact.

However, a new interesting observation resides in the impact as IT employees have a more significant effect on productivity than tertiary education ones.

5.2 The response of wellbeing (taken as GDP per capita)

Figure 12 (a and b) show that the impact of the employees with tertiary education and IT training is positive, thus confirming hypothesis 2. Besides, it emerges that tertiary education employees have a more significant impact on well-being (taken as GDP per capita) than employees with IT training.

5.3 The response to social exclusion

As observed in Figure 13 (a and b), the response to social exclusion is negative, thus proving our hypothesis H3 to be right. Therefore, it makes perfect sense that by increasing educational attainment, there will be a decrease in social exclusion. However, it emerges that tertiary education has a more significant impact than IT training.

5.4 The influence of IT training on enterprises

Figure 14 (a and b) highlight a divergent response to IT training. Thus, the number of employees with tertiary education negatively reacts to IT training, but after year 5, the impact turns positive. *Therefore, companies' shock of IT training is resorbed, so IT training in enterprises has to be continuous to respond to the fast changes in IT skills.* In terms of IT employees, the impact is positive; there will be a need for IT personnel. However, with time, as the training continues, the need for IT personnel is no longer as high, as certain employees can take the skills needed in terms of IT education. *So, the continuous IT training offered by enterprises is reducing the need for IT personnel.*

Therefore, hypothesis 4_a is confirmed partially, as the impact becomes positive after year 5 in Figure 14 (a and b), is positive in the beginning, and turns negative.

5.5 The response of IT training to increasing IT employees

In Figure 15, we observe the response of IT training in enterprises to the increase of IT personnel. IT training will decrease when more IT personnel are hired, thus confirming hypothesis 4_b. This response makes perfect sense, as the tasks performed by IT personnel are replacing the skills created by training. Thus, the company will need to perform a cost-benefit analysis to observe which decision is more appropriate regarding both HRM and a financial perspective.

Chi-sq	df	Prob
380.8246	252	0.0000

Source(s): Author's own creation

Table 13.
VAR residual
heteroskedasticity
tests: no cross terms
(only levels and
squares)

5.6 Control variable: response of social exclusion to increasing GDP per capita

Figure 16 was used to control variables to observe if the social exclusion is decreasing, while the GDP per capita is increasing. Our control variables are correct since the literature review confirms that by increasing GDP per capita, in *ceteris paribus* conditions, the social exclusion will decrease.

5.7 Summary of findings

No.	Impulse response function	Observation
1	The response of productivity to employees with tertiary education	The impact is positive and long-lasting. Thus, we can state that employees with tertiary education are improving their productivity
2	The response of productivity to IT employees	The impact is positive and long-lasting. It is possible to state that in the BIG DATA era, IT&C personnel are improving productivity
3	The response of GDP to employees with tertiary education	The impact is positive and long-lasting. Thus, we can state that employees with tertiary education, by improving productivity, are also increasing GDP, hence the level of well-being
4	The response of GDP to IT employees	The impact is positive and long-lasting. Thus, we can state that IT employees, by improving productivity, are also increasing GDP per capita
5	The response of social exclusion to employees with tertiary education	The impact is negative and long-lasting. Therefore, employees with tertiary education are reducing social exclusion. The trend is maintained for the entire period of observation
6	The response of social exclusion to IT employees	The impact is negative but not as intensive as the person with tertiary education
7	The response of employees with tertiary education to IT training performed by enterprises	The impact starts as negative but continues as positive. We can state that although the company hired personnel with tertiary education, there is still a need for IT training within the company. Thus, IT skills need periodic updates
8	The response of IT employees to IT training performed by enterprises	Here, the impact starts as positive but becomes negative. Thus, we can affirm that IT training for the needs of the enterprise is necessary for IT personnel. However, the impact diminishes; thus, we can confirm that periodical IT training is needed
9	The response of IT training to IT personnel	We can observe that the reaction to IT training is negative to the increased IT personnel. Therefore, hiring an IT employee diminishes the need to invest in IT training. Thus, the management can pursue a cost-benefit analysis to observe if the context of sustainable HR management is more cost-efficient to hire an IT employee rather than pay for IT training
10	Control variable – response of social exclusion to GDP per capita	We can observe that the control variables are correct. Thus, an increase in GDP per capita will decrease social exclusion

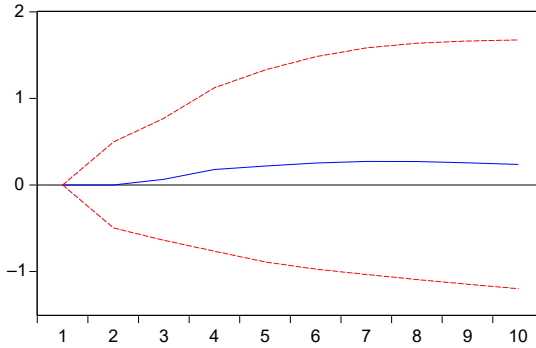
Table 14.
Summary of findings

Source(s): Author's own creation

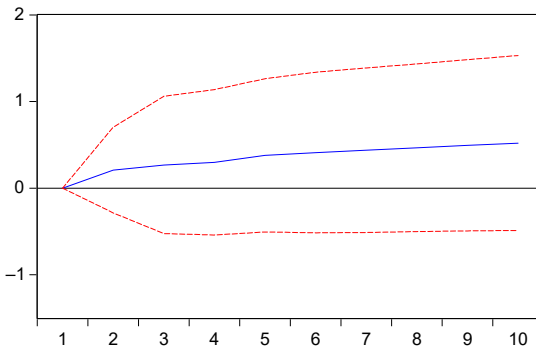
6. Discussions of findings

BD research is emerging as an essential discipline in the HRM field, even if it's still discontinuous and limited. Virtually all HRM subareas deserve special attention: people resourcing, learning and development, career, employee relations, performance and awards, as well as a flexible work system. Investigations are mainly conducted through case studies and conceptual papers, meaning that there is an increasing need to develop an integrated and standardized method for managing human resources in organizations and transforming BD

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.
 Accumulated Response of D_PRODUCTIVITY to DL_EMPLOYEES3



Accumulated Response of D_PRODUCTIVITY to DL_ITEMPLOYEES



Source(s): Author's own work

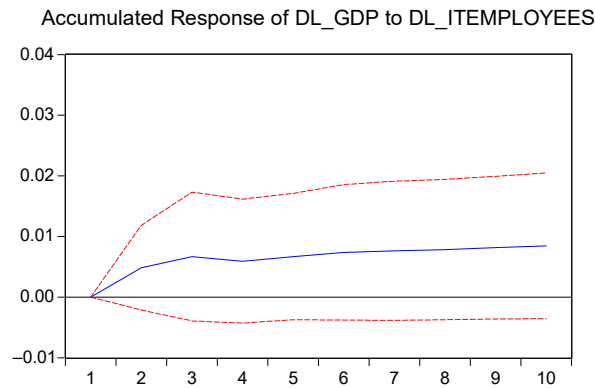
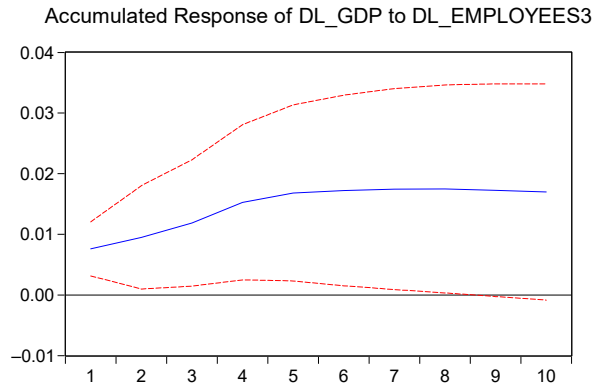
Figure 11.
 (a and b): Response of productivity to training (employees with tertiary education and IT education)

into a real sustainable advantage for companies. Using highly complex information could support managerial strategies to plan actions for future scenarios. The systematic literature review, developed in the first part of the paper, has demonstrated that using BD bring many benefits in corporate operational and strategic HRM. It is becoming increasingly clear that we are facing a new era of HRM, one in which new technologies, BD, artificial intelligence and the latest developments in work-from-home phenomena will shape the major trends of HRM faster than we would have expected a few years ago.

6.1 Operational HRM

6.1.1 People resourcing. Managing people remains a top organizational priority. The proliferation of BD has given rise to new ways of organizing employees. Based on employees' characteristics (Fathian *et al.*, 2017) and talent management (Yuan *et al.*, 2015; Martin-Rios *et al.*, 2017; El-Kassar and Singh, 2019; Cheng *et al.*, 2018; Fathian *et al.*, 2017; Osuszek *et al.*, 2016; Campion *et al.*, 2018), BD can be helpful to define reasonable solutions for managing work assignments (Yuan *et al.*, 2015), absenteeism, retention, permits and turnover (Martin-Rios *et al.*, 2017; Wang and Cotton, 2018) of staff. However, using BD in HRM has some risks:

Accumulated Response to Chole sky One S.D. Innovations \pm 2 S.E.



Source(s): Author's own work

Figure 12.
(a and b): Response of well-being to training (employees with tertiary education and IT education)

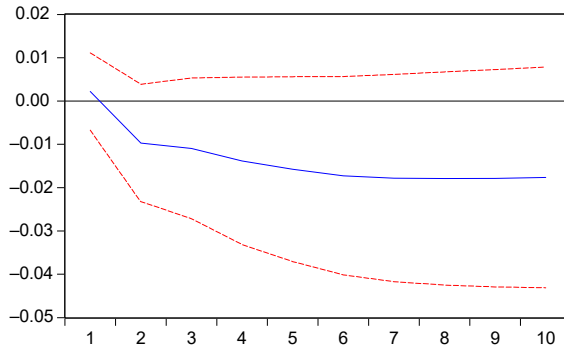
it may give room for inequalities at work. Employees' rights may be infringed in the hiring/promotion process, and their voices manipulated (Calvard and Jeske, 2018).

6.1.2 Recruitment process. In an age characterized by a "war of talent" (Chambers *et al.*, 1998), capturing the best talent becomes a priority for any company. In the recruitment process (Yuan *et al.*, 2015; Campion *et al.*, 2018; De Mauro *et al.*, 2018; Fathian *et al.*, 2017), BD can guarantee the selection of the best candidates with skills, personality traits and abilities (Martin-Rios *et al.*, 2017), in connection with the searched profile and the existing database of most-suited employees for the roles. All this is possible in short response times, with the possibility of filling the vacant position more quickly while significantly reducing recruitment costs. The companies' predictability and ability in relation to BD are used to make them self-sufficient and capable of achieving highly competitive advantages. However, the use of big information in the recruitment process could be a risk for companies (Calvard and Jeske, 2018). The information at hand could not be accurate or inaccessible (even without authorization) to enterprises; in this case, the selection process could be guided by false information.

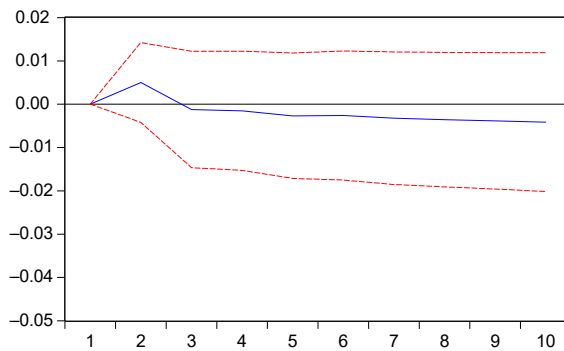
6.1.3 Performance, awards and career. Compensation is one of the most relevant factors in the process of attracting new employees into companies. Attracting the best candidates

Accumulated Response to Chole sky One S.D. Innovations \pm 2 S.E.

Accumulated Response of DL_EXCLUSION to DL_EMPLOYEES3



Accumulated Response of DL_EXCLUSION to DL_ITEMPLOYEES



Source(s): Author’s own work

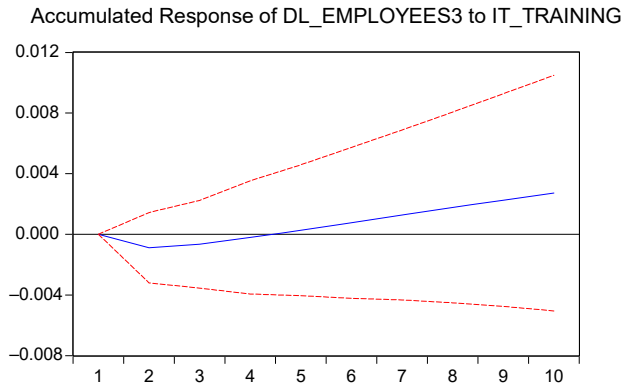
Figure 13. (a and b): Response of well-being to training (employees with tertiary education and IT education)

ensures high worker performance, but the employing company must guarantee excellent compensation and attractive economic rewards. BD can be utilized to give management specific and fast information on each employee’s work content, daily workload and task achievement (Zhang, Y. (2017); Yuan *et al.*, 2015; Wang and Cotton, 2018; Campion *et al.*, 2018; De Mauro *et al.*, 2018; Popović, Hackney, Tassabehji and Castelli, 2018; Osuszek *et al.*, 2016; Cheng *et al.*, 2018; Fathian *et al.*, 2017; Martin-Rios *et al.*, 2017; El-Kassar and Singh, 2019). With such far-fetched and fast information, talents can be easily and rapidly identified, thus improving efficiency and efficacy in HR management and career planning.

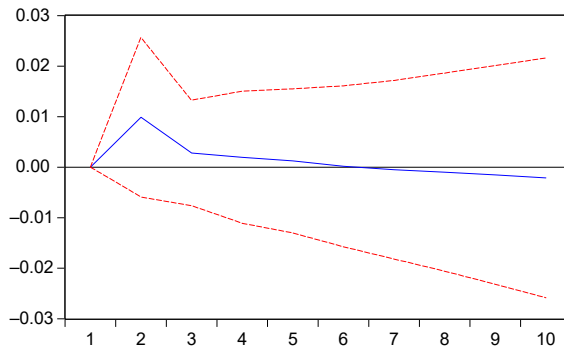
6.1.4 Learning and development. Training is an integral aspect of HRM. Collecting and analyzing data and intensifying the knowledge level are generally vital to increasing performance (Zhang, Y. (2017); Martin-Rios *et al.*, 2017; El-Kassar and Singh, 2019). Furthermore, the advent of BD in workplaces henceforth allows for:

- (1) Exploring new options to determine the skills and topics that should be covered to develop the right expertise.
- (2) Finding the most appropriate programs.

Accumulated Response to Chole sky One S.D. Innovations \pm 2 S.E.



Accumulated Response of DL_ITEMPLOYEES to IT_TRAINING



Source(s): Author's own work

Figure 14.
(a and b): Response of
number of employees
to IT training

- (3) Studying the behavior of each employee for feedback.
- (4) Choosing the best form of teaching for the future.

6.1.5 *Flexible work systems.* Over the past years, companies have developed new flexible-working systems in response to the economic crisis, and the employees need to balance their private life and their work. In this context, BD represent innovative support to speed up development and explore new opportunities for part-time jobs, as it provides connectors between the company and its workers.

In addition, working from home has become a significant phenomenon in recent months due to the COVID-19 epidemic. Thus, it remains to be seen whether the largest work-from-home experiment in history had a limited span at the time of the epidemic or it will already be proven effective and cumulated with BD; it will forever change working and, in the *ceteris paribus* conditions, HRM.

6.1.6 *Employee relations.* Maintaining good employee relations is an integral part of a company's success. Happy and engaged employees produce the best possible work. An employee relations program that uses BD could be effective because of its ability to explore a variety of information representing the history of the company's rules, procedures

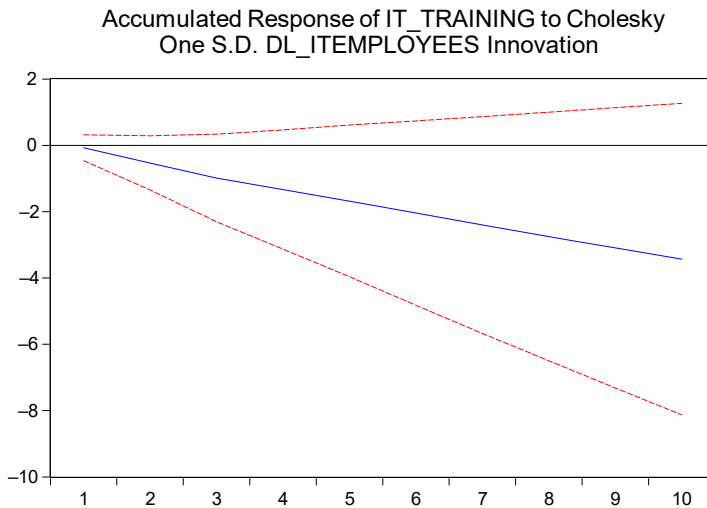


Figure 15.
The response of IT training to IT personnel

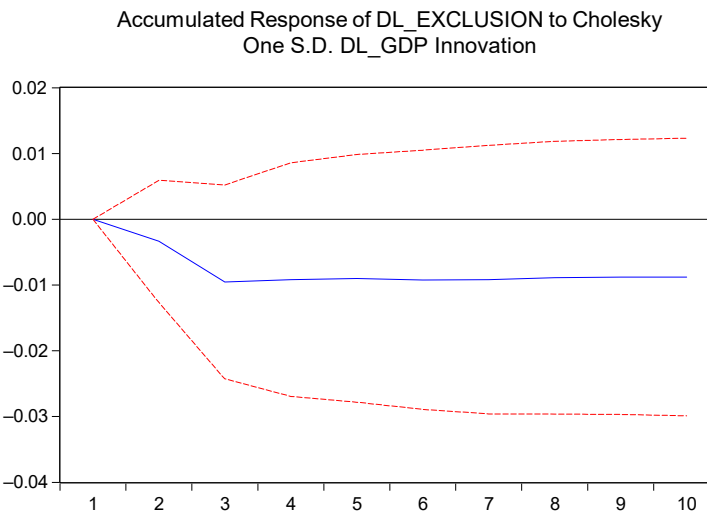


Figure 16.
Control variable (impact of GDP per capita on social exclusion)

Source(s): Author's own work

and philosophy, all of which are useful for addressing employee-related matters and helping resolve their problems in the workplace.

6.2 Strategic HRM

The current state of research demonstrates that BD can support decision-making processes (Calvard and Jeske, 2018; Martin-Rios *et al.*, 2017; El-Kassar and Singh, 2019). BD offer a high form of knowledge and intelligence (Knapp, 2013) that can generate appropriate planning for HRM. The core asset of BD in HRM is its potential to produce new knowledge compared to other information systems. This entails a strategic view for gathering, storing, managing and

manipulating vast amounts of data, with important implications in creating competitive and sustainable advantage.

6.3 Empirical analysis

The results of empirical analysis prove the testing hypotheses. Tertiary education and IT education are having a positive impact on productivity (H1) and well-being (H2), as was supposed. In addition, training and education are having a negative impact on social exclusion (H3). According to H4a and H4b, an interesting finding is that investing in IT training for a company will have a negative and significant impact on the number of tertiary education personnel during the first half of the analyzed period. The first conclusion is that the enterprise has to keep investing in IT training to adapt well to the new skill requirements in the labor market. Second, investing in IT training will decrease the need for IT employees with IT education. So, IT skills can be taught through training, thus replacing IT employees with IT education.

Another interesting finding in our study is that the IT training offered decreases when IT personnel are hired (H4b). However, in our opinion, the company will need to perform a cost-benefit analysis to observe which decision is more appropriate with regard to both HRM and financial perspective. In conclusion, the findings of this study demonstrate the numerous benefits of leveraging BD in HRM decisions to optimize the relationship between training, productivity and well-being. Data-driven training needs analysis, personalized training and development, enhanced training evaluation, predictive analytics for workforce planning, employee well-being and agile decision-making are all areas where BDA can bring significant advantages. By harnessing these benefits, organizations can make informed decisions that enhance productivity, foster employee well-being and create a harmonious balance between training initiatives and organizational objectives. However, it is crucial to address data privacy concerns and ethical considerations and ensure effective communication with employees to build trust and ensure responsible use of BD in HRM. The findings of this study demonstrate the positive influence of integrating BD technologies into HRM practices on sustainable performance. Improved decision-making, talent acquisition, personalized development, employee well-being, diversity and inclusion and environmental sustainability are all areas where BDA can drive positive outcomes. By leveraging these insights and implementing data-driven strategies, organizations can enhance their HRM practices and achieve long-term sustainability goals. However, it is important to consider ethical implications, data privacy concerns and organizational readiness when adopting and implementing BDA in HRM to ensure responsible and sustainable practices.

6.4 A holistic comparison of our findings with other studies

The main findings of our study showed that numerous studies employed the combination of BD and HRM, and their effects on the firm's sustainability remain inconsistent and inconclusive. Although some consistent studies emerged, these studies focused on investigation, which is based on BD and HRM components separately or in the form of a combination. However, our findings shed light that it is possible to identify three clusters: (1) the combination of BD and HRM; (2) the combination of studies on HRM and sustainability, and (3) studies based on BD and sustainability. For example, [Amrutha and Geetha \(2020\)](#) investigated the impact of green HRM practices on productivity, but researchers did not investigate the relevance of BD. [Gardas et al. \(2019\)](#) identified an integrated model based on only two dimensions: HRM and sustainability. In the same way, [Zaid et al. \(2018\)](#), [Joshi and Dhar \(2020\)](#) and [Maas and Reniers \(2014\)](#) examined challenges in HRM for a sustainable business. The state-of-the-art, such as [Sivathanu and Pillai \(2018\)](#), [Bag et al. \(2020\)](#), [Song et al. \(2017\)](#), [Dubey et al. \(2017\)](#) and [Ur Rehman \(2016\)](#), demonstrated how

digital technologies can support sustainability, while several studies investigated by Calvard and Jeske (2018), Campion *et al.* (2018), Hamilton and Sodeman (2020), Angrave *et al.* (2016) and De Mauro *et al.* (2018) focused on the relationship between BD and HRM.

Thus, this paper demonstrates a comprehensive view of BD, HRM and sustainability and presents the usage of these core areas in the business world. Further, this paper highlights how academic studies must leave the universe to find inspiration and innovate through a more holistic approach. In a nutshell, the current study has underlined that only two papers (El-Kassar and Singh, 2019; Singh and El Kassar, 2019) consider all the dimensions of BD, HRM and sustainability. Consequently, our paper contributes to the academic body of knowledge by highlighting that companies must review traditional HRM models in order to make them capable and align the principles of the BD with the principles of sustainability.

7. Concluding remarks

Our study was designed with the purpose of bringing to light, through a systematic literature review, the ability of companies to integrate and improve HRM with BD technologies, as well as their influence on sustainable performance. Thanks to the findings of the review, a conceptual holistic research model was identified and tested empirically to highlight the benefits of BD in HRM decisions that can optimize the relationship between training, productivity and well-being.

The results clearly show the many potential benefits of BD in HRM and the close relationships built between HRM, BD and sustainability to achieve a sustainable competitive advantage. Though existing relevant studies remain insufficient (notably regarding the link with sustainability, with only one research work identified), such relationships are evident and should be further investigated. Future studies may consider the conditions and BD impact on “individual employee sustainability and the ability of HRM systems to attract, regenerate and develop motivated and engaged employees continuously” (Ehnert *et al.*, 2013) while reinforcing their sustainability as viable corporate systems. In addition, it may be interesting to analyze the sustainability factor in terms of cooperation with top management for well-achieved economic, ecological, social and human goals. At this stage of research, it is possible to foresee a further study in the following directions: (1) to continue to improve the focus research on BD, HRM and sustainability; (2) to identify empirical applications in which BD could be a useful tool for managerial topics to support sustainability in companies; (3) to develop quantitative studies to examine, from a practical perspective, how the HRM analytic results support strategic decision-making in further steps and (4) to extend the experimental, data analysis and survey in this field to support policies and market forces.

Regarding BD generation, our research has found that the response of productivity to IT employees is positive and long-lasting. Thus, in the BD era, IT&C personnel are improving productivity. In addition, the response of GDP to IT employees is positive and long-lasting; thus, we can state that IT employees, by improving productivity, are also increasing GDP per capita. The impact of IT personnel has a positive impact on productivity and well-being, both considered GDP per capita and social exclusion.

In addition, the response of IT employees to IT training performed by enterprises starts as positive but becomes negative. Thus, IT personnel need IT training for the enterprise are needs. However, the impact diminishes; therefore, we can affirm that periodical IT training is needed. Continuous digital training is fundamental and necessary for organizational renewal, capable of integrating, building and reconfiguring internal resources and skills.

In our opinion, therefore, it represents a strategic asset capable of achieving challenging personal goals and developing skills that allow workers to act in the most effective way possible and allowing the company always to have new knowledge and internal skills useful for success.

Technology requires constant change. Current knowledge and skills risk becoming obsolete if companies are unable to keep up with the pace of change. Continuous training is necessary to keep up to date with the IT skills required by the sector.

However, the response of IT training to IT personnel is negative. Therefore, hiring an IT employee diminishes the need to invest in IT training. We can state that the management can and should pursue a cost-benefit analysis to observe if it is more cost-efficient to hire an IT employee rather than pay for IT training in the context of sustainable HR management.

There are many factors to consider. The cost of hiring a new employee depends on the size of the company but is usually higher for a small business than for a medium or large one, while training an internal member has the advantage that this person will already know the processes and systems he uses. This means that all training will be focused solely on the additional skills to be acquired.

Hiring a new employee can be an injection of new energy into the company and add new and interesting points of view that will help your company grow. Offering employees growth opportunities helps significantly to motivate and increase the sense of belonging within the company.

The dilemma, therefore, remains open: upskilling or hiring?

7.1 Theoretical and practical implications of the study

BD and its use in the decision-making process is a powerful tool that certainly could increase the effectiveness of HRM and firms' sustainable performance. In particular, this study has put evidence that BD use guarantees a quality HRM system and its continuous improvement in terms of sustainability. These findings, consistent with previous theoretical research (El-Kassar and Singh, 2019; Singh and El-Kassar, 2019), represent a step forward in this research field, even if in theoretical and empirical research, BD are not yet perceived as a potentiality for the development of HRM green practices.

Our study highlights that the exploitation of BD emphasizes the long-term effects on human resources. Furthermore, it has been shown that tertiary education and IT education and training positively influence productivity. These research results can help researchers in a thorough understanding of BDA for sustainable business. In the context of Industry 4.0, the need for IT graduates and IT training will increase over time, changing the paradigm of HRM toward a more digitalized and sustainable economy.

In sustainable working relationships, BD represent a key element to achieving well-being in terms of structural, interpersonal and individual dimensions of work. In particular, there is a positive impact in terms of availability and fluidity of information, recognition, incentives and clarity of corporate functions and roles. From an interpersonal dimension, BD allow the achievement of a better quality of relationship with the company, relationships with superiors, and colleagues, the cohesion of the working group, collaboration, communication dynamics and relationship satisfaction. Finally, BD implements a sense of belonging, satisfaction, motivation, responsibility and autonomy of freedom of expression from an individual dimension. These observations are validated by previous studies (El-Kassar and Singh, 2019; Singh and El-Kassar, 2019). This paper contributes to the advancing knowledge of the impact of BD and HRM on a firm's performance.

7.2 Policy recommendation

Our study has several practical implications and policy recommendations for leaders and managers to improve organizations' sustainable performance in public and private organizations. The impact of our findings in the present context of the COVID-19 epidemic and the new orientation toward working from home, the need for more digital skills and digital education will increase, changing the requirements and the job description toward

enhancing digital alphabetization. The BD's use in HRM facilitates developing the skills, motivations, values and trust among organizations and stakeholders, guaranteeing at the same time the long-term sustainability of internal and external stakeholders, with policies that reflect equity, development, and well-being and support environmentally friendly practices.

In this way, organizations will develop a culture of ethics, respect, integrity, empowerment and commitment of employees who can expand collaborative networks, enhance diversity, open and interactive dialogue with stakeholders and corporate transparency. In addition, this sustainable approach in public and private organizations will encourage the establishment of corporate identity in line with sustainability principles. Organizations are generating vast amounts of data as the world becomes increasingly digitized. Integrating BDA into HRM, practices offers numerous opportunities to enhance decision-making, improve employee well-being and promote sustainability within organizations. By integrating BDA into HRM practices, organizations can pave the way toward sustainability by enhancing decision-making, fostering employee well-being and promoting diversity and inclusion. This policy recommendation emphasizes the need for ethical guidelines, robust data governance, collaboration, predictive analytics and a continuous improvement mindset. By following these strategies, organizations can maximize the potential of BD in HRM while ensuring long-term sustainability and positive employee experiences.

7.3 Limitations of the study and future research

The approach used in our study was mainly one from a macroeconomic level, not going into the economic sectors, where results could be different due to the heterogenous characteristics of the sectors. In addition, although BD can help in the decision-making process of HRM, there will always be certain behavioral characteristics of the manager, which will lead him/her toward a subjective decision, despite certain BD analyses and recommendations. Also, the VAR methodology we have applied always brings certain limitations to it, such as the ad hoc specification, restrictions identified, ordering of the variables and so on. Therefore, future studies can focus on a theoretical approach to holistic methods to take care of this limitation of our study. Furthermore, implementing BDA in HRM requires significant technological infrastructure and organizational readiness. Not all organizations may have the necessary resources or capabilities to adopt and leverage BD effectively. Therefore, future research should examine the barriers and challenges organizations face in implementing BDA in HRM and provide insights into strategies for overcoming these obstacles. Finally, we have conducted our study in European countries empirically; then, future research should expand the sample to other regions. By addressing these limitations and focusing on these future research directions, scholars can further enhance our understanding of integrating BDA in HRM for sustainable practices and contribute to developing effective frameworks and guidelines.

References

- Alaimo, C. and Kallinikos, J. (2021), "Managing by data: algorithmic categories and organizing", *Organization Studies*, Vol. 42 No. 9, pp. 1385-1407. doi: [10.1177/0170840620934062](https://doi.org/10.1177/0170840620934062).
- Amrutha, V.N. and Geetha, S.N. (2020), "A systematic review on green human resource management: implications for social sustainability", *Journal of Cleaner Production*, Vol. 247, 119131, doi: [10.1016/j.jclepro.2019.119131](https://doi.org/10.1016/j.jclepro.2019.119131).
- Angrave, D., Charlwood, A., Kirkpatrick, I., Lawrence, M. and Stuart, M. (2016), "HR and analytics: why HR is set to fail the big data challenge", *Human Resource Management Journal*, Vol. 26 No. 1, pp. 1-11, doi: [10.1111/1748-8583.12090/](https://doi.org/10.1111/1748-8583.12090/).

- Bag, S., Wood, L.C., Xu, L., Dhamija, P. and Kayikci, Y. (2020), "Big data analytics as an operational excellence approach to enhance sustainable supply chain performance", *Resources, Conservation and Recycling*, Vol. 153, 104559, doi: [10.1016/j.resconrec.2019.104559](https://doi.org/10.1016/j.resconrec.2019.104559).
- Bartel, A.P. (1995), "Training, wage growth, and job performance: evidence from a company database", *Journal of Labor Economics*, Vol. 13 No. 3, pp. 401-425.
- Blazquez, D. and Domenech, J. (2018), "Big Data sources and methods for social and economic analyses", *Technological Forecasting and Social Change*, Vol. 130, pp. 99-113, doi: [10.1016/j.techfore.2017.07.027](https://doi.org/10.1016/j.techfore.2017.07.027).
- Bleich, M.R. (2018), "Quality and safety as a core leadership competency", *The Journal of Continuing Education in Nursing*, Vol. 49 No. 5, pp. 200-202, doi: [10.3928/00220124-20180417-03](https://doi.org/10.3928/00220124-20180417-03).
- Bosco, F.A., Uggerslev, K.L. and Steel, P. (2017), "metaBUS as a vehicle for facilitating meta-analysis", *Human Resource Management Review*, Vol. 27 No. 1, pp. 237-254, doi: [10.1016/j.hrmr.2016.09.013](https://doi.org/10.1016/j.hrmr.2016.09.013).
- Brereton, P., Kitchenham, B.A., Budgen, D., Turner, M. and Khalil, M. (2007), "Lessons from applying the systematic literature review process within the software engineering domain", *Journal of Systems and Software*, Vol. 80 No. 4, pp. 571-583, doi: [10.1016/j.jss.2006.07.009](https://doi.org/10.1016/j.jss.2006.07.009).
- Calvard, T.S. and Jeske, D. (2018), "Developing human resource data risk management in the age of big data", *International Journal of Information Management*, Vol. 43, pp. 159-164, doi: [10.1016/j.ijinfomgt.2018.07.011](https://doi.org/10.1016/j.ijinfomgt.2018.07.011).
- Campion, M.C., Campion, M.A. and Campion, E.D. (2018), "Big data techniques and talent management: recommendations for organizations and a research agenda for IO psychologists", *Industrial and Organizational Psychology*, Vol. 11 No. 2, pp. 250-257, doi: [10.1017/iop.2018.14](https://doi.org/10.1017/iop.2018.14).
- Canova, F. and Ciccarelli, M. (2013), "Panel Vector Autoregressive Models: a Survey☆ the views expressed in this article are those of the authors and do not necessarily reflect those of the ECB or the Eurosystem", in *VAR Models in Macroeconomics—New Developments and Applications: Essays in Honor of Christopher A. Sims*, Emerald Group Publishing, pp. 205-246.
- Caputo, F., Cillo, V., Candelo, E. and Liu, Y. (2019), "Innovating through digital revolution: the role of soft skills and Big Data in increasing firm performance", *Management Decision*, Vol. 57 No. 8, pp. 2032-2051.
- Chambers, E.G., Foulon, M., Handfield-Jones, H., Hankin, S.M. and Michaels, E.G., III (1998), "The war for talent", *The McKinsey Quarterly*, No. 3, p. 44.
- Chang, Y.H. and Yeh, Y.J.Y. (2018), "Industry 4.0 and the need for talent: a multiple case study of Taiwan's companies", *International Journal of Product Development*, Vol. 22 No. 4, pp. 314-332, doi: [10.1504/IJPD.2018.091150](https://doi.org/10.1504/IJPD.2018.091150).
- Chen, J., Lv, Z. and Song, H. (2019), "Design of personnel big data management system based on blockchain", *Future Generation Computer Systems*, Vol. 101, pp. 1122-1129.
- Cheng, M.M. and Hackett, R.D. (2021), "A critical review of algorithms in HRM: definition, theory, and practice", *Human Resource Management Review*, Vol. 31 No. 1, 100698.
- Cheng, Z., Xu, Y. and Cui, J. (2018), "The Formation of employee retention basing on computer communication networks", *Wireless Personal Communications*, Vol. 103, pp. 547-561, doi: [10.1007/s11277-018-5460-8](https://doi.org/10.1007/s11277-018-5460-8).
- Cotes, J. and Ugarte, S.M. (2021), "A systemic and strategic approach for training needs analysis for the International Bank", *Journal of Business Research*, Vol. 127, pp. 464-473.
- Dahlbom, P., Siikanen, N., Sajasalo, P. and Jarvenpää, M. (2020), "Big data and HR analytics in the digital era", *Baltic Journal of Management*, Vol. 15 No. 1, pp. 120-138.
- De Mauro, A., Greco, M., Grimaldi, M. and Ritala, P. (2018), "Human resources for Big Data professions: a systematic classification of job roles and required skill sets", *Information Processing and Management*, Vol. 54 No. 5, pp. 807-817, doi: [10.1016/j.ipm.2017.05.004](https://doi.org/10.1016/j.ipm.2017.05.004).
- Deng, M. and Cao, Y. (2018), "Innovation and effect evaluation model of education and training outsourcing of state-owned enterprises under big data", *Educational Sciences: Theory and Practice*, Vol. 18 No. 6.

- Dessureault, S. (2019), "Rethinking fleet and personnel management in the era of IoT, big data, gamification, and low-cost tablet technology", *Mining, Metallurgy and Exploration*, Vol. 36 No. 4, pp. 591-596.
- Dubey, R., Gunasekaran, A., Childe, S.J., Papadopoulos, T., Luo, Z., Wamba, S.F. and Roubaud, D. (2017), "Can big data and predictive analytics improve social and environmental sustainability?", *Technological Forecasting and Social Change*, Vol. 144, pp. 534-545, doi: [10.1016/j.techfore.2017.06.020](https://doi.org/10.1016/j.techfore.2017.06.020).
- Dutta, D. and Bose, I. (2015), "Managing a big data project: the case of ramco cements limited", *International Journal of Production Economics*, Vol. 165, pp. 293-306, doi: [10.1016/j.ijpe.2014.12.032](https://doi.org/10.1016/j.ijpe.2014.12.032).
- Ehnert, I., Harry, W. and Zink, K.J. (2013), "Sustainability and HRM: an introduction to the field", in *Sustainability and Human Resource Management: Developing Sustainable Business Organizations*, Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 3-32.
- Eisenhardt, K.M. and Martin, J.A. (2000), "Dynamic capabilities: what are they?", *Strategic Management Journal*, Vol. 21 Nos 10-11, pp. 1105-1121.
- El-Kassar, A.N. and Singh, S.K. (2019), "Green innovation and organizational performance: the influence of big data and the moderating role of management commitment and HR practices", *Technological Forecasting and Social Change*, Vol. 144, pp. 483-498, doi: [10.1016/j.techfore.2017.12.016](https://doi.org/10.1016/j.techfore.2017.12.016).
- Elkington, J. (1994), "Towards the sustainable corporation: win-win-win strategies for sustainable development", *California Management Review*, Vol. 36 No. 2, pp. 90-100, doi: [10.2307/41165746](https://doi.org/10.2307/41165746).
- Elkington, J. (2004), "Enter the Triple Bottom line", in Henriques, A. and Richardson, J. (Eds), *The Triple Bottom Line: Does it All Add up?*, Earthscan, London.
- Evans-Pughe, C. (2014), "Analogue makes light work of big data", *Engineering and Technology*, Vol. 9 No. 12, pp. 36-40, doi: [10.1049/et.2014.1202](https://doi.org/10.1049/et.2014.1202).
- Farrington, T. and Alizadeh, A. (2017), "On the Impact of Digitalization on R&D: r&D practitioners reflect on the range and type of digitalization's likely effects on R&D management", *Research-Technology Management*, Vol. 60 No. 5, pp. 24-30, doi: [10.1080/08956308.2017.1348130](https://doi.org/10.1080/08956308.2017.1348130).
- Fathi, R., Thom, D., Koch, S., Ertl, T. and Fiedrich, F. (2020), "VOST: a case study in voluntary digital participation for collaborative emergency management", *Information Processing and Management*, Vol. 57 No. 4, 102174.
- Fathian, M., Saei-Shahi, M. and Makui, A. (2017), "A new optimization model for reliable team formation problem considering experts' collaboration network", *IEEE Transactions on Engineering Management*, Vol. 64 No. 4, pp. 586-593, doi: [10.1109/TEM.2017.2715825](https://doi.org/10.1109/TEM.2017.2715825).
- Garcia-Arroyo, J. and Osca, A. (2021), "Big data contributions to human resource management: a systematic review", *The International Journal of Human Resource Management*, Vol. 32 No. 20, pp. 4337-4362.
- Gardas, B.B., Mangla, S.K., Raut, R.D., Narkhede, B. and Luthra, S. (2019), "Green talent management to unlock sustainability in the oil and gas sector", *Journal of Cleaner Production*, Vol. 229, pp. 850-862, doi: [10.1016/j.jclepro.2019.05.018](https://doi.org/10.1016/j.jclepro.2019.05.018).
- Gu, W., Foster, K., Shang, J. and Wei, L. (2019), "A game-predicting expert system using big data and machine learning", *Expert Systems with Applications*, Vol. 130, pp. 293-305.
- Gupta, M. and George, J.F. (2016), "Toward the development of a big data analytics capability", *Information and Management*, Vol. 53 No. 8, pp. 1049-1064.
- Hamilton, R.H. and Sodeman, W.A. (2020), "The questions we ask: opportunities and challenges for using big data analytics to strategically manage human capital resources", *Business Horizons*, Vol. 63 No. 1, pp. 85-95.
- Harvey, A.C. (1990), *The Econometric Analysis of Time Series*, Mit Press.
- Ivaschenko, A., Dvoynina, O., Andreev, M., Sitnikov, P. and Martyshkin, D. (2015a), "Knowledge engineering based on big data for enterprise project management", *International Journal of Applied Engineering Research*, Vol. 10 No. 14, pp. 34532-34534.

- Ivaschenko, A., Martyshkin, D., Fedotov, S., Sitnikov, P. and Surnin, O. (2015b), "Intelligent human resources (HR) portalbased on knowledge engineering", *International Journal of Applied Engineering Research*, Vol. 10 No. 14, pp. 34535-34536.
- Ivaschenko, A., Martyshkin, D., Fedotov, S., Sitnikov, P. and Vasin, P. (2015c), "Knowledge engineering method implementationfor digital archives", *International Journal of Applied Engineering Research*, Vol. 10 No. 14, pp. 34537-34539.
- Jiang, C. and Li, Y. (2019), "Health big data classification using improved radial basis function neural network and nearest neighbor propagation algorithm", *IEEE Access*, Vol. 7, pp. 176782-176789.
- Johnson, A.E., Ghassemi, M.M., Nemati, S., Niehaus, K.E., Clifton, D.A. and Clifford, G.D. (2016), "Machine learning and decision support in critical care", *Proceedings of the IEEE*, Vol. 104 No. 2, pp. 444-466, doi: [10.1109/JPROC.2015.2501978](https://doi.org/10.1109/JPROC.2015.2501978).
- Joshi, G. and Dhar, R.L. (2020), "Green training in enhancing green creativity via green dynamic capabilities in the Indian handicraft sector: the moderating effect of resource commitment", *Journal of Cleaner Production*, Vol. 267, 121948, doi: [10.1016/j.jclepro.2020.121948](https://doi.org/10.1016/j.jclepro.2020.121948).
- Jun, S.P., Yoo, H.S. and Choi, S. (2018), "Ten years of research change using Google Trends: from the perspective of big data utilizations and applications", *Technological Forecasting and Social Change*, Vol. 130, pp. 69-87, doi: [10.1016/j.techfore.2017.11.009](https://doi.org/10.1016/j.techfore.2017.11.009).
- Ke, Y. (2017), "90. Exploration and development of public service of human resources and social security based on big data", *Boletín Técnico*, Vol. 55 No. 16, ISSN: 0376-723X.
- Kim, H.W., Park, J.H. and Jeong, Y.S. (2016), "Human-centric storage resource mechanism for big data on cloud service architecture", *The Journal of Supercomputing*, Vol. 72 No. 7, pp. 2437-2452, doi: [10.1007/s11227-015-1390-3](https://doi.org/10.1007/s11227-015-1390-3).
- Kitchenham, B. (2004), "Procedures for performing systematic reviews", Keele, Keele University, Vol. 33 No. 2004, pp. 1-26.
- Kitchenham, B., Brereton, O.P., Budgen, D., Turner, M., Bailey, J. and Linkman, S. (2009), "Systematic literature reviews in software engineering—a systematic literature review", *Information and Software Technology*, Vol. 51 No. 1, pp. 7-15, doi: [10.1016/j.infsof.2008.09.009](https://doi.org/10.1016/j.infsof.2008.09.009).
- Knapp, M.M. (2013), "Big data", *Journal of Electronic Resources in Medical Libraries*, Vol. 10 No. 4, pp. 215-222.
- Konings, J. and Vanormelingen, S. (2015), "The impact of training on productivity and wages: firm-level evidence", *Review of Economics and Statistics*, Vol. 97 No. 2, pp. 485-497.
- Li, B. (2014), "Basin management supported by regional green innovation system and related big data project evaluation framework in Zhejiang, East China", *The Open Cybernetics and Systemics Journal*, Vol. 8 No. 1.
- Ling, Z. and Aili, W. (2018), "The application of big data technology in the comprehensive management of the national macro multi-level human resources", *Journal of Advanced Oxidation Technologies*, Vol. 21 No. 2.
- Liu, C., Li, H., Tang, Y., Lin, D. and Liu, J. (2019), "Next generation integrated smart manufacturing based on big data analytics, reinforced learning, and optimal routes planning methods", *International Journal of Computer Integrated Manufacturing*, Vol. 32 No. 9, pp. 820-831.
- Luo, T. (2019), "Research on financial network big data processing technology based on fireworks algorithm", *EURASIP Journal on Wireless Communications and Networking*, Vol. 2019, pp. 1-11.
- Maas, S. and Reniers, G. (2014), "Development of a CSR model for practice: connecting five inherent areas of sustainable business", *Journal of Cleaner Production*, Vol. 64, pp. 104-114, doi: [10.1016/j.jclepro.2013.07.039](https://doi.org/10.1016/j.jclepro.2013.07.039).
- Martin-Rios, C., Pougnet, S. and Nogareda, A.M. (2017), "Teaching HRM in contemporary hospitality management: a case study drawing on HR analytics and big data analysis", *Journal of Teaching in Travel and Tourism*, Vol. 17 No. 1, pp. 34-54, doi: [10.1080/15313220.2016.1276874](https://doi.org/10.1080/15313220.2016.1276874).

- McAfee, A., Brynjolfsson, E., Davenport, T.H., Patil, D.J. and Barton, D. (2012), "Big data: the management revolution", *Harvard Business Review*, Vol. 90 No. 10, pp. 60-68, available at: <https://wiki.uib.no/info310/images/4/4c/McAfeeBrynjolfsson2012-BigData-TheManagementRevolution-HBR.pdf>
- McHale, I.G. and Relton, S.D. (2018), "Identifying key players in soccer teams using network analysis and pass difficulty", *European Journal of Operational Research*, Vol. 268 No. 1, pp. 339-347, doi: [10.1016/j.ejor.2018.01.018](https://doi.org/10.1016/j.ejor.2018.01.018).
- Mello, R. and Martins, R.A. (2019), "Can big data analytics enhance performance measurement systems?", *IEEE Engineering Management Review*, Vol. 47 No. 1, pp. 52-57.
- Mikalef, P., Pappas, I.O., Krogstie, J. and Giannakos, M. (2018), "Big data analytics capabilities: a systematic literature review and research agenda", *Information Systems and E-Business Management*, Vol. 16 No. 3, pp. 547-578, doi: [10.1007/s10257-017-0362-y](https://doi.org/10.1007/s10257-017-0362-y).
- Min, L. (2018), "The application of big data in human resource management", *Journal of Advanced Oxidation Technologies*, Vol. 21 No. 2.
- Nair, K. (2019), "Overcoming today's digital talent gap in organizations worldwide", *Development and Learning in Organizations: An International Journal*, Vol. 33 No. 6, pp. 16-18.
- Ngai, E.W. and Wat, F.K.T. (2002), "A literature review and classification of electronic commerce research", *Information and Management*, Vol. 39 No. 5, pp. 415-429, doi: [10.1016/S0378-7206\(01\)00107-0](https://doi.org/10.1016/S0378-7206(01)00107-0).
- Nocker, M. and Sena, V. (2019), "Big data and human resources management: the rise of talent analytics", *Social Sciences*, Vol. 8 No. 10, p. 273.
- Osuszek, L., Stanek, S. and Twardowski, Z. (2016), "Leverage big data analytics for dynamic informed decisions with advanced case management", *Journal of Decision Systems*, Vol. 25 sup1, pp. 436-449, doi: [10.1080/12460125.2016.1187401](https://doi.org/10.1080/12460125.2016.1187401).
- Oswald, F.L., Behrend, T.S., Putka, D.J. and Sinar, E. (2020), "Big data in industrial-organizational psychology and human resource management: forward progress for organizational research and practice", *Annual Review of Organizational Psychology and Organizational Behavior*, Vol. 7, pp. 505-533, doi: [10.1146/annurev-orgpsych-032117-104553](https://doi.org/10.1146/annurev-orgpsych-032117-104553).
- Palpanas, T. (2015), "Data series management: the road to big sequence analytics", *ACM SIGMOD Record*, Vol. 44 No. 2, pp. 47-52, doi: [10.1145/2814710.2814719](https://doi.org/10.1145/2814710.2814719).
- Pejic-Bach, M., Bertoncel, T., Meško, M. and Krstić, Ž. (2020), "Text mining of industry 4.0 job advertisements", *International Journal of Information Management*, Vol. 50, pp. 416-431.
- Pfander, D., Daiß, G. and Pflüger, D. (2019), "Heterogeneous distributed big data clustering on sparse grids", *Algorithms*, Vol. 12 No. 3, p. 60.
- Pfeffer, J. (1994), *Competitive Advantage through People*, Boston/Mass.
- Polyvyanyy, A., Pika, A., Wynn, M.T. and Ter Hofstede, A.H. (2019), "A systematic approach for discovering causal dependencies between observations and incidents in the health and safety domain", *Safety Science*, Vol. 118, pp. 345-354.
- Popovič, A., Hackney, R., Tassabehji, R. and Castelli, M. (2018), "The impact of big data analytics on firms' high value business performance", *Information Systems Frontiers*, Vol. 20 No. 2, pp. 209-222, doi: [10.1007/s10796-016-9720-4](https://doi.org/10.1007/s10796-016-9720-4).
- Prahalad, C.K. (1983), "Developing strategic capability: an agenda for top management", *Human Resource Management*, Vol. 22 No. 3, pp. 237-254, doi: [10.1002/hrm.3930220304](https://doi.org/10.1002/hrm.3930220304).
- Purcell, J., Hutchinson, S., Kinnie, N., Rayton, B. and Swart, J. (2003), *Understanding the Pay and Performance Link: Unlocking the Black Box*, CIPD, London.
- Qiu, L. and Zhao, L. (2018), "Opportunities and challenges of artificial intelligence to human resource management", *Academic Journal of Humanities and Social Sciences*, Vol. 2 No. 1, pp. 144-153.

- Ragini, J.R., Anand, P.R. and Bhaskar, V. (2018), "Big data analytics for disaster response and recovery through sentiment analysis", *International Journal of Information Management*, Vol. 42, pp. 13-24, doi: [10.1016/j.ijinfomgt.2018.05.004](https://doi.org/10.1016/j.ijinfomgt.2018.05.004).
- Ratner, H. (2020), "Topologies of organization: space in continuous deformation", *Organization Studies*, Vol. 41 No. 11, pp. 1513-1530, doi: [10.1177/0170840619874464](https://doi.org/10.1177/0170840619874464).
- Resch, B., Hoyer, P. and Steyaert, C. (2021), "Affective control in new collaborative work: communal fantasies of purpose, growth and belonging", *Organization Studies*, Vol. 42 No. 5, pp. 787-809, doi: [10.1177/0170840620941616](https://doi.org/10.1177/0170840620941616).
- Rialti, R., Zollo, L., Ferraris, A. and Alon, I. (2019), "Big data analytics capabilities and performance: evidence from a moderated multi-mediation model", *Technological Forecasting and Social Change*, Vol. 149, 119781.
- Rodríguez-Sánchez, J.L., Montero-Navarro, A. and Gallego-Losada, R. (2019), "The opportunity presented by technological innovation to attract valuable human resources", *Sustainability*, Vol. 11 No. 20, p. 5785.
- Roifman, I., Qiu, F., Connelly, K.A., Wright, G.A., Farkouh, M., Jimenez-Juan, L. and Wijesundera, H.C. (2018), "Validation of billing code combinations to identify cardiovascular magnetic resonance imaging scans in Ontario, Canada: a retrospective cohort study", *BMJ Open*, Vol. 8 No. 10, e021370, doi: [10.1136/bmjopen-2017-021370](https://doi.org/10.1136/bmjopen-2017-021370).
- Saberi, M., Hussain, O.K. and Chang, E. (2019), "Quality management of workers in an in-house crowdsourcing-based framework for deduplication of organizations' databases", *IEEE Access*, Vol. 7, pp. 90715-90730.
- Sellitto, C. and Hawking, P. (2015), "Enterprise systems and data analytics: a fantasy football case study", *International Journal of Enterprise Information Systems (IJEIS)*, Vol. 11 No. 3, pp. 1-12, doi: [10.4018/IJEIS.2015070101](https://doi.org/10.4018/IJEIS.2015070101).
- Shamim, S., Zeng, J., Shariq, S.M. and Khan, Z. (2019), "Role of big data management in enhancing big data decision-making capability and quality among Chinese firms: a dynamic capabilities view", *Information and Management*, Vol. 56 No. 6, 103135.
- Sianesi, B. and Reenen, J.V. (2003), "The returns to education: macroeconomics", *Journal of Economic Surveys*, Vol. 17 No. 2, pp. 157-200.
- Singh, S.K. and El-Kassar, A.N. (2019), "Role of big data analytics in developing sustainable capabilities", *Journal of Cleaner Production*, Vol. 213, pp. 1264-1273, doi: [10.1016/j.jclepro.2018.12.199](https://doi.org/10.1016/j.jclepro.2018.12.199).
- Sivathanu, B. and Pillai, R. (2018), "Smart HR 4.0-how industry 4.0 is disrupting HR", *Human Resource Management International Digest*, Vol. 26 No. 4, pp. 7-11. doi: [10.1108/HRMID-04-2018-0059](https://doi.org/10.1108/HRMID-04-2018-0059).
- Song, M., Cen, L., Zheng, Z., Fisher, R., Liang, X., Wang, Y. and Huisingh, D. (2017), "How would big data support societal development and environmental sustainability? Insights and practices", *Journal of Cleaner Production*, Vol. 142, pp. 489-500, doi: [10.1016/j.jclepro.2016.10.091](https://doi.org/10.1016/j.jclepro.2016.10.091).
- Sun, B., Jia, X. and Huang, H. (2018), "Decision-making and management system based on internet of things for Hulun Buir State Farm [J]", *Chinese Science Bulletin*, Vol. 26 No. 3, pp. 209-227.
- Teece, D.J., Pisano, G. and Shuen, A. (1997), "Dynamic capabilities and strategic management", *Strategic Management Journal*, Vol. 18 No. 7, pp. 509-533.
- Tsou, M.C. (2019), "Big data analysis of port state control ship detention database", *Journal of Marine Engineering and Technology*, Vol. 18 No. 3, pp. 113-121.
- ur Rehman, M.H., Chang, V., Batool, A. and Wah, T.Y. (2016), "Big data reduction framework for value creation in sustainable enterprises", *International Journal of Information Management*, Vol. 36 No. 6, pp. 917-928, doi: [10.1016/j.ijinfomgt.2016.05.013](https://doi.org/10.1016/j.ijinfomgt.2016.05.013).
- Wamba, S.F., Gunasekaran, A., Akter, S., Ren, S.J.F., Dubey, R. and Childe, S.J. (2017), "Big data analytics and firm performance: effects of dynamic capabilities", *Journal of Business Research*, Vol. 70, pp. 356-365, doi: [10.1016/j.jbusres.2016.08.009](https://doi.org/10.1016/j.jbusres.2016.08.009).

- Wang, L. and Cotton, R. (2018), "Beyond Moneyball to social capital inside and out: the value of differentiated workforce experience ties to performance", *Human Resource Management*, Vol. 57 No. 3, pp. 761-780, doi: [10.1002/hrm.21856](https://doi.org/10.1002/hrm.21856).
- Wang, G., Gunasekaran, A., Ngai, E.W. and Papadopoulos, T. (2016), "Big data analytics in logistics and supply chain management: certain investigations for research and applications", *International Journal of Production Economics*, Vol. 176, pp. 98-110, doi: [10.1016/j.ijpe.2016.03.014](https://doi.org/10.1016/j.ijpe.2016.03.014).
- Wang, Y., Kung, L. and Byrd, T.A. (2018), "Big data analytics: understanding its capabilities and potential benefits for healthcare organizations", *Technological Forecasting and Social Change*, Vol. 126, pp. 3-13, doi: [10.1016/j.techfore.2015.12.019](https://doi.org/10.1016/j.techfore.2015.12.019).
- Wang, D., Cui, L., Vu, T. and Feng, T. (2020), "Political capital and MNE responses to institutional voids: the case of Chinese state-owned enterprises in Africa", *Organization Studies*, Vol. 43 No. 1, pp. 105-126. doi: [10.1177/0170840620954011](https://doi.org/10.1177/0170840620954011).
- Waurzyniak, P. (2016), "SOFTWARE'S vital importance in the connected machines era", *MANUFACTURING ENGINEERING*, Vol. 157 No. 4, pp. SS3-SS9.
- Wu, F., Zheng, Q., Tian, F., Suo, Z., Zhou, Y., Chao, K.M., . . . and Li, F. (2020), "Supporting poverty-stricken college students in smart campus", *Future Generation Computer Systems*, Vol. 111, pp. 599-616.
- Xie, Z., Phinn, S.R., Game, E.T., Pannell, D.J., Hobbs, R.J., Briggs, P.R. and McDonald-Madden, E. (2019), "Using Landsat observations (1988-2017) and Google Earth Engine to detect vegetation cover changes in rangelands-A first step towards identifying degraded lands for conservation", *Remote Sensing of Environment*, Vol. 232, 111317.
- Yang, L. (2017), "Construction and optimization for performance appraisal index system of enterprise human resource in big Data Era", *Agro Food Industry Hi-Tech*, Vol. 28 No. 3, pp. 3468-3470.
- Yu, S., Xia, F. and Liu, H. (2019), "Academic team formulation based on Liebig's barrel: discovery of anticask effect", *IEEE Transactions on Computational Social Systems*, Vol. 6 No. 5, pp. 1083-1094.
- Yuan, W., Deng, P., Yang, C., Wan, J., Zhang, D., Chen, X., . . . and Liu, Y. (2015), "A smart work performance measurement system for police officers", *IEEE Access*, Vol. 3, pp. 1755-1764, doi: [10.1109/ACCESS.2015.2481927](https://doi.org/10.1109/ACCESS.2015.2481927).
- Zaid, A.A., Jaaron, A.A. and Bon, A.T. (2018), "The impact of green human resource management and green supply chain management practices on sustainable performance: an empirical study", *Journal of Cleaner Production*, Vol. 204, pp. 965-979, doi: [10.1016/j.jclepro.2018.09.062](https://doi.org/10.1016/j.jclepro.2018.09.062).
- Zhang, G. (2017), "Construction of the college education quality management system based on big data and its Evaluation", *Agro Food Industry Hi-Tech*, Vol. 28 No. 1, pp. 3124-3127.
- Zhang, Y. (2017), "An empirical study on dynamic ability evaluation of enterprise mankind resource management based on adaptability theory. Boletín Tecnico/Technical Bulletin, Vol. 55 No. 18, pp. 352-358.
- Zhang, K., Jia, X. and Chen, J. (2019), "Talent management under a big data induced revolution: the double-edged sword effects of challenge stressors on creativity", *Management Decision*, Vol. 57 No. 8, pp. 2010-2031.

Further reading

- Avram, C.D. and Dan, R.L., *Considerations Regarding the Role of Capital in the Financing Decision*, Annals of the University of Craiova, Economic Sciences Series - ISSN 1223-365X, available at: http://feaa.ucv.ro/annals/v2_2019/003.pdf
- Bingyu Sun, X.J. and Huang, He (2018), "Decision-making and management system based on internet of things for Hulun Buir State Farm", *Chinese Science Bulletin*, Vol. 26 No. 3, pp. 209-227.
- Bresciani, S., Ferraris, A. and Del Giudice, M. (2017), "The management of organizational ambidexterity through alliances in a new context of analysis: internet of Things (IoT) smart

city projects”, *Technological Forecasting and Social Change*, Vol. 136, pp. 331-338. doi: [10.1016/j.techfore.2017.03.002](https://doi.org/10.1016/j.techfore.2017.03.002).

Dan, R.L., Buglea, A. and Aniş, C., “The main models of corporate governance”, *Proceedings of International Academic Conferences 3105360, 2015*, International Institute of Social and Economic Sciences, doi: [10.20472/IAC.2015.020.028](https://doi.org/10.20472/IAC.2015.020.028).

Frey, C.B. and Osborne, M.A. (2017), “The future of employment: how susceptible are jobs to computerisation?”, *Technological Forecasting and Social Change*, Vol. 114, pp. 254-280, doi: [10.1016/j.techfore.2016.08.019](https://doi.org/10.1016/j.techfore.2016.08.019).

Lu, H. and Zhao, L. (2018), “Research on human resources performance management competency model under the big data background”, *Journal of Advanced Oxidation Technologies*, Vol. 21 No. 2.

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