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Big data analytics as a management tool: an overview, trends and challenges

Аналитика велике количине података као менаџмент алат: преглед стања, трендови и изазови

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Abstract: Innovative digital technologies and ever-changing business environment have and will continue to transform businesses and industries around the world. This transformation will be even more evident in view of forthcoming technological breakthroughs, and advances in big data analytics, machine learning algorithms, cloud-computing solutions, artificial intelligence, internet of things, and the like. As we live in a data-driven world, technologies are altering work and work-related activities, and everyday activities and interactions. This paper is focused on big data and big data analytics (BDA), which are viewed in the paper from organisational perspective, as a means of improving firm performance and competitiveness. Based on a review of selected literature and researches, the paper aims to explore the extent to which big data analytics is utilized in companies, and to highlight the valuable role big data analytics may play in achieving better business outcomes. Furthermore, the paper briefly presents main challenges that accompany the adoption of big data analytics in companies.
Keywords: big data, big data analytics, technological change, firm performance, competitive advantage
JEL classification: C550, L210, O31, O390

Сажетак: Иновативне дигиталне технологије и стално променљиво пословно окружење су трансформисали, и тек ће трансформисати, компаније и привредне гране широм света. Имајући у виду предстојећа технолошка достигнућа, и развој аналитике велике количине података (енгл. big data analytics), алгоритама машинског учења (енгл. machine learning algorithms), решења у оквиру рачунарства у облаку (енгл. cloud computing), вештачке интелигенције (енгл. artificial intelligence), интернета ствари (енгл. internet of things), ова трансформација ће постати још очигледнија. Будући да живимо у свету који је све више оријентисан, односно који се све више ослања на податке (енгл. data-driven), технологије уносе промене како у пословне и активности везане за посао, тако и у активности и интеракције које обављамо свакодневно. Овај рад је усредсређен на „велике“ податке (енгл. big data) и на аналитику велике количине података чије усвајање, посматрано са становништва организација, може допринети побољшању пословних перформанси и конкурентности. Циљ рада је да, на основу прегледа одабране литературе и истраживања, испита у којој мери је аналитика велике количине података заступљена у компанијама, као и да нагласи важну улогу коју аналитика велике количине података може играти у постизању бољих пословних резултата. Поред тога, сажето су представљени важнији изазови и потешкоће који се јављају приликом усвајања програма аналитике велике количине података у компанијама.
Кључне речи: „Велики“ подаци, аналитика велике количине података, технолошке промене, пословне

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Introduction

Digital transformation, or digitisation, is well under way. New technologies, environmental and climate concerns, globalisation, shifts and uncertainties caused by the global pandemic, are all disrupting, reshaping, and transforming today's business environment. In addition, as we live and work in the digital era, we create enormous amount of data every day. This data comes from a wide variety of sources – websites, applications, social media, smartphones, embedded systems, "smart", connected devices, sensors, customer databases, online transactions, and others (Davenport, 2014; Hagiu & Wright, 2020). To meet the challenges of such business environment, organisations need management tools that will "best help them make the business decisions that lead to enhanced processes, products and services - and deliver superior performance and profits" (Rigby 2015, p. 10).

The amount of generated data has increased greatly over the past few years: according to a recent report published by Statista, it hit another all-time peak in 2020, when the amount of globally produced, captured, consumed data reached 64.2 zettabytes; due to its impressive, continued growth, the amount will likely reach 181 zettabytes in 2025 (von See, 2021). Furthermore, according to IDC's study (sponsored by Seagate), there will be more than 6 billion people interacting with data on a daily basis by 2025, and each of them will generate no less than one data interaction every 18 seconds (Reinsel, Gantz & Rydning, 2018, p. 5). It seems that we are already "creating oceans of data as businesses, government agencies, and individuals interact across public and private networks around the globe" (Open Data Center Alliance, 2012, p. 5). However, while data is unquestionably constantly growing in volume, the focus of this paper is on data analysis, i.e., on obtaining valuable insights that could produce desired business outcomes.

As early as 1954, UPS (United Parcel Service) launched its analytics group and began introducing the idea of operational research, which meant using analysis for achieving greater efficiency in the company's operation. Still, although numerous businesses were already using different (yet traditional) tools and techniques to analyse data, aiming to improve their performance and to increase their competitive advantage (applying data analysis for decision-making, OLAP, business intelligence, analytics), it was not until the last quarter of 2010 that the term "big data" came into much wider use (Davenport, 2014, pp. 3-10). For example, as explained by Hagiu and Wright (2020), collecting and analysing customer information to improve products and services is certainly not a new realm – the concept was used by companies for a long time, but the overall process was too slow, time-consuming, and hard to scale up. It is the emergence of new technologies, cloud computing, connected products and the like that has profoundly influenced the way that data is gathered, analysed, processed, and converted into valuable information, enabling companies to obtain insights from big data quickly (Hagiu & Wright, 2020, p. 96). Apparently, with new technologies came new, big data.

Data and analytics have thus become a significant "differentiating factor in industry competition", since high-performing companies make the most of data and analytics to boost revenue growth, enter ("or even create") new markets, strengthen and improve customer relationships, and enhance organisational efficiencies (Henke et al., 2016, p. 25). Therefore, it is not "regular", but rather "big" data that has received much attention in recent years. The term "big data" refers to those data sets that are "too large or too complex for traditional data processing applications" (Liu, 2020), i.e., "too big to fit on a single server, too unstructured to fit into a row-and-a column database, or too continuously flowing to fit into a static data warehouse" (Davenport, 2014, p. 1).

Many authors have discussed the suitability of the term "big data", though. According to Davenport (2014, pp. 1–2), the term itself does not seem to give a fitting description of the big data phenomenon – although being "undeniably big", big data is less about the volume, and more about the lack of structure; it is about much needed analysis, transforming data into insights, deriving value, producing business outcomes. It is also worth noting that "big data", "big data analytics", and even "advanced analytics" are, as terms, often used interchangeably. Furthermore, it was noticed that the term "big data" frequently refers to predictive analytics or other methods and techniques of extracting value from data (Liu, 2020). Still, as Sherman (2014) have concluded, "most agree that advanced analytics is the umbrella term" (p. 375). Accordingly, big data analytics refers to the "use of advanced analytic techniques against very large, diverse big data sets that include structured, semi-structured and unstructured data, from different sources, and in different sizes from terabytes to zettabytes" (IBM, 2021).

This paper focuses on big data and big data analytics (BDA) which, as could be noted, have experienced a surge of interest in recent years among researchers and practitioners. Although the area of big data analytics covers numerous techniques, methods, tools, algorithms, and the like, this paper aims to explore big data analytics from a broader, organisational perspective. For that purpose, BDA is in this paper viewed as a management tool that can pave the way for enhanced business performance and stronger competitive position. The paper consists of selected literature review of big data and BDA, and a review of selected studies that have highlighted the role of BDA in improving firm performance and competitiveness. The paper therefore contributes to enriching the existing literature on big data analytics and its impact on business productivity, performance, competitiveness. Furthermore, even though companies that aim to excel at their performance acknowledge the significance of BDA, they are also aware that various challenges need to be considered when adopting BDA initiatives. In this paper, key (previously identified) challenges associated with the deployment and adoption of BDA in a company are outlined briefly.

1. Main characteristics of big data

Researchers and practitioners have recognised several key features of big data. It is widely accepted, though, that (1) volume, (2) velocity, and (3) variety (also known as "3Vs") are three dominant characteristics of big data, first identified by Douglas Laney some twenty years ago (Diebold, 2012). Soon after, these became a part of Gartner's big data definition,

which was recently slightly modified: "big data is *high-volume, high-velocity and/or high-variety* information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation" (Gartner, 2021). Three key characteristics of big data are briefly described below.

Volume. Vast amount of data comes from numberless sources, including internet, social media, connected devices. To illustrate, there were 4.66 billion internet users around the world as of January 2021, and huge majority of these users (92.6 per cent) were accessing the internet through any type of mobile device (Johnson, 2021). What is more, numerous forms and types of social media are becoming extremely popular. The number of monthly active social media users is projected to reach 3.43 billion by 2023 (Statista Research Department, 2021). In addition, the number of IoT (internet of things) connected devices will likely reach 30.9 billion units by 2025 (Vailshery, 2021). Anyhow, the summation of all data, whether it is created, captured, consumed, and/or stored, will likely reach 120 zettabytes (ZB) in 2023, a rise from 33 ZB in 2018, and 9 ZB in 2013 (von See, 2021). *Velocity*. Incredible speed of data generation, combined with advanced analytics, enable real-time or at least near real-time processing of data. As described by Gressel, Pauleen & Taskin (2020, p. 27), accessing (and analysing) data in real-time or near real-time enhances businesses' flexibility and provides quicker responses, hence radically affecting the decision-making process. *Variety*. Big data takes various forms and types (structured, unstructured, semi-structured data) (Taleb, Serhani & Dssouli 2018, p. 70), captured from countless sources. These forms include texts, numbers, sensor-generated data, click-stream data, audio and video data, social networks posts, all sorts of industrial big data, and others. It is estimated that as much as 80 per cent of all generated and collected data could be characterized as unstructured data (data with no/unknown structure) (Taleb et al., 2018, pp. 70-74). Still, even though these data are mostly unstructured, there is "a huge amount of signal in the noise, simply waiting to be released", and it is analytics that makes big data "simpler and more powerful" (McAfee & Brynjolfsson, 2012, p. 63).

The above three, widely recognised (and originally used) big data attributes (volume, velocity, variety; also "3Vs", or "3Vs model"), have provided a starting point for many researchers focused on identifying additional distinctive big data features, also known as big data traits (Wook et al., 2021, p. 4). For example, IBM added "veracity" to emphasise data uncertainty ("4Vs" model); this model was followed Demchenko's "5Vs" ("volume, velocity, variety, veracity, value"), while Microsoft used Laney's model to point out the importance of three additional features, by forming its "6Vs" model ("volume, velocity, variety, variability, veracity, visibility") (Sassi, Anter & Bekkhoucha, 2019, pp. 240–241). It was explained that "variability" was used to highlight numerous variables within the sets of data, "veracity" was added to draw attention to the importance of data trustworthiness and accuracy, while "visibility" underlined the necessity of using an overall perspective as to make any data-based decisions (Sassi et al., 2019, pp. 239–241).

An interconnection between big data characteristics and data quality has been found in several studies, while others have looked into data quality and its potential for BDA application (Wook et al., 2021, p. 2). Moreover, by surveying students familiar with BDA, Wook et al. (2021) have explored how big data characteristics (velocity, veracity, value,

and variability were used as indicators of big data traits) and data quality could affect the application of BDA, viewed from the perspective of individuals. They have found that big data characteristics have a significant effect on all data quality dimensions (in this study: accuracy, believability, completeness, timeliness, as well as ease of operation), which is in line with findings from similar studies. Interestingly, their findings have also shown that of these five quality dimensions, only "ease of operation" has a considerable effect on BDA application – an (unexpected) insight which could be useful for organisations, as it reflects an individual-level point of view from novice users (Wook et al., 2021, pp. 8-12).

2. Big data analytics (BDA): turning data into value

As noted previously, big data allow for extraction of new insights, or creation of new "forms of value, in ways that change markets, organizations, the relationship between citizens and governments, and more" (Mayer-Schönberger & Cukier, 2013, p. 6). Therefore, a particular attention should be paid to data analysis, as an effective means of gaining insights and innovations, and achieving value (Davenport, 2014, p. 2).

Big data analytics employs advanced techniques to analyse big data sets for (hidden) patterns, and to derive valuable knowledge from these extremely large data sets (Elragal & Klischewski, 2017, p. 4; Seyedan & Mafakheri, 2020, p. 9). Still, systems need to "not only perform data analysis, but then also communicate the results that they find in a clear, concise narrative form": the real value of big data lies in converting data into a story (i.e., a narrative) that enables providing a context to data, thus ensuring that companies gain meaningful insights from numbers (Hammond, 2013). Therefore, BDA is not only about the (big) data and the analytics (that is applied to the data), but it is also about finding effective ways of presenting analytics results, in order to enable value creation for organisations and their customers (Maroufkhani, Wagner, Wan Ismail, Baroto, Nourani, 2019, p. 2). BDA consists of descriptive, predictive, and prescriptive analytics; predictive and prescriptive analytics could be particularly important for organisations, as these techniques support decision-making processes at various levels, help with building the right strategies, identify and/or propose new strategic and business opportunities, etc. (Atta, 2020, p. 199). It was also suggested that prescriptive analytics could help incumbents to reduce the threats from new (digital) entrants, by leveraging huge amount of existing customer data (du Toit, Anderson & Hatherall, 2020).

Data-derived insights provide numerous opportunities. As McKinsey's (MGI and McKinsey Analytics) 2016 research has shown, data has become a "critical corporate asset" (p. 6), and analytics capabilities are "rapidly reshaping industry competition" (p. 27) urging companies, particularly incumbents, to incorporate data and analytics into the very foundations of their business in order to keep up with digital natives (Henke et al., 2016). Companies apply BDA to extract latest insight/information to be used for improved decision-making, and/or to create new/improve existing offerings (products and services), reduce costs/time (Davenport, 2014, p. 22), improve organisational processes, transform existing business models to harness the power of big data (Rigby, 2015, p. 17), examine new opportunities (Gressel et al., 2020, p. 34). Moreover, as Pentland has noted, big data

could help "green the environment, create transparent government, deal with pandemics, and, of course, lead to better workers and better service for customers" (Berinato, 2014, p. 102). Hagiu and Wright (2020, p. 96) have also emphasised that technological advancements enable high-speed data processing, which leads to obtaining purposeful information. For example, products connected to internet have the ability to gather customer data directly; after data analysis and interpretation are carried out by machine learning algorithms, companies' products and/or services could be automatically improved and/or adjusted to meet the needs of individual customers (Hagiu & Wright, 2020, p. 96).

For the analytics, as the "central step in BDA", numerous techniques (or models), such as machine learning, data mining, statistics, could be selected to be applied to the data (Elragal & Klischewski, 2017, p. 9). In this paper, BDA is viewed from organisational perspective, as a management tool with huge potential to positively affect businesses (e.g., their performance and competitiveness).

3. BDA – increasing popularity and adoption rate

The number of papers and publications in the field of big data analytics is on the rise (Mikalef, Pappas, Krogstie, & Pavlou, 2020). In addition to various BDA techniques, tools, methods and solutions that are used across industries, an increased attention has been paid to many other aspects of this complex and multidisciplinary area. For example, it was shown that there was a steady upward trend in the number of articles focused on supply chain "demand forecasting" in the presence of big data, between 2005 and 2019, which is expected to continue (Seyedan & Mafakheri, 2020), and that the number of studies in the area of big data business models (BDBM) was on the rise during the reference period (from 2008 to 2017), with "impressive and encouraging" number of studies since 2014 (Wiener, Saunders & Marabelli, 2020, pp. 71-81). Likewise, another study (Maroufkhani et al., 2019) has found that scholars are increasingly exploring the relationship between BDA and company performance, with a growing number of both papers published in this area (especially since 2017), and received citations (pp. 5-6).

Since multiple aspects and factors are associated with the effective adoption of big data analytics, academics and practitioners have also begun focusing on "big data analytics capabilities" ("BDA capabilities", BDAC) to explore issues about organisational resources needed for the successful transformation of big data into (actionable) insights (Mikalef, Pappas, Krogstie & Giannakos, 2018). Generally, the term "BDA capability" refers to "orchestrating and managing" all resources related to big data successfully; it is the ability of a company to leverage big data for strategic and operational insights, improved performance, competitive advantage (Mikalef et al., 2018).

As noted earlier, since leading and managing in the digital era can be very challenging, executives use management tools to help them make quicker and better decisions, thus enhancing the opportunities for growth and improved performance. These management tools include big data analytics (advanced analytics) (Rigby & Bilodeau, 2018). Bain & Company has been tracking the effectiveness of 25 most used management tools in companies by surveying executives around the world. Big data analytics (BDA)

was added to Bain's survey of management tools and trends in 2012, and since 2017, the name "advanced analytics" was used instead (Rigby & Bilodeau, 2018). It could be concluded from the reports that BDA (i.e., advanced analytics) is growing in popularity among companies, with an upward trend in usage: 42 per cent of companies used this tool in 2017, a rise from 29 per cent in 2014, and 26 per cent in 2012 (Rigby & Bilodeau, 2018, p. 3; 2015, p. 14; 2013, p. 11). In addition, respondents were generally quite satisfied with this tool throughout the years, as its satisfaction rate remained steady, but significantly above the average: it was just under 4 in 2012 (5=highest satisfaction), 4.01 in 2014 (when it was number one tool regarding user satisfaction), and 4.06 in 2017 (Rigby & Bilodeau, 2013, p. 10; 2015, p. 14; 2018, p. 3).

As reported in another Bain's global survey (of executives - respondents at more than 700 companies) on tools and trends in the area of customer experience, most large companies have their analytics groups devoted to finding the ways that would best leverage analytics for better description, anticipation and improvement of customer interactions (du Toit, Dullweber, Hatherall & Moreau, 2018, p. 2). Predictive analytics was among three most-used customer experience tools across industries in 2018 (including consumer markets, as well as business-to-business markets) but, despite extremely high levels of usage and adoption throughout the companies, it remained among the lowest ranked tools in terms of satisfaction (du Toit et al., 2018, pp. 2-6).

Still, according to a 2020 survey of nearly 1,200 executives, customer experience tools overall usage has increased in 2020 (especially due to Covid-19's impact on consumer behaviour), as has the number of satisfied users (du Toit et al., 2020). Many of these tools rely on (advanced) analytics. For example, "customer journey mapping and analytics" tool (visualising potential customer interactions to create a holistic view) was used by 60% of respondents (78% were satisfied with it); "propensity model" (using advanced analytics to predict customer behaviour) was adopted by 53% of respondents (82% satisfied), "predictive forecasting or scheduling" (data analysis to predict future supply/demand) was used by 67% of respondents (79% were satisfied), while 51% of respondents adopted "personalization engine" (using advanced analytics for better understanding the needs of a customer as individual), and 81% of them were satisfied with this tool (du Toit et al., 2020). According to this report, companies expect much wider adoption of all customer experience tools by 2023, including those that rely on big data and advanced analytics.

Therefore, being "at the heart of digital transformation", data has become an extremely significant asset for companies (Reinsel et al., 2018, p. 3), and big data and big data analytics have become increasingly important for contemporary organisations (Mikalef et al., 2020). Nowadays, more than half (56 per cent) of the worldwide companies are relying on data to drive business innovation (Mlitz, 2022b). According to the latest report published by Fortune Business Insight (2021), global market size of big data analytics (BDA) rose by 11.7 per cent in 2020, reaching almost USD 207 billion; this market is expected to grow to almost USD 550 billion in 2028 – a rise from USD 231 billion in 2021. Similarly, as reported in IDC's Spending Guide, BDA (in this report: "Big Data and business analytics") spending in Europe has continued its rise in 2020 regardless of

disruption(s) caused by the Covid-19 pandemic, and it is likely to show a continued upward trend during the next five years (IDC, 2021).

4. Big data analytics as a source of competitive advantage

According to McGrath (2013, p. 64), digital revolution is one of several forces behind profound changes in business environment - with "too unpredictable" customers and "too amorphous" industries, maintaining a company's competitive advantage(s) has become very rare. In order to be at least one step ahead of competition, companies should be constantly developing/launching new strategic initiatives, while simultaneously building a number of "transient" advantages (McGrath, 2013, pp. 64–65).

Strategies based on data will play an increasingly significant role in competitive differentiation: big data and advanced analytics could be seen as a means for improving business performance, but this would require developing strengths and enhancing capabilities within three areas (Barton & Court, 2012, p. 79). These areas include (Barton & Court, 2012, pp. 80–82): (1) *data sources*, which refers to the need to discover new and creative ways to recognise usable (existing) data, exploiting external data coming from multiple, "surprising" sources, providing appropriate IT infrastructure; (2) *building analytics models* based on identifying opportunities and potential improvements of business performance, to produce both prediction and optimisation of business outcomes; and (3) *organisational change*, so that "the data and models actually yield better decisions"; this includes adjusting/changing the culture, developing capabilities and analytics compatible with the existing processes and decision-making standards, incorporating analytics into simple tools, and so forth.

Moreover, by reviewing and summarising highly ranked papers related to BDA and firm performance, published from 2013 to 2019, Maroufkhani et al. (2019) have identified key factors that may positively affect the adoption of BDA and the impact it has on firm performance. They have found that "individual aspect" (technical knowledge and capability of people) was the most important factor, which is followed by "organizational aspect" (organisational readiness, management support, culture, infrastructure), "BDA capability" (using all resources related to big data crucial for taking the maximum advantage of it), "data-related aspect" (factors related to data quality), and others. Indeed, according to a study of Ashrafi, Zare Ravasan, Trkman & Afshari (2019), developing business analytics capabilities has been shown to have a significant positive impact on firm performance by enhancing information quality, which positively influences the agility of companies. Since agility enables improved performance, it could be seen as a means of achieving competitive advantage, particularly in turbulent business environment (Ashrafi et al. pp. 4-9).

Benefits of the deployment of "data science for business" (which encompasses big data and BDA; DSB), as reported by DSB users, do include improved organisational performance, productivity, competitiveness, as a recent study of Medeiros, Hoppen and Maçada (2020) has shown. In addition, another study indicates that competitive advantage has been one of the determining factors behind decisions on investments into big data and

artificial intelligence (along with other offensive factors, such as innovation and transformation) for nearly 65 per cent of companies (Mlitz, 2022a).

Although many studies have demonstrated that larger companies may have higher returns from their investments in BDA solutions than smaller companies (e.g., Raguseo, Vitari & Pigni, 2020), there is also empirical evidence that adopting BDA positively impacts organisational performance (e.g., Shabbir & Gardezi, 2020), i.e., both financial and marketing performance of small and medium sized companies (e.g., Maroufkhani, Tseng, Iranmanesh, Ismail & Khalid, 2020). Anyhow, BDA assets in companies are associated with improvements in productivity (Müller, Fay & vom Brocke, 2018) and performance, but generating value from BDA requires "the orchestration of complementary organizational resources" (Mikalef, Boura, Lekakos & Krogstie, 2019, p. 262). Mikalef et al. (2019, pp. 268-271) have found that various combinations of BDA-related resources, such as data, technology, people i.e., skills, organization (practices, data-driven culture), process (procedural practices) could, to a greater or lesser extent, contribute to firm performance, depending on the context the resources are used in, including the factors such as size of a company, and dynamism, heterogeneity and hostility of external environment.

5. Key challenges

Companies still struggle to obtain value from data; a 2019 survey by Accenture, of 190 executives (in the U.S.), has revealed that only 32 per cent of companies report that they have the ability to realise tangible, measurable value from data (Vasal et al., 2019, p. 4).

Noticeably, companies need to tackle a number of specific challenges related to the adoption of big data analytics. As reported in McKinsey's 2015 survey of more than 500 executives, numerous challenges accompany this area, and barriers to the use of (i.e., obtaining value from) data and analytics in an organisation could be grouped into three categories. Challenges/barriers within the first category are associated with (1) *strategy* (i.e., strategic vision that should be developed to support/incorporate data and analytics), *leadership* (e.g., involvement of senior management, internal leadership for projects in this area), *talent* (refers to finding and/or retaining the right analytics/technical talent/"business translators"). These are followed by challenges related to (2) *organisational structure* (which should not only support the activities related to data and analytics, but also monitor their impact), *organisational processes* (as they need to be flexible to make the most of insights), and (3) *IT infrastructure* (e.g., designing, investing at scale, providing support to business functions, data-sharing) (as cited in Henke et al., 2016, pp. 36–38).

According to Medeiros et al. (2020), deployment of data science for business (which encompasses big data and BDA concepts) poses challenges for companies through the following four dimensions: (1) "leadership and culture", (2) "strategy, structure, and processes", (3) "talent management", and (4) "information technology". More specifically, their study has revealed that companies find challenges related to data-driven culture (indicator within the first dimension), training, i.e., developing relevant skills and knowledge (indicator within the third dimension), allocation of investments in

information/analytics technologies (indicator within the fourth dimension), and data governance and strategy (indicators within the second dimension) to be most significant (pp. 159-161). To address these issues, companies need to develop data strategies and data governance mechanisms, foster data-driven culture, encourage the development of specific skills, and allocate investments in technologies (Medeiros et al., 2020, p. 161).

As could be seen, challenges that accompany the adoption of BDA is among the topics of interest to scholars. Recent critical review of literature (Wiener et al. 2020) has identified challenges associated with the deployment of big data business models, and categorised them into internal and external. Internal challenges are related to *big data management and governance* (e.g., data quality, data access, internal politics; data context, privacy and security); *infrastructures* (technical, e.g., IT architectures, software, algorithms, and human, e.g., lack of internal BDA skills and knowledge); (expected) *costs and value* (e.g., discovering value of big data; payoff of BD investments; operational costs, costs related to infrastructure, skill development), *organisational context* (e.g., transformation - structures, processes, culture, etc.; integration into existing models), while external include *environment and market* (e.g., weak regulation, lack of standards), and *consumers/public* (e.g., ethical and concerns about privacy) (Wiener et al., 2020, pp. 88-89). Moreover, authors have indicated that the existing literature is mostly focused on internal and operational (big data management and governance), infrastructural, and challenges regarding cost vs. value, while less attention has been paid to external challenges, including (increasingly significant) ethical issues and associated privacy concerns (pp. 73-75).

Indeed, increased digital surveillance and the deployment and adoption of various big data solutions to mitigate the COVID-19 pandemic have raised even more concerns about privacy and data protection (Newlands et al., 2020). Companies thus need to respond to considerable challenges related to data protection, trust, ethics, transparency, cybersecurity, regulatory compliance. For example, they need to check if General Data Protection Regulation (GDPR), relevant EU legislation/documents, national laws/legislation and the like apply to specific country/company/project/research. To illustrate, in terms of data protection in research settings, a project/research need to be in compliance with EU's GDPR, relevant EU directives/measures, national laws/legislation on data protection, etc., as explained by European Commission (2021). A special emphasis should be placed on processing operations that may pose "higher risks to the rights and freedoms of data subjects" (p.4); these operations include, among others, big data analytics, automated decision-making, and data-mining techniques (European Commission, 2021, p. 4). Therefore, as Pentland has argued, when describing his concerns about data collection, data privacy, data ownership, and controlling the flow of data (first introduced in 2007 within the "New Deal on Data"), a solution should be found in creating "a win for customers and citizens, a win for companies, and a win for government" (Berinato, 2014, pp. 101–102).

Anyhow, another study (Vasal et al., 2019) has revealed that cultural and operational challenges, including the lack of trust in data; inability to manage data at scale i.e., operationalise it and use data strategically (e.g., due to silo-ed, slow data); and the lack of

enterprise strategy, data-driven culture, skills and talent, C-level sponsorship, are among the biggest obstacles to obtaining the expected value from investments in big data (pp. 2-7).

To overcome these challenges, companies not only need to take completely new approach to strategy, but also employ (new) data-driven strategy which, like all strategies, "comes down to where resources are allocated and how resources are used" (Vasal et al., 2019, p. 3, 20). However, aside from being mindful of all areas that could make a difference in obtaining value from data, companies also need to consider expected costs and gains, the time (and complexity) required for developing some big data-related resources (e.g., data-driven culture), and possible resistance to change (which would require developing detailed and effective mechanisms and practices for overcoming organisational inertia) (Mikalef et al. 2019, pp. 270-271).

Conclusion

Changes in business environment and market dynamics are rapid and ever-present. What is more, the volume of (big) data is constantly growing (von See, 2021), exceeding the capacity and capability of traditional database systems. The availability and use of advanced technologies and the data they generate have a notable impact on companies across industries, profoundly changing their business strategies, business models, processes. Still, the "real revolution is not in the machines that calculate data but in data itself and how we use it" (Mayer-Schönberger & Cukier, 2013, p. 7). According to Reinsel et al. (2018), it will be essential for companies to perceive the role data plays in their company, so as to be and stay relevant during the next several years. Indeed, companies that embraced data-driven decision-making have shown better results than those of competitors (that did not rely on data when making decisions) by being more productive, and more profitable (McAfee & Brynjolfsson, 2012, pp. 63–64).

Companies use management tools to help them "boost revenues, innovate, improve quality, increase efficiencies or plan for the future", especially when they need to cope with the challenges of turbulent business environment (Rigby, 2015, p. 10). In this regard, big data analytics (BDA) is viewed as a management tool in this paper. Based on a review of selected literature, the paper has emphasised the growing interest in BDA among practitioners and academics, and the importance of BDA for today's businesses, i.e., their productivity, performance, competitiveness, thus adding to a body of literature focused on correlations between the BDA adoption in companies and improved outcomes. It could be concluded that big data analytics creates business value for companies (e.g., Müller et al., 2018), and that BDA and BDA capabilities are associated with improvements in organisational performance (e.g., Mikalef et al., 2019; Ashrafi et al., 2019, pp. 4, 9; Raguseo et al., 2020; Medeiros et al., 2020). Still, BDA is not only about data and technologies. From a managerial point of view, some of the important implications arising from the reviewed literature have been selected and pointed out in this paper, including multiple challenges related to the adoption of BDA. Certainly, there is a need for companies to not only address these challenges, but also have the ability to overcome them. When considering the investments in adoption of BDA within a company, different

(combinations of) BDA resources/factors (including data, technology, organisational structure, top management support, people, i.e., technical and managerial skills) need to be emphasised for best results (that could lead to better performance), depending on contextual factors (such as company size, uncertainty of external environment) (Mikalef et al., 2019).

Furthermore, companies will need to radically change the way BDA initiatives are "approached, designed and refined", while revising (and examining the alignment to business strategy) resource planning, resource orchestration, and expected performance results, which would all enable them to identify proper key development indicators (KPIs) (Mikalef et al., 2020). Data-driven culture (e.g., using data in decision-making), people with adequate skills and knowledge, data strategies, as well as governance mechanisms, are some of the factors of great importance for obtaining value from (big) data. (Medeiros et al., 2020). Besides, it was also argued that developing and adopting analytics tools that "focus on business outcomes and that are relevant and easy to use for everyone from the C-suite to the front lines" is the matter of critical importance. (Barton & Court, 2012, p. 81). Nevertheless, various disruptions have shown how important it is for companies to be adaptive, agile, innovative, and ready to embrace new technologies as a means of improved business outcomes; these technologies, evidently, include big data analytics.

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