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Selecting a Business Intelligence Solution that is Fit for Business Requirements

MARKO PRIBISALIĆ, IGOR JUGO & SANDA MARTINČIĆ-IPŠIĆ

Abstract Many companies, organizations, institutions and governments have recognized the operating advantages they can achieve by using new business intelligence (BI) technologies. However, to achieve those advantages, they need to choose a BI solution that best fits their needs. In this paper, we present an overview of twenty business intelligence solutions present on the market and describe their most essential and upcoming features. The features are presented in two groups - basic and advanced (upcoming) features. We present two tools that can facilitate the selection process of the organization's BI solution – the comparison table and the features pyramid. We detect four classes of maturity of BI tools reflected through the implementation of advanced features. Finally, we discuss obtained insights and provide some guidelines for choosing the right BI solution together with detected development trends.

Keywords: • Business Intelligence • Data Analytics • Big Data • Data Lake • Augmented Analytics •

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1   Introduction

More than two decades ago, business intelligence (BI) started as a query and reporting software module. New features such as online analytical processing (OLAP), data visualization, and mobile functionality have been added over the years, with the aim to make the use of such complex solutions as simple as possible for the end users. The growing need for BI is fueled by an explosive growth of data volume, competition in the market for customer acquisition and retention, and the growing availability of a variety of BI tools.

The market for BI is continuously evolving. Trends seasonally change, and the primary task of this work is to highlight important issues in the field and assess future areas of interest. Global BI solutions market is slated for significant technological changes. Data quality, master data management, data discovery, visualization, and self-service BI are the top points of interest. Also, technologies that BI users can expect are cloud BI deployments, mobile BI, machine learning (ML) and deep learning (DL) powered analytics, and stringent data privacy and security regulations (BARC, 2018a).

Artificial Intelligence (AI) and Machine Learning (ML) continue the process of BI software transformation. Organizations will increasingly depend on the automated data-analysis capabilities of powerful BI systems. Deep learning (DL) applications have begun to hit the markets, while AI research and ML applications have reached light maturation. In 2018, BI and analytics coupled with IoT thus rising the IoT-driven analytics. Most BI solutions offer data analysis, data visualization, ad hoc analysis, dashboards, ad-hoc query tools, ad-hoc reports, KPIs, and performance metrics which are all considered as the basic features of BI solutions. The rise of advanced business analytics across BI solutions can be directly attributed to cheap storage, high availability of massive volumes of data, and IoT devices (Dhar, 2012). All of this, supported by the rise of cloud services availability is one of the main reasons for the explosive rise of big data analytics.

At the 2018 Tableau Conference (Labbe, 2019) an approach that automates insights using machine learning and natural language processing (Gartner, 2018a) called augmented analytics was presented as the most important analytical trend. Rita Sallam, a Gartner analyst, said, "This kind of user experience will transform

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

445

the market again. Augmented analytics is really about using AI. This technology enables more people to gain access to insights without having to be a data scientist". Additionally, numerous BI vendors tried to better incorporate AI technologies into their analytics products in 2018. Also, Gartner provides an overview of the latest market trends and vendor trends in 2019. Analytics and BI Gartner Magic Quadrant (Gartner, 2019). Some of them implemented AI assistants for easier queries. "They are all looking to augmented analytics" said Adam Smith, COO at Automated Insights. More startups dealing in augmented analytics can be expected as well as more partnerships/acquisitions by major BI vendors in 2019. Numerous solutions that specialize in a particular area of advanced analytics have partnership ties to BI platforms (e.g. Tableau, Qlik or Microsoft Power BI). CEO Adam Selipsky noted at the Tableau's user conference that the vendor made strides in 2018 to enable third-party developers to easily and deeply integrate their products and services into the Tableau platform. Other vendors will surely follow these trends. Cloud computing simplified the use of analytic tools and increased their popularity. Now businesses do not need to buy individual licenses for analytical programs and expensive computers for complex analytical processes because vendors offer low-cost subscriptions to use their business intelligence tools in the cloud. John Crupi, vice president of IoT analytics at IoT software vendor Greenwave Systems stressed: "Analytics is also going to be used in cloud computing and IoT, as users push for real-time analytics and analytics on connected devices, things that classic cloud computing cannot handle."(Labbe, 2019).

BI analytics exhibits the growth and development of SQL-on-Hadoop engines and solutions that provide native BI functionality inside data lakes which enable users to perform BI tasks on different types of data (structured or unstructured) either on-premises or in cloud-based data lakes. In the past, organizations have dealt with extracting, transforming, and loading data from data lakes into data warehouses for querying, reporting, and data exploration. Now, these new features reduce the need for those activities, since technology enables the data to stay in the original format. The feature which is also essential for easier and faster access to the contents of data lakes are search capabilities across all the diverse types of data. Next, it is to be expected that organizations will increase their utilization of SQL-on-Hadoop, as a native BI feature, enabling access to the data in data lakes. From technology, the focus will be shifted toward the development

of interactive dashboards and other new types of visualizations (Rajesh, & Ramesh, 2016).

Streaming data and real-time analytics have also become one of the major strategic priorities for a rising number of organizations allowing a comparative advantage. Primarily this includes organizations that have deployed IoT devices as part of operational technology (Gartner, 2018g) and Industrial Internet strategies (Intrinsic Communications,2019). In cybersecurity, fraud detection, and other areas where immediate awareness is of essential importance these technologies are already relatively well established. However, it should be emphasized that BI software vendors are pursuing a range of technologies to provide BI and analytics users with ML algorithms enabling automated decision management systems from fresh data and frequent updates. Many organizations implemented operational data stores, which today may use Apache Hadoop clusters. To identify and capture data changes and data structures as they occur and inform users of those changes organizations are using change data capture (CDC) technology (Stodder, 2018).

It is a common denominator that organizations in the BI era should improve their flexibility and agility to explore and analyze data. Users are changing their information needs, and transition from dashboards toward new technologies and development methods need to be undertaken. Agile methods are used to improve how users and developers collaborate. In the same time, a significant step forward has been made in the implementation of agile, DevOps, and design thinking methods (Hani et.al., 2017) . DevOps methods have increased speed and flexibility of the implementation process, and design thinking methods help teams unleash creativity in developing requirements. BI self-service technologies fit well with agile and design thinking methods.

Following the rise of importance of BI powered decision making organizations are creating new positions such as chief data officer (CDO) or assigning "chief of data" responsibility to their CIO (chief information officer), chief analytics officer (CAO), or head of BI and data warehousing (DW). Primary responsibilities for the CDO are to improve trust, governance and usefulness of the data, adherence to regulations, oversee the protection of data assets, and increase the value of these assets. Self-service solutions allow users freedom to do more on their own, including data selection, preparation, blending, and

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

447

visualization, but users still need to work with IT to expand, protect, manage and sustain what they may have achieved with self-service tools. Consequently, users better understand their information needs and IT and CDO should aim to create an environment where users are provisioned with trusted, governed data. Technology vendors will offer solutions with sophisticated capabilities to enable IT or CDO guidance.

In parallel, AI is finding its way into each facet of analytics, BI, data integration, and data management. It is expected to have a significant impact on the nontechnical user experience. The self-service BI trend enables users to become productive in the use of visualizations and data, so that analytics insights are a natural part of decision making and collaboration (Hani et al., 2017 & Umble et al. 2003). Advanced AI features will improve self-service capabilities further to let nontechnical users engage in more relevant data analysis. Advancement of ML, DL, and NLP will enable users to expand the scale and speed of analysis or reporting from larger volumes of data. BI solutions will offer continued innovation in using AI to augment BI and analytics for nontechnical users and will provide not just easier but smarter and faster usage (Victor, 2018).

The paper gives an overview of BI solutions against their basic and advanced features and provides possible directions for the integration of new BI features. Besides, two tools (a comparison matrix and a features pyramid) are presented for selecting the proper BI solution in a real setup. The matrix and pyramid enable the identification of current trends among BI tools and detailed insight into their functionalities.

This paper is organized as follows: an inventory of features in BI solutions on the market is given in Section 2. Section 3 presents the methodological framework for conducted comparison and presents the comparison matrix and the feature pyramid. Section 4 wraps up the main conclusions of this research.

2   Selecting the right business intelligence solution

To choose the right BI solution between a vast number of possible options available on the market it is necessary to decide which features are required and which ones are not necessary for the organization's needs. Does one choose a solution with basic capabilities or opt for an advanced platform with more

specialized features? The answer is not straightforward, and to the end of this paper, we would like to elaborate on some of the possible answers.

Most BI solutions on the market today (>90%) offer basic (standard) features: data analysis, ad-hoc reports, dashboards, data visualization, performance metrics, ad-hoc query, ad-hoc analysis, and key performance indicators (KPIs) (Badawy et al., 2016). When choosing a BI solution, we should be cautious of the fact that some advanced platforms with more advanced or specialized functions do not cover all of the basic functionalities. Hence, some tradeoffs between the advanced functionalities and broadness of the tools are necessary. Additionally, it is possible that a product implements certain basic or advanced features from other solution vendors.

First, we present a comprehensive inventory of **advanced** features in BI solutions which users can expect/demand when looking for the right solution on the market:

- **Master Data/Data Quality Management** (MD/MDQ) - right decisions can only be based on correct data. The importance of MD/DQM stems from the need for data of high quality: complete, accurate, integral, consistent and timely. In that regard, BI solution vendors have concentrated on providing enhanced capabilities for managing master data and data quality such as data quality cycle (BARC, 2018a). Data quality cycle covers all the phases involved in providing high-quality information to business users: metric identification and definition, assessment, data repairing and cleaning, storage/cataloging/archiving, and exploration/ranking (Debattista et al., 2014 & BARC, 2018c). In this way, customers will be able to monitor and manage data quality from a single, unified source holding the master data instead of from multiple, disconnected databases.

- **Data Discovery/Visualization** - BI tools with advanced data discovery and visualization capabilities will decrease the need for involvement of data scientists during rushed preparation of data for decision-making. Exploratory data discovery coupled with visualization foster solving of sophisticated data analysis challenges. Moreover, machine learning is integrated into data discovery tools to guide business analysts through all steps from preparation to analysis to presentation (BARC, 2018a). The

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

449

solution must offer key features for connecting diverse sources, cleaning, enriching and shaping data to create new data sets to be used in the visual analysis or advanced analytics.

- **Self-Service BI** – a process in which end users design and deploy their reports and analyses within an approved and supported architecture and tools portfolio (Gartner, 2018b). Gartner predicts that the analytics output of business users with self-service capabilities will surpass that of professional data scientists. It will facilitate the learning of business users on how to use and benefit from effective analytics and BI tools, driving favorable business outcomes in the process (Gartner, 2018c). Self-service BI improves agility and speeds up the time to insight, but this should not affect the quality of results or efficiency. It must meet many requirements such as the increased speed must not compromise trust in data; enabling easy access and understanding of the data; all stakeholders and responsible parties should be involved in the restructuring process; data quality and consistency must be ensured through increased data security and governance. It is also vital to meet requirements in terms of architecture and governance and in achieving a balance between flexibility and control (Informatec, 2018 & BARC, 2018b & Henschen, 2013).

- **Data Governance** - a process that ensures that data meets precise standards and business rules when entering into a system (Experian, n.d.). In the past, lack of data protection caused considerable damage to many businesses (Norman, 2001). Hence, for the prevention of this failures data governance is implementing a data strategy, including managing of policies and frameworks, monitoring and protecting data capital while taking people, processes, and technologies into account. Data governance in compliance with regulations like General Data Protection Regulation (GDPR) (Marelli et al., 2018) is a sought hot feature for BI solutions.

- **Cloud BI/Data Management** - according to Gartner, many organizations will move a significant part of their data activities to the cloud by 2021 (Gartner, 2017). Hence, the majority of BI and data management vendors on the market offer a cloud-based solution at this time. Although cloud BI and data management have very similar functional capabilities to the corresponding on-premises product, they usually offer lower prices and reduce the burden of IT departments.

- **Augmented Analytics** - automates data insight by using ML and NLP to automate data preparation and discovery and enable data sharing. This process simplifies data to present clear results and provides access to sophisticated tools so business users can make the right decisions (Gartner, 2018a). AI and ML contributed to transforming augmented analytics into the discipline which is intuitive and comprehensible to ordinary business users, thus transforming the user experience (Victor, 2018). The expansion of augmented analytics also delivers improvement for IT decision-makers and managers.

- **Mobile BI** - organizations examine the benefits of providing decision-making opportunities to employees or managers no matter where they are located. Increased use of tablets and mobile devices are increasing the strength of mobile BI, witnessing increased business adoption, due mainly to their capacity to provide strong and clear data visualization in the form of charts and graphs as well as dashboards and scorecards (García, 2010).

- **Deep Learning-Powered Analytics** - DL is a type of ML that trains a neural model to perform human-like tasks, such as recognizing speech, answering questions in natural language or identify objects/actions in images or videos. By 2023, deep learning will take over as the preferred solution approach for data applications according to (Gartner, 2018d).

- **Real-Time Analytics** – the discipline that applies logic and mathematics to data to provide insights for making better decisions in a real time. For some use cases, real-time means the analytics is completed within a few seconds or minutes after the arrival of new data (Gartner, 2018e). Faster reporting and analysis of data is a challenge in many companies. Organizations have an increasing need to make data from transactional systems available immediately to support faster and fact-based operational decision-making. BI with real-time analytics features can complement an organization's existing BI strategy to gain new insights into data with additional, valuable findings (BARC, 2018a). To identify and capture data changes and data structures as they occur and inform users of those changes organizations have started using advanced change data capture (CDC) technology.

- **Agile BI Development** - a flexible and scalable architecture that embraces rapid, iterative development and the commoditization of data storage. It offers organizations the opportunity to swiftly adapt to changing business requirements while reducing total cost of ownership (Logi Analytics, n.d.).

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

451

Agile BI requires collaboration between business and IT, using rapid prototyping, enables organizations to increase development speed while better responding to business needs. The agile BI development approach is also supported by agile project management, by which planning, requirements collection, development, but also functional, regression and usability testing are managed in an iterative manner (BARC, 2018a).

- **Data Warehouse Modernization** - organizations are aware of new technological and business challenges. They recognize the potential of alternative methodologies to DW architecture design and utilizing other technical options like in-memory processing, cloud storage or data warehouse automation tools. IT must meet the needs for changing analytical requirements, and they must compete against new and cheaper implementation options from external service providers. Collaborative approaches are needed to cover the increasing expectations of the business to maximize the business value of the data. It is time to compare old data warehouses against present requirements and evaluate how updated hardware and technology could make the business better and easier (BARC, 2018a). Traditional data warehouses are not designed to handle the rapid growth in data and varying data types – hence big data. Also, they are not designed to keep pace with the continually changing needs of end users and the applications that rely on (Snowflake, n.d.).

- **Data-Driven Culture** - today's workforce offers more than ever before. The level of education, engagement, and know-how is higher than ever. With data-driven culture, organizations can extract all relevant data and fully utilize their values. Data-driven culture helps driving organizational culture to the next level of performance, by deriving relevant KPI's rooted in business. The transparency of data derived KPI's, is a key factor in data-driven culture approach in organizations (Data Driven Culture, n.d.).

- **Data Preparation for Business Users** - is the process of cleaning, structuring and enriching data for exploratory and advanced analytics. Data preparation aims to provide tools for shaping data to their analytical requirements without having to resort to IT technology. Intuitive and user-centric tools with sophisticated user guidance and immediate results are vital to spreading data preparation to business users (BARC, 2018a).

- **Integrated Platforms for BI and Performance Management** (PM) - supporting BI and PM on an integrated data platform with an integrated tool

is the aim of many organizations. For that reason, it has become one of the most stable and present trends in the BI market (BARC, 2018a).

- **Embedded BI and Analytics** - embedding intelligence in operational applications. Embedded BI and analytics are usually adding features associated with BI software (dashboard reporting, data visualization, and analytics tools) to existing non-BI applications. Embedded BI provides a much cleaner and friendlier user experience for customers and therein lies its primary advantage over solutions that require two separate platforms (Bitner, 2018).

- **Data Storytelling** – is tasked with data visualizations, infographics, dashboards, data presentations, etc. It is more than just creating visually appealing charts. Data storytelling is a structured approach for communicating data insights, and it includes a combination of three key elements: data, visuals, and narrative. When combining the right visuals and narrative with the right data, a data story that can influence and drive change (Dykes, 2016).

- **Using External/Open Data** - valuable insights can be gathered from social media, customer, market, meteorological, geographical and demographic data, and even from existing analytical findings. Organizations can acquire these and many other types of data from other BI generalists, specialist service providers or data trade platforms. Open data is often used to build business models around targeted analysis (Micek, 2017).

- **Analytics Teams/Data Labs** - are separate business units, specifically designed to begin data science in an organization. They require investments in new technologies to store, process and analyze data. As analytics gains in maturity, the deployment and productivity of such solutions become more critical. It is new challenges for software solutions providers and requires revised organizational approaches to link data labs, IT departments and business units (BARC, 2018a).

- **Visual Design Standards** - the practice of presenting relevant information in a way that it can be understood in an effective and efficient manner. Due to the growing need to analyze vast amounts of data in order to stay competitive and to provide the results most directly, the trend of visual design standards is establishing and gaining attention in the last three years. Support for visual design standards is increasingly seen as a criterion which

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

453

should be fulfilled for BI vendors in software selection processes (BARC, 2018a).

- **IoT Analytics** - while new sensor, mobile, and wireless technologies are driving the evolution of the internet of things (IoT) it is real business value needs to be found in analytics rather than in hardware novelties. Vendors are starting to offer such features to their customers, thus expanding their service portfolios into new business areas. IoT data requires real-time data analysis. Moreover, the diversity of IoT data means that new architecture, tools, and processes are necessary to implement in order to process, store and run effective analysis on IoT data (Harris, n.d.).

- **Big Data Analytics** - provides the means to analyze data sets of huge volume, variety and velocity gathered from internal and external sources including text, sensor, geolocation and clickstream data, etc. In this setup, big data analytics must effectively process large datasets in real-time or near real-time - including modeling, visualization, prediction, and optimization (Hu et al., 2014). Organizations are using big data analytics to support decision-making and process optimization (Galetto, 2016). Big data analytics includes structured data analytics, text analytics, web analytics, multimedia analytics, social networks analytics and mobile analytics (Hu et al., 2014).

- **Data Lake** –a large data store in a native state of structured and unstructured data according to the original definition by James Dixon (Rajesh & Ramesh, 2016). It is possible to store and process data in its raw, original form, straight from the data sources, without any cleansing, standardization, remodeling, or transformation. Data lake enables ad-hoc queries, data exploration, and discovery-oriented analytics because data management and structure can be applied on the fly at runtime (TDWI, n.d.). Design of a data lake is to store all of the data (relational, non-relational and big data) on the same platform (Shepherd et al., 2018).

- **Edge Computing and NLP** – delivers NLP processing closer to user requests. BI is witnessing efforts toward understanding user's behavior, attitudes, and emotions (Cambria, 2016; Shi, 2016). NLP in collaboration with DL has a pivotal role in understanding written or spoken language. Recently AI has made tremendous step ahead toward this goal, and it is to expect more BI solutions with integrates speech or language understanding technologies (Chandrayan, 2017).

3   Analysis and Discussion

The features outlined in the previous Section are integrated into many BI solutions on the market. The list includes basic features that are an integral part of all the analyzed solutions and advanced features that are rarely implemented into existing solutions. Advanced features are the ones to be expected soon.

For this research, we performed a thorough analysis of BI solutions on the market and their features against the selected features. We then narrowed the list of BI tools on the market to 20. Used methodology enabled structured analysis and comparison of BI solutions, hopefully providing better insights into the current state on the market and helping to select BI solutions that offer all/subsets of the features listed above. Moreover, the conducted analysis allows identifying current trends in BI solution development. This analysis can serve as the roadmap that may be consulted when selecting a BI solution that fits well with the organization's requirements. To this end, we created a feature-to-BI-solution cross table and derived a pyramid of features that reflect the trends in BI solution development – with a particular focus on new and upcoming features.

In Table 1 we list 20 selected BI tools (solutions) that are currently present on the market with a link to their specifications. In addition to the solutions offered by leading vendors (e.g., Microsoft, IBM, SAP), we have included smaller vendors that offer some interesting features (e.g., Avlino, Sisense, QlikTech). Majority of the analyzed tools have been included in Gartner's list of leading solutions for BI (King, 2018). Some of them, such as Domo, Sisense, Tableau, Power BI and Qlik, are on the Gartner list of best business intelligence and analytics software of 2018 as reviewed by customers (Gartner, 2018h). In general, the list includes easy-to-use solutions that support a full range of analytic workflow capabilities, which do not require substantial involvement from IT specialist, allowing end users quick adoption of tools. For example, tools can predefine data models upfront as a prerequisite to analysis, and in some cases, they allow automatic generation of a reusable data model.

Note that BI vendors are frequently releasing new versions with new features, so in this work, we are analyzing the state in the second half of 2018. For this reason, when choosing a BI solution for organization, it would be advisable to inquire about current and upcoming features offered in the BI solution of a particular

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

455

vendor. The pace of BI solution development/release should be taken as one of the key factors for the selection because the number of its features increases and improves rapidly monthly. For the BI solutions listed in Table 1 in the next section, we analyze by assessing their functionalities against the proposed basic and advanced features of BI tools.

Table 1: BI solutions selected for the comparison, source: authors.

BI Solutions	Web page
Tableau	https://www.tableau.com/
MicroStrategy	https://www.microstrategy.com/us
BOARD	https://www.board.com/en
Looker	https://looker.com/
Longview	https://www.longview.com/
Sisense	https://www.sisense.com/
Pentaho	https://www.hitachivantara.com/go/pentaho.html
Domo	https://www.domo.com/
Yurbi	https://www.yurbi.com/
Power BI	https://powerbi.microsoft.com/en-us/
Qlik	https://www.qlik.com/us
Birst	https://www.birst.com/
Yellowfin	https://www.yellowfinbi.com/
GoodData	https://www.gooddata.com/
Dundas BI	https://www.dundas.com/dundas-bi
SAP Crystal Cloud	https://www.sap.com/products/crystal-bi.html

IBM Cognos Analytics	https://www.ibm.com/products/cognos-analytics
Salesforce	https://www.salesforce.com/
Avlino	https://avlino.com/
Jupiter	https://jupyter.org/

3.1 Feature to BI solution comparison table

In this section, we analyze the selected 20 BI tools against their functionalities in the form of product/feature matrix depicted in Table 2. Green checkmarks indicate integrated features of tools, and red x-es are showing the missing ones. This table allows reviewing the features for a particular BI solution and comparing it to other solutions. It gives us insight into the current situation on the BI market and helps identify solutions with advanced features. We can also identify solutions that offer some features that are not standardly included in BI solutions, such as data lakes and IoT integration, augmented analytics, deep learning, edge computing, and NLP.

The analysis revealed that over 90% of the analyzed solutions offer data analysis, ad hoc analysis, dashboards, ad hoc query tools, ad hoc reports, KPIs, and performance metrics, which belong **the basic group of features**. Besides, they are offering: data quality/master data management, data discovery/visualization, self-service BI, cloud BI deployments, BI on mobile, machine learning, real-time analysis, and big data analysis. It is important to point out that although most manufacturers offer the full spectrum of features in their solutions, they may, but not necessarily be, of the same level of functionality and quality as features in other solutions. Also, manufacturers do not need to develop each functionality separately. Since there are vendors in the market that are narrowly specialized in producing specific features, it is possible for manufacturers of complete BI solutions to implement these solutions in their tools, so that they will not spend their resources in developing the already-developed features. Hence, integration, connectivity, collaboration and partnerships between BI solutions manufacturers enabled quick solution development of the BI tools market.

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

457

The analysis confirmed that the majority of solutions enable integration of specific features from other products. For instance, advanced visualization capabilities of one solution can be incorporated into other products in order to offer their customers the best visualization solution. It is expected that vendors will lean toward integration of the highest rated solutions of other suppliers into their products, rather than developing their own.

Big data analytics already has a strong penetration into BI tools, since 19 out of 20 solutions list capabilities to perform big data analytics. Other advanced features will follow this development trend in 2019.

More than 40% of solutions already offer data lakes and IoT analysis – as advanced BI features. With the implementation of these upcoming BI features, organizations reduce the need for extracting, transforming, and loading data from data lakes into data warehouses for querying, reporting, and data exploration. Also, these options offer easier and faster access to the contents of data lakes and search capabilities of all the diverse types of data. Streaming data and real-time analytics have become one of the major strategic priority for a higher number of organizations as well. IoT analysis allows the organization to monitor and integrate into analytical systems all kinds of devices like industrial machines, vehicles, and readings from personal wearables. It enables better management of operational processes through real-time data, as well as future improvements through predictive maintenance or data-driven business models (BARC, 2018b). Users now have the option to implement the Internet of Things (IoT) devices as part of operational technology and industrial internet strategies. Since these technologies are not so new in the market, we can expect that these features should shortly become the standard of modern BI solutions.

Finally, analyzed BI solutions, as well as the rest of the technological world, are geared towards bringing machine learning, NLP and AI to their clients. As Gartner notes: Until 2020., the number of users of modern business intelligence and analytics solutions that are differentiated by augmented data discovery capabilities will grow at twice the rate — and deliver twice the business value (Bauer, 2018). BI solutions market trend indicates augmented analytics as a strategic planning topic, a paradigm that includes natural language query and narration, augmented data preparation, automated advanced analytics, and visual-based data discovery capabilities.

Table 2: Business intelligence solutions and the capabilities they offer presented in a business intelligence features checklist, source: authors.

BI Solution	Master Data / Data	Data Discovery /	Self-Service BI	Data Governance	Cloud BI / Data	Mobile BI	Real-Time Analytics	Agile BI	Development	Data Warehouse	Data-Driven Culture	Data Preparation for Business Users	Integrated Platforms for BI	Apps integration	Embedded BI and Analytics	Data Storytelling	Using External / Open Data	Analytics Teams / Data Labs	Visual Design Standards	Big Data Analytics	Data Lake	IoT Analytics	Augmented Analytics	Deep Learning - powered	Edge Computing and NLP
Tableau	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
MicroStrategy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
BOARD	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
Looker	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗
Longview	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗
Sisense	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗
Pentaho	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
Domo	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗
Yurbi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
Power BI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Qlik	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗
Birst	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
Yellowfin	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
GoodData	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
Dundas BI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗
SAP Crystal Cloud	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗
IBM Cognos Analytics	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Salesforce	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗
Avlino	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗
Jupiter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

459

3.2 BI features pyramid

Next, we introduce the feature pyramid, which organizes BI features based on the frequency of their occurrence in BI solutions, as shown in Figure 1. The most common features implemented in the majority of the BI tools are grouped at the bottom of the pyramid, and rear features are at the top.

The **bottom** layer contains features that we categorized as **basic** and they are common to 60% of BI tools. The **second** layer is comprised of **augmented analytics, IoT analytics and data lakes**, which are implemented in roughly 20% of BI tools. However, about 40% of analyzed solutions report that they have started with the implementation of augmented analytics – in a more or less advanced form. Solutions offer revolutionary, visual access to complex data, backed by smart recommendation algorithms which make it easy for business decision makers to uncover hidden and useful insights. Also, the time required for data preparation using automation and embedded intelligence has significantly decreased. However, the analysis indicates that all the solutions are firmly directed towards augmented analytics.
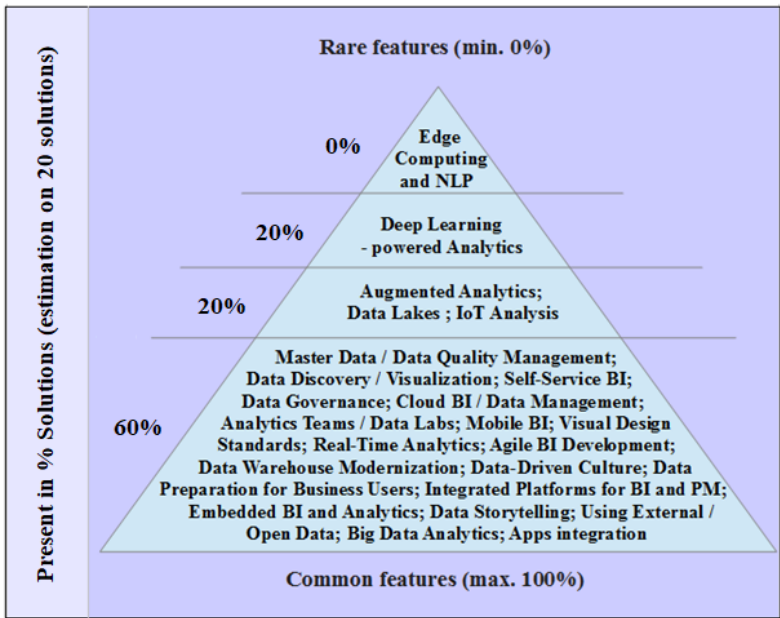

Figure 1: The pyramid of BI tools features, source: authors.

The **third** layer category contains **deep learning-powered analytics**. This analysis indicates that roughly 20% of the analyzed BI solutions offer variants of deep learning-powered analytics, where we emphasize the following examples of implementation:

- with the aim of solving complex problems the way human brains do (understand different patterns, run comparisons, understand differences across not a few, but millions of multilingual documents) we can get answers through a simple hover above the text - intelligence is embedded directly into web browsers, applications, and BI tools, and delivers results without any clicks and without delays;
- asking questions in natural language and getting instant responses - integrating solutions such as Alexa to turn analytics applications into a voice-enabled personal coach;
- personalized insights - dynamic and intelligent display that presents a personalized view of information based on who is standing nearby; or a smarter way to see - possibility use bluetooth-based identity detection to bring up data about some person or GPS technology to fetch data on a property or location.

The **top** layer contains emerging features like **edge computing and NLP**, allowing the BI solutions to understand human opinions, behavior, and emotions. The solutions we have analyzed do not offer such options yet (0%), but by reviewing trends, we can conclude that these features will soon be implemented in the next BI releases.

4   Conclusion

In order for the organization to gain the best value from its data, it is necessary to find the BI solution that best suits its needs. It is necessary to define which features the solution should have implemented whether the solution is easily adaptable, or is it easy to use, what kind of support it offers, how well it handles security issues, and finally what is the cost of such a solution. In order to help overcome all of these challenges, we have analyzed the current situation in the BI market at the end of 2018 and compared a list of 20 BI solutions against 24 features-functionalities.

M. Pribisalić, I. Jugo & S. Martinčić-Ipšić: Selecting a Business Intelligence Solution that is Fit for Business Requirements

461

The comparison matrix helps to compare the basic and advanced features of 20 analyzed BI solutions. The comparison matrix revealed that most of the BI solutions offer all the basic features, but significant differences can be found in the penetration of advanced features, present in less than 20% of tools. With the results of the analysis, we can conclude that Domo, Sisense, Tableau, Power BI and Qlik tools are on Gartner's list of best business intelligence and analytics software of 2018 as reviewed by customers because these solutions offer their customers more advanced features than other solutions. In addition to these tools included in Gartner's list, there are other tools including ones in this research that offer similar features and which should be taken into consideration. The table gives us the ability to use the same method of analyzing for any other tool and comparing it to some of the leading tools on the market and other tools analyzed in this paper. Also, if we are looking for a BI solution, this can be a starting point to gain a brief overview of the market and can help organizations in the selection process.

The feature pyramid offers insights into the current maturity on the market and indicates future trends in BI development. It gives a clear view of the standard features which are implemented in all of the solutions and clusters features that are just emerging and will be implemented in solutions in the future. Pyramid provides the general framework to assess the maturity of BI solution and enables detection of upcoming trends in provided BI features. Moreover, combined with categorization in Table 2 assess the exact position of BI solution with respect to features in competitive solutions. From the results, we have detected that none of the manufacturers have implemented edge computing and NLP in their solutions yet. However, we emphasize some of these features as a clear development direction which the most modern BI solutions will follow. Finally, BI solutions market is a very dynamic area, and it is likely that edge computing and NLP will transform future BI systems, which we plan to monitor in the future work.

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463

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465

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