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RELEVANCE OF BIG DATA FOR BUSINESS AND MANAGEMENT. EXPLORATORY INSIGHTS (PART I)

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Abstract:

Over the last few decades Big Data has impetuously penetrated almost every domain of human interest/action and it has (more or less consciously) become a ubiquitous presence of day to day life. The main questions this exploratory paper seeks to address (throughout its two parts) are the following: What is the (actual) impact of Big Data on Business & Management and How can businesses (through their management) leverage the potential of Big Data to their benefit? A gradual, step by step approach (based on literature review and a variety of secondary data) will guide the paper in search for answers to the abovementioned questions: starting with a concise history of the topic Big Data as reflected in academia and a critical content analysis of the Big Data concept, the paper will then continue by emphasizing some of the most significant realities and trends that characterize the supply-side of the big data industry; the second part of the paper is dedicated to the investigation of the demand-side of the big data industry – by highlighting some evidences (and projections) on the impact of big data analytics on Business & Management (both at aggregate and granular level) and exploring what companies could and should do (through their management) in order to best capitalize on the opportunities of big data and avoid/minimize the impact of its threats.

Key words: *Big Data, Big Data Analytics, Value, Business, Management*

1. Introduction

Over the last few decades Big Data has impetuously penetrated almost every domain of human interest/action and it has (more or less consciously) become a ubiquitous presence of day to day life. “The big data revolution” (Cuzzocrea, Song, & Davis, 2011) – “a revolution that will transform how we live, work, and think” (Mayer-Schonberger, & Cukier, 2013) – has brought with it “the era of big data” (Brown, Chui, & Manyika, 2011) / ”the age of big data” (Lohr, 2012) – that the “world of big data” (Cumbley, & Church, 2013) is experiencing nowadays.

But beyond big data, and what makes it more than just a buzzword, fueling its transformative power, are “big data analytics” – as “application of advanced analytic techniques to very big data sets” (Russom, 2011), able to pave the way “from insights

to value" (LaValle, et al., 2011) – in general, and "business intelligence" – as "managerial perspective on analytics" (Turban, et al., 2013), capable of making the shift "from big data to big impact" (Chen, Chiang, & Storey, 2012) by "turning big data into big money" (Ohlhorst, 2012) – in particular.

Announced as "the next frontier for innovation, competition, and productivity" (Manyika, et al., 2011), "big data is envisioned as a game changer capable of revolutionizing the way businesses operate in many industries" (Lee, 2017) – because "at its heart big data is not about technology as much as it's about business transformation, (…) about leveraging the unique and actionable insights gleaned about your customers, products, and operations to rewire your value creation processes, optimize your key business initiatives, and uncover new monetization opportunities" (Schmarzo, 2013). Thus, "the use of big data is becoming a key way for leading companies to outperform their peers" (Manyika, et al., 2011), while "smart leaders across industries will see using big data for what it is: a management revolution" (McAfee, et al., 2012).

Against this background, the main questions this exploratory paper seeks to address are the following: What is the (actual) impact of Big Data on Business & Management and How can businesses (through their management) leverage the potential of Big Data to their benefit? A gradual, step by step approach (based on literature review and a variety of secondary data) will guide the paper in search for answers to the abovementioned questions: starting with a concise history of the topic Big Data as reflected in academia and a critical content analysis of the Big Data concept, the paper will then continue by emphasizing some of the most significant realities and trends that characterize the supply-side of the big data industry and its main vendors; the second part of the paper is dedicated to the investigation of the demand-side of the big data industry – by highlighting some evidences (and projections) on the impact of big data analytics on Business & Management (both at aggregate and granular level) and exploring what companies could and should do (through their management) in order to best capitalize on the opportunities of big data and avoid/minimize the impact of its threats.

2. Big Data – the Concept and it's Reflection in Academia

Chronologically speaking, the first appearance of the topic Big Data into the Clarivate Analytics' Web of Science (WoS) Core Collection (wcs.webofknowledge.com) is dated 1993 (Schwardmann, 1993), and regards an Article (as Document Type) belonging to the Computer Science Research Area and placed into the following WoS Categories: Computer Science, Hardware & Architecture; Computer Science, Theory & Methods. Between 1993 and 2006 WoS provides thirty-one results for the "big data" topic; then, it registers an explosive evolution from only 4 entrances in 2007 (three Proceedings Paper and an Editorial Material, placed into the following WoS Categories: Computer Science Artificial Intelligence; Computer Science Theory Methods; Chemistry Applied; Computer Science Information Systems; Computer

Science Interdisciplinary Applications; Computer Science Software Engineering; Engineering Electrical Electronic; Imaging Science Photographic Technology; and Mathematical Computation Biology) to 7,848 entrances in 2017 (Figure 1.).

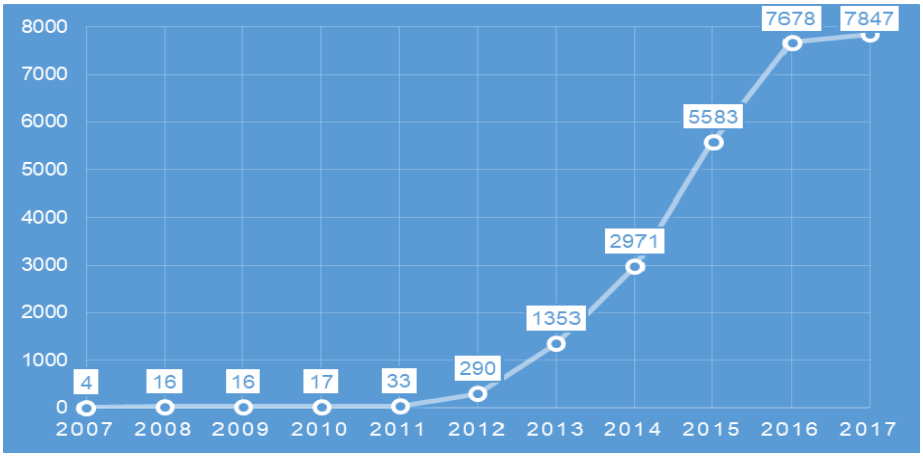

Figure 1: Web of Science Core Collection –"big data" topic results (2007-2017)
Source of data: Web of Science, 2018

By the end of 2017, the WoS Core Collection has gathered a total of 25,839 results for the "big data" topic, the Top 10 records being related to The following WOS Document Types and WOS Categories respectively (Table 1.):

Table 1: WoS Top 10 records for the "big data" topic in terms of Document Types and Categories (at the end of 2017)

Top 10	WOS Categories*	WOS Document Types*
1.	Computer Science Information Systems (6,676)	Proceedings Paper (13,910)
2.	Computer Science Theory Methods (6,547)	Article (9,394)
3.	Engineering Electrical Electronic (6,048)	Editorial Material (1,303)
4.	Computer Science Artificial Intelligence (3,348)	Book Chapter (908)
5.	Computer Science Interdisciplinary Applications (2,466)	Review (748)
6.	Telecommunications (2,176)	Meeting Abstract (351)
7.	Computer Science Hardware Architecture (1,897)	Book Review (99)
8.	Computer Science Software Engineering (1,835)	Book (77)
9.	Automation Control Systems (810)	News Item (75)
10.	**Management (755)**	Letter (66)

*one entrance is placed into multiple WoS Categories and Document Types
Source of data: Web of Science, 2018

A similar (exponential) evolution of entrances has been registered by WoS as regards the Management (755 records – 10th place) and Business (613 records – 14th place) WoS Categories (Table 2.) – with the specification that, out of the 1,368 total entrances for Business and Management, 288 are common for the two WoS Categories (which makes 1,080 unique entrances on one hand, and reflects the strong

content connection between the two WoS Categories when dealing with "big data" on the other hand).

Table 2: Distribution of records for the "big data" topic in the Management and Business WOS Categories – by Year and Document Type (at the end of 2017)

By year			By Document Type		
	Management	**Business**		**Management**	**Business**
2004	-	1	Article	366	294
2005	-	-	Proceedings Paper	289	246
2006	1	-	Book Chapter	108	89
2009	1	1	Editorial Material	61	46
2011	1	1	Review	17	11
2012	8	9	Book	12	11
2013	40	33	Book Review	12	5
2014	93	86	Letter	1	1
2015	130	87	Meeting Abstract	1	3
2016	204	183			
2017	277	212			

Source of data: Web of Science, 2018

A content analysis of the definitions provided (by the Google Scholar platform this time) for the "big data" concept reveals at least three streams of thought:

- ✓ a technical / operational based approach:
  - *"In general, big data shall mean the datasets that could not be perceived, acquired, managed, and processed by traditional IT and software/hard tools within a tolerable time"* (Chen, Mao, & Liu, 2014);
  - *"Big Data is a collection of very huge data sets with a great diversity of types so that it becomes difficult to process by using state-of-the-art data processing approaches or traditional data processing platforms"* (Chen & Zhang, 2014).
- ✓ a dimensions / characteristics based approach:
  - from the "classical" (and quasi-unanimous accepted) *"3 Vs"* of big data – *"volume, velocity and variety"* (Laney, 2001) – to the *"42 Vs"* of big data (Shafer, 2017) – passing through more or less *"Vs"* in between: *4 Vs – "volume velocity, variety, and value"* (Dijcks, 2012) or *"volume, variety, velocity, and veracity"* (Schroeck, et al., 2012); *8 Vs – "volume, variety, velocity, value, veracity, variability, viscosity, and virality"* (Vorhies, 2014), and so on;
  - non-exclusively based on *"Vs"*: *"big data have seven essential characteristics: volume, velocity, variety, exhaustivity, resolution/indexicality, relationality, and flexibility/scalability that distinguish them from small data"* (Kitchin, 2014).
- ✓ a holistic value based approach:

- *"Big data is defined as large amount of data which requires new technologies and architectures so that it becomes possible to extract value from it by capturing and analysis process*" (Katal, Wazid, & Goudar, 2013);
- *"Big Data is the Information asset characterized by such a High Volume, Velocity and Variety to require specific Technology and Analytical Methods for its transformation into Value*" (De Mauro, Greco, & Grimaldi, 2016).

The last stream of thought is the one that leads to the understanding of the (actual) importance and (potential) impact of big data – that basically rely on the "value" big data can deliver. This kind of approach is in line with Marr's (2016) more practical/concrete way of addressing the concept – by arguing that *"currently the term 'big data' is used to describe the fact that everything we do, say, write, visit or buy leaves a digital trace, or it soon will, and the resulting data can then be used by us and others to gain new insights and improve results*" (Marr, 2016) – and opens the doors for (the discussion and analysis of) the "big data industry" in general (Demchenko, Ngo, & Membrey, 2013; Martin, 2015; Kwon, Kwak, & Kim, 2015), and the "big data relevance for business and management" (Waller, & Fawcett, 2013; George, Haas, & Pentland, 2014; Coleman, et al., 2016) in particular.

3. Big Data – the Supply-Side of the Industry

An overall view on the Big Data industry provides the best argument that "big data is about making money" (Schmarzo, 2013) – and *Wikibon's 2018 Big Data Analytics Trends and Forecast Report* (Kobielus, 2018), as well as *Wikibon's 2018 Big Data and Analytics Market Share Report* (Burris, 2018) fully support the abovementioned assertion.

Starting from the premise that "*in the 21st-century, the enterprises that succeed are those that converge their big data analytics (BDA) investments into data-driven transactions, operational business intelligence, predictive analytics, machine learning (ML), deep learning (DL), artificial intelligence (AI), stream computing, and other big data-fueled capabilities in cloud-native environments"*, the *Wikibon's 2018 Big Data Analytics Trends and Forecast Report* (Kobielus, 2018) is acknowledging that "*consequently, BDA has become a boardroom conversation; although, too often the question being discussed is 'why aren't we generating the expected returns from BDA?'"* – and concludes that "*the tech industry is making progress on answering those questions*" (Kobielus, 2018). Under these circumstances, some of the most significant realities and trends that characterize the Big Data industry and its main players are as follows:

"The worldwide BDA market grew at 24.5% in 2017 vs 2016. (…) Looking forward, the overall the BDA market will grow at an 11% compounded annual growth rate (CAGR) to $103B by 2027" (Kobielus, 2018); a more detailed look at numbers (Figure 2.) allows the following observations:

- ✓ the big data market revenue worldwide is projected to grow from $35 B in 2017 to $103 B in 2027 – almost tripling its value, while doubling its value in the middle of the interval, in 2022 ($70B);
- ✓ based on a 16% CAGR for Software, 9% CAGR for Hardware and a 9% CAGR for Service, the worldwide Big Data Software revenue segment is estimated to grow more than four times (4.2), while the worldwide Big Data Hardware revenue and the worldwide Big Data Service revenue segments are estimated to more than double themselves (2.4 and 2.35 respectively) between 2017 and 2027;
- ✓ in terms of revenue structure by categories, the weight of the worldwide Big Data Software segment is estimated to increase from 31.4% in 2017 to 44.66% in 2027, while the weights of the other two segments are estimated to decrease – from 28.6% to 23.3% (Hardware) and from 40% to 32.04% (Service) respectively.

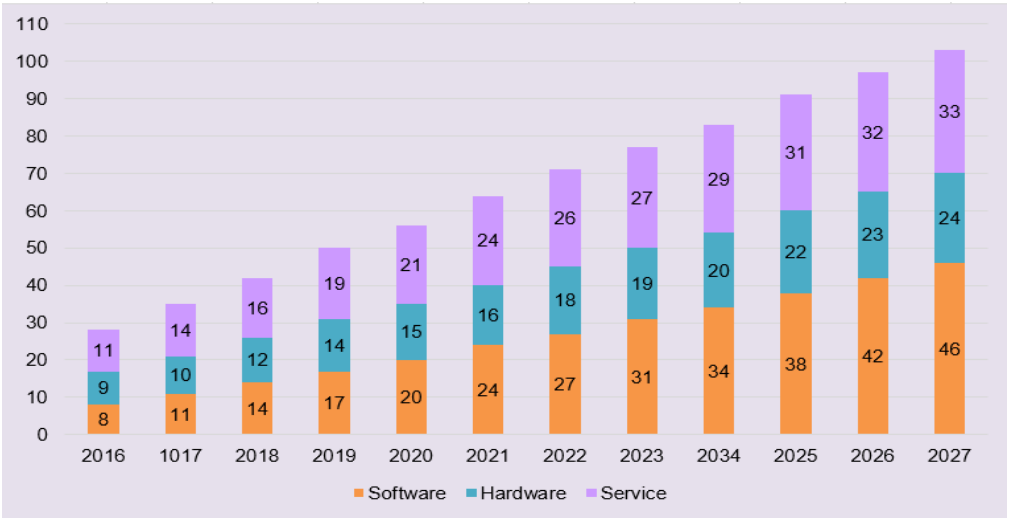

Figure 2: Worldwide Big Data Hardware, Software, and Services Revenue $B (2016-2027)

Source of data: Wikibon.com, 2018

As regards the "BDA Software solutions" segment (of the big data market worldwide) – by components and their projected evolution from 2017 to 2027, the *Wikibon's 2018 Big Data Analytics Trends and Forecast Report* (Kobielus, 2018) estimates the following (Figure 3.):

- ✓ for the *Analytic Applications* component – providing solutions for "data query, reporting, business analytics, dashboarding, cataloguing, discovery, visualization, and exploration, as well as packaged solutions that incorporate deep domain content for particular industry or line-of-business applications" – the revenues will grow from $1.4B in 2017 to $17.8B in 2027 (29% CAGR), while their weight in the "big data software" category will increase from 13% in 2017 to 39% in 2027;

- ✓ for the *Data-Science Pipelines* component – providing solutions for "ML, DL, AI, data modeling, data preparation, data mining, predictive analytics, and text analytics tools and platforms" – the revenues will grow from $0.3B in 2017 to $2.8B in 2027 (26% CAGR), while their weight in the "big data software" category will increase from 3% in 2017 to 6% in 2027;
- ✓ for the *Stream-Computing* component – providing solutions for "real-time, streaming, low-latency data acquisition, movement, ingest, processing, analytics, query, and other approaches for managing data in motion" – the revenues will grow from $0.3B in 2017 to $1.2B in 2027 (32% CAGR), while their weight in the "big data software" category will decrease from 12% in 2017 to 6% in 2027;
- ✓ for the *Application Infrastructure* component – providing solutions for "data integration, transformation, augmentation, governance, and movement in BDA architectures" – the revenues will grow from $2.4B in 2017 to $7.4B in 2027 (12% CAGR), while their weight in the "big data software" category will decrease from 22% in 2017 to 16% in 2027;
- ✓ for the *Analytic And Application Databases* component – which includes any of several data platforms (relational, OLAP, in-memory, Hadoop, NoSQL, file systems, etc.) for storing, processing, and managing data for delivering actionable insights" – the revenues will grow from $6.4B in 2017 to $12.0B in 2027 (6% CAGR), while their weight in the "big data software" category will decrease from 60% in 2017 to 26% in 2027.

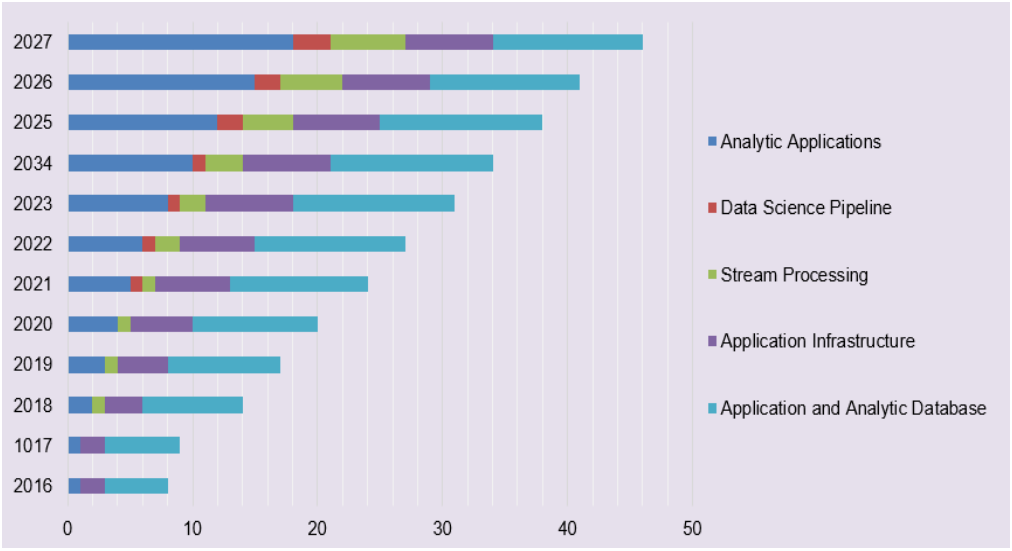

Figure 3: Worldwide Big data Software Revenue ($B) by Category

Source of data: Wikibon.com, 2018

On the other hand, according to the *Wikibon's 2018 Big Data and Analytics Market Share Report* (Burris, 2018), the supply-side of the Big Data market worldwide is composed of a variety of tools and solution providers – the Services segment

being populated by 1000s of players, the Software segment by 100s of them, while fewer players operate in the Hardware segment – able to help businesses in dealing with thorny (both strategic and operational) issues such as: "achieving strategic outcomes, reducing latencies, streamlining processes, and tightening controls and safeguards".

The classes of vendors that define the market structure – by being engaged, each of them, in a different approach to it – are represented by: traditional database and solution software providers (e.g., Oracle & SAP), professional services providers (e.g., IBM & Accenture), analytics and tools software providers (e.g., Informatica, IBM, & SAS), traditional infrastructure hardware providers (e.g., Dell & HPE), rapidly growing big data software pure plays (e.g., Splunk, Cloudera & Hortonworks) and hardware suppliers (e.g., Dell Emc & HPE) (Burris, 2018).

As regards the leading vendors (including hardware, software, and professional services suppliers) operating on the 2017's $34,900M Big Data market worldwide (Table 3.):

- ✓ their revenues are between $368M (Cloudera) and $2,657M (IBM);
- ✓ their growth rate (2017 comparative to 2016) varies from 16% (IBM) to 60% (AWS) – the average growth rate being 24%;
- ✓ their total market share is 32.1% - the individual market share varying from 1.1% (Cloudera) to 7.6% (IBM), while the market share of all the other competitors is 67.9%;
- ✓ some of them can also be found amongst the Software Top 10 vendors (IBM, Splunk, Oracle, AWS, Palantir, Microsoft, and Cloudera), the Hardware Top 10 vendors (IBM, Dell, Oracle, AWS, and HPE) or the Services Top 10 vendors (IBM, Accenture, Dell, and Palantir).

Table 3: Big Data Revenue, Growth Rate, and Market Share by Leading Vendors – 2017

Top Big Data Vendors	Revenue ($M)	Growth Rate (%)	Market Share (%)
IBM	2,657	16	7.6
SPLUNK	1,240	31	3.6
DELL	1,225	17	3.5
ORACLE	1,148	27	3.3
AWS	1,038	60	3.0
ACCENTURE	889	30	2.5
PALANTIR	762	27	2.2
SAP	661	27	1.9
HPE	640	17	1.8
MICROSOFT	574	40	1.6
CLOUDERA	368	42	1.1
OTHERS	23,697	23	67.9
TOTAL	**34,900**	**24**	**100**

Source of data: Wikibon.com, 2018

4. Conclusions

Both cause and consequence of (especially technological) development, Big Data has become a defining and ever growing feature of nowadays' environment, vector of global transformations in (almost) all the areas of human concern (including everyday life).

In order to (further) evaluate the relevance of Big Data for Business & Management, this (part of the) paper has performed a concise history of the topic Big Data as reflected in academia and a critical content analysis of the Big Data concept, followed by an examination of the most significant realities and trends that characterize the supply-side of the Big Data industry and its main players; the following conclusions can be drawn at this point:

Firstly, the Big Data concept (still) lacks an unanimously accepted definition (as the analysis of the definitions provided by the literature and extracted from the Google Scholar platform reveals at least three streams of thought: a technical/operational based approach, a dimensions/characteristics based approach, and a holistic value based approach); but, despite this diversity of opinions, there are also some congruencies across these definitions – regarding the (main) characteristics of Big Data (volume, velocity and variety) on one hand, and the potential of Big Data (analytics) to deliver (different kinds of) value on the other hand.

Secondly, the real-life developments registered by Big Data have been documented by academia in an increasing number of records: since 1993 – when the first reference to the topic Big Data has been made into a paper – to the end of 2017, the WoS Core Collection has gathered a total of 25,839 results for the "big data" topic; a similar (exponential) evolution of entrances has been registered by WoS as regards the Management (755 records between 2006 and 2017) and Business (613 records between 2004 and 2017) WoS Categories.

Thirdly, Big Data has emerged as a flourishing (new) industry, providing – through the solutions and tools it develops within its different segments (software, hardware and services) – a (global) ecosystem of support for a variety of other industries; the big data market revenue worldwide is projected to grow from $35 B in 2017 to $103 B in 2027 (Kobielus, 2018) – almost tripling its value, while the inner (structural) different dynamics of its components will reflect a tendency towards industry maturation – fueled by both the supply-side of the industry (especially through technological advancements and competitive positioning) and the demand-side of it (through the crystallization and development of their needs – based on the perceived benefits of big data analytics).

Fourthly, the above mentioned tendency towards market maturation is confirmed if looking at the main players on the Big Data and Analytics market – as "early vendors that represented the mix-and-match open source approach continue to have modest success taking their leading-edge customers into wide-scale

production. But vendors of increasingly integrated platforms as well as semi-custom applications are growing faster and moving up the ranks" (Burris, 2018).

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