Evaluating Self-Service BI and Analytics Tools for SMEs

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Abstract: In the vast Data Science domain, Business Intelligence (BI) and Data Analytics are two of the most relevant topics nowadays. Regardless of the data type an end-user needs to work on, data visualization and/or analytics can be a valuable support for a successful decision-making process in management. For that, free and open-source business intelligence and analytics solutions are on the market as an indispensable opportunity for companies to start benefiting from data analytics at no cost. In addition, that task has been currently eased by a group of BI and Analytics tools named as "Self-service", which is an Advanced Analytics topic and designed to enable users with no IT background to perform analyses of data and find business opportunities themselves with minimal or no assistance from IT technicians. Considering that, to help Small and Medium-sized Enterprises (SMEs) decide on a free self-service data tool according to their needs, we compare in this paper, on a functionality basis, 5 popular Self-Service BI and Analytics tools: Metabase, Pentaho Community, Power BI Free, QlikView, and Tableau Public.

1 INTRODUCTION

Self-Service Analytics Software allows business users to analyse data to find business opportunities without an IT background. These technological applications are an approach to advanced analytics. They ensure that users can easily benefit a lot from their business data without necessarily possessing statistical or technological background. Many organizations have recognized the importance of Self-Service Analytics Software, as they have been using these computer tools for their processes (Pat Research, 2019b).

Self-service Analytics belongs to the Business Intelligence (BI) field and empowers line-of-business professionals to build reports and queries on their own with minimal support from IT specialists. Additionally, Self-Service Analytics is represented by BI tools, which have a slight learning curve and offer uncomplicated data access through basic Analytics and simplified underlying data models (Gartner, 2020).

There are many features that makes Self-Service Analytics Software important to organizations, and some of them are: Data Gathering, Filters, Visualizations, Reporting, Collaboration, Data Analysis, Dashboards, Predictive and Real-time Analytics, high ease-of-use for lower-skilled users, Integration of Data, Natural Language Processing, and Security. All that naturally in addition to the software capabilities designed for the high-skilled or more technical users (Pat Research, 2019b).

The most visible benefits of the features mentioned above are predictive power for project future trends and events to plan as soon as possible for their effects. Thus, it is possible to discover business opportunities which stimulates insights that are invisible in not-yet-analysed data. Additionally, urgent issues can be addressed with help of real-time-analysis, and easier access to data about customers, as the business will possess and analyse the data of their customers itself, with no need to wait for industry reports or other third-party sources of data (Bernardino, 2011).

The more end-users can do BI and Analytics on their own by performing, for instance, drill-

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throughs/downs, customizable reports/ dashboards, and *ad-hoc* calculations, the more decreases the IT resource drain in the company freeing up then the IT department for more strategic duties.

Self-Service BI and Analytics brings several gains for companies (Greengard, 2015). Thus, organizations can deal with decision-making by empowering users with no IT skills to produce valuable information through data science software. Considering that, we have decided to search for the most popular free and open-source Self-Service BI and Analytics tools and evaluate them according to criteria based on the available relevant features.

This work aims to make a comparative analysis of existing functionalities in Self-Service BI and Analytics solutions to help small and medium enterprises adopt a software solution adequate to their needs and budget. We also believe it is beneficial to promote information about BI and Analytics solutions, focusing on their great associated benefits.

The rest of this paper is organized as follows. Section 2 contains Related Work. Section 3 describes the five of most popular BI and Analytics tools. Section 4 explains the Evaluation Criteria used in our study. Section 5 presents a Comparative Analysis of the tools. Finally, Section 6 presents the conclusions and future work.

2 RELATED WORK

In 2016, McCafferty mentioned that through 2020, according to the industry research, investment on acquiring Self-service data tools would grow 2,5 faster than on traditional data tools, as those tools were already helping significantly businesses adopt the Do-it-yourself Analytics approach which enables organizations to boost and improve the speed, ease-of-use and quality of analytics efforts (McCafferty, 2016).

In 2015, Greengard concluded that over the last decade Self-service BI and Analytics tools had become a critical resource to help firms of all shapes and sizes operate faster and smarter (Greengard, 2015).

3 ANALYTICS TOOLS

The initial idea of this work was to evaluate preferably only open-source solutions rather than proprietary ones. Then, we started by doing exhaustive search on websites which list Self-Service

BI and Analytics solutions to build our top 5 tools for evaluation. Curiously, that research revealed an indeed reduced number of open source solutions. In addition, almost all found open-source tools were not recommended or well rated by distinguished research companies such as Gartner or Predictive Analytics Today, which base their reviews not only on customer ratings but also on an unbiased methodology (Pat Research, 2019a).

Considering the low number of found open-source tools and to not evaluate only proprietary solutions, we decided to build our top 5 solutions including three most popular free but non-open source solutions and two open-source ones, so that we could check ourselves if there was no highly competitive open-source alternatives. Thus, the proprietary ones were Power BI Free, Qlik View and Tableau Public. In addition, the open-source ones were Metabase and Pentaho. The first one is free, completely open source, referred as promising, and has a good review on the Predictive Analytics webpage (Pat Research, 2019c). The latter is highly recommended by Gartner, but it is not totally free.

It is also worth highlighting that we could not consider several of the various curated lists of top Self-Service BI and Analytics found on the web. Those lists tended to be of dubious value for self-service solutions, as they indicated, for instance, JavaScript libraries for adding interactive charts to a website, what may not be of straightforward implementation for end-users who need to visually query data without having the specific IT skills.

In the following sections, we describe the main characteristics of each solution. Besides that, major advantages and limitations of each one are outlined.

3.1 Metabase

Metabase is a web-based, open-source visual query and BI tool designed visualizations released in 2015 (Metabase, 2020b). It releases updates frequently and is intended for companies of all sizes.

It is built and packaged as a Java jar file and can be run anywhere if Java is available. It also provides a binary Mac OS X application for installation or can run on Docker (Metabase, 2020a). It is a server application accessible to the entire company.

This platform is available under three types of licences: Affero General Public License (AGPL), which is free of costs, and other two versions, Premium Embedding and Enterprise with acquisition costs.

It addresses the vital, but less complex questions that make up most day-to-day data analytics

operations. In addition, it can organize information in a central place and connects various interaction points to perform data storytelling.

This software allows filter and/or group data, without resorting to Structured Query Language (SQL). Furthermore, it monitors questions created by users to provide insights on the available data. These questions can produce graphs and charts, and these visualizable results can be saved and organized in dashboards (Santos et al., 2019).

We can see in Figure 3 that the platform has a clean user interface, where it is shown a screen related to a feature which suggests some automated explorations for newly connected data.
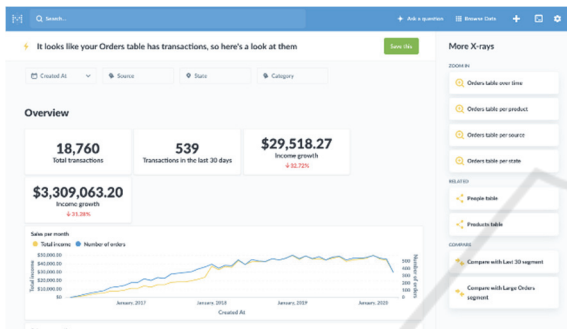

Figure 1: Metabase User Interface. (Source: https://www.metabase.com/docs/latest/users-guide/images/x-rays/x-rays-browse.png).

The most expensive license includes features such as white labelled embedding, row level permissions, and auditing tools. Following we have some strengths and weaknesses of it (Pat Research, 2019c) (Do, 2018).

Advantages:

- Rich dashboards with auto refresh and full screen;
- Clean user interface;
- Supports numerous standard data sources;
- Large choice of visualizations.

Limitations:

- A server is necessary to maintain the infrastructure;
- Only Mac OS users can deploy it quickly using a binary application;
- Limited variety of charts and settings;
- Weak permission control.

Metabase provides different ways to be deployed anywhere, is constantly improving due a strong community behind it for support and development.

3.2 Pentaho Community Edition

Pentaho is an open source suit of tools for Business Analytics released in 2009 (Pentaho, 2015). It is one of the first open source solutions of its type and it is frequently updated. It runs on Windows, Linux or Mac OS and is designed for companies of all sizes.

It provides analytics for several user roles, from visual data analysis for business analysts to tailored dashboards for executives. It features *ad-hoc* analysis and visualization, data visualization, On-line Analytical Processing (OLAP) services, custom dashboard creation, data mining and report designer. Furthermore, it supports multiple Big Data integration/analytics and offers mobile business analytics (Pentaho, 2013).

As can be seen in Figure 1, the platform has an architecture divided into two main layers: Presentation and ETL. The first one contains tools for reporting, analyses, dashboards and process management, whereas the ETL is designed for Extraction, Load and Transformation of data.
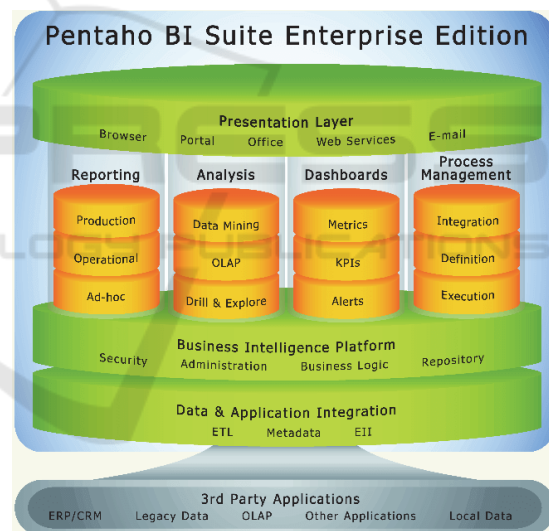

Figure 2: Architecture of the Pentaho Open BA Suite. (Source: https://pt.slideshare.net/nvvrajesh/pentaho-bi-suite-overview-presentation/8?smtNoRedir=1.).

Pentaho has a community and an enterprise version, which are free and paid, respectively. The key differences are the free version does not allow mobile features, interactive reporting, and dashboard designer. Moreover, it restricts access to some more advanced functionalities within the free available features for data integration and big data [13]. A few advantages and limitations of Pentaho are mentioned next.

Advantages:

- Mature data access and data transformation features;

- Reporting is fast due to in-memory caching techniques;

- Easy integration with third party applications, such as Google Maps;

- It runs on almost all platforms: Android, iPhone, iPad, Mac, Web-based, Windows.

- Features regarding predictive analyses and big data sources are present at no cost.

Limitations:

- The type of graphs and layouts proposed for some diagrams and charts are limited and partly outdated.

One of the key Pentaho's differentiators is the strength of being supported by a large community, due to its strong open source software roots. Moreover, its mobile data discovery functionality ensures users are productive no matter where they are. SMEs with lots of different types of data and big data sources are highly recommended to use Pentaho.

3.3 Power BI Free

Power BI is a free desktop proprietary Microsoft platform released in 2011 (Wikipedia, 2019). It works in conjunction with a cloud application that makes possible to publish reports throughout the business. Power BI can only be installed on Windows OS and is updated every month. It is intended for small to midsize organizations.

It has connections to several data source types, interactive/sharable reports and dashboards for web or mobile, and real-time data. Furthermore, it has the same rich visualizations and filters as the paid version, such as auto-detect to find and create data relationships between tables, Python support, and a natural language query feature. Additionally, it is possible to save, upload and publish reports to the web with a storage limit of 10 GB per user (Techtarget, 2020).

As can be seen in Figure 2, the platform works in an architecture divided into three layers: Business Analyst tools (Excel and Power BI designer), Microsoft Cloud to host reports and datasets, and visualization media, which includes computer web-browsers and mobile devices.
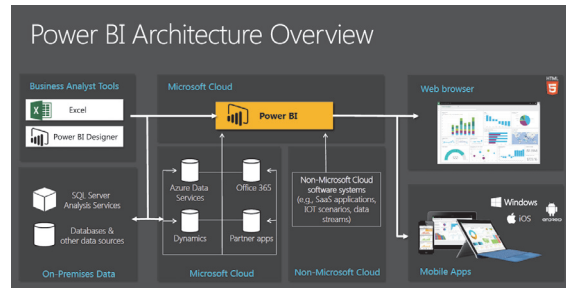

Figure 3: Power BI Architecture Overview. (Source: https://yodalearning.com/tutorials/power-bi-architecture-power-bi-security/).

It is worth mentioning that its other two types of license, Pro and Premium, which are not free. These licenses allow the ability to collaborate reports with other Power BI users, analyse data in Excel, direct query, more advanced analytics features, and the use of the Power BI Report Server (Microsoft, 2020a).

Advantages:

- Inexpensive to upgrade;

- Wide range of custom visualizations;

- Seamless integration with Excel;

- Fast learning curve for basic functionalities.

Limitations:

- Rigid about relationships between tables;

- Bulky user interface;

- Upload limit of 1GB per dataset;

- Need to learn several Microsoft interrelated solutions to take full advantage of it;

- On-line report must be public to the Internet;

- A few options to configure visualizations;

- It uses DAX, a hard language to work with.

Power BI Free has available a huge number of learning resources spread on the web. It has an active community, over 70 numerous integrations and data sources (Microsoft, 2020b). In addition, it is attached to Microsoft, which is always investing resources into it and working for new features and updates.

3.4 QlickView Free

QlikView is a robust proprietary desktop platform for business discovery which offers a powerful free version in terms of features. It was released in 2012 and is frequently updated (Qlik, 2020). Besides that, it is suitable for companies of all sizes, allowing installation only on Windows OS.

This software is one of the major Tableau platform competitors. Its free version has no limitations in terms of time or functionality compared with its paid edition.

It supports visual data discovery, reporting, *ad-hoc* queries, dashboards, shareable reports, guided model creation, mapping data, reporting and scalability with data integration, various forms of data presentation, and predictions with historical data.

As can be seen in Figure 4, the platform's architecture is based on three main components: **QV Server** (provides functionality to the client and must run on a Windows OS), **Client** (web browser or an application shell that provides a container for the client code), and a **Web Server** (http server for pages, user authentication, and communication between QV Server and Client).
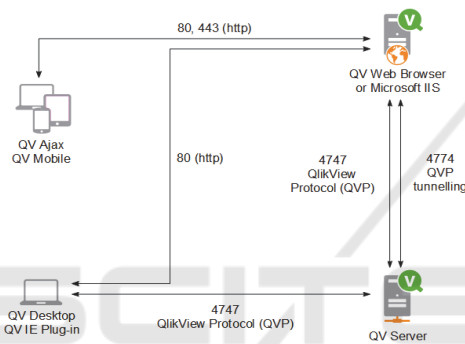

Figure 4: QlikView Architecture. (Source: https://help.qlik.com/en-US/qlikview/November2017/pdf/Deploying%20QlikView.pdf).

However, the files/documents created by a free-license user cannot be opened on another computer or shared with a user who has a paid license.

Advantages:

- Fast user experience due to be a memory-resident application;

- Transparent reporting and scalability with data integration;

- Fast implementation.

Limitations:

- Need of macros, duplication, and maintenance of the QlikView objects for formatted report;

- It runs only on Windows OS;

- Reloading can take a significant amount of time as it loads most data into the system RAM.

Qlikview is excellent in visually analysing data relationships. Its in-memory engine recognizes patterns in data that we are not normally able to do it by using SQL alone (Kumar, 2019).

3.5 Tableau Public

Tableau is one of the oldest and most famous "self-service" analytics platforms on the market. It was first released in 2010. It is not open source, but it has a commercially free platform and releases updates frequently.

It must be installed on Windows or Mac OS to be used in conjunction with the web free version. It allows anyone to analyse data, create and publish interactive data visualizations in the cloud.

It offers many of the same powerful visualization capabilities as its paid desktop and server versions. It has a variety of analytical methods, inspection and manipulation of data in a variety of ways and even analysis template creation. Interactive and shareable dashboards can be distributed, depicting trends, changes and densities in graphs and charts. In addition, it allows data mixing, real-time collaboration and data-analyses.

Data Analyse is possible from sources such as Excel sheets for geographical visualizations, Gantt charts, tree maps and other templates. The free version has a limitation of 15.000.000 data rows per workbook (Tableau, 2016).

As can be seen in Figure 3, the platform's architecture is categorized into two main segments: Tableau server and Tableau desktop. There is a server application to receive, treat, analyse, transform and publish data and the desktop one to send data. Besides that, the web and mobile clients to visualize analytics outputs.

However, it is possible only to connect to Excel sheets, text file formats, statistical files, Google sheets, and web data connectors, which must be uploaded to the cloud.
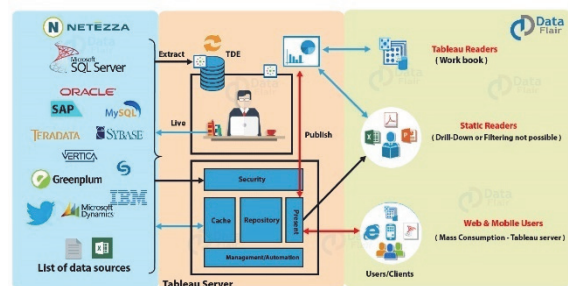

Figure 5: Tableau Architecture. (Source: https://data-flair.training/blogs/tableau-architecture/).

Advantages:

- Quick responsiveness;
- Extensive training resources available for free on the Tableau Public site;
- Very intuitive user interface;
- Dashboards can be viewed on multiple devices like tablet, mobile and laptops;
- Extensive community documentation.

Limitations:

- To keep workbooks private, a paid subscription is required;
- Complex visualizations require time and cost-intensive training.

Tableau Public is a very sophisticated and advanced system. It surpasses other tools mostly in data visualization. It provides an all-inclusive and user-friendly data visualization experience (Tableau, 2020).

4 EVALUATION CRITERIA

First, we needed to create a list of essential functionalities for a high-quality Self-Service BI and Analytics solution. For that, we consulted the 15 Critical Capabilities of an Analytics and BI Platform according to Gartner (Howson, Richardson, Sallam, & Kronz, 2019).

However, we did not utilize criteria related to Metadata Management, Scalability and Data Model Complexity, Embedding of Analytic Content, and Advanced Analytics for Citizen Data Scientists, once they do not fit exactly the "Self-Service" concept addressed in this paper, which relates mainly to basic Analytics. Besides that, for the non-technical end-users these capabilities will probably not weight when they must decide themselves on a tool, considering they require more than basic background in Analytics to be properly explored.

Moreover, the functionalities/criteria list relates to the capabilities recommended by Gartner, but it is written in a way intended to be of more straightforward understanding and reference. To confirm the relevance of the chosen features, we also checked the criteria list present on the Predictive Analytics Today Research website (Pat Research, 2019b). We explain the selected features ahead.

As self-service analytics deals sometimes with confidential data, **Access Control and Security** is an essential feature through the implementation of user permission levels.

Following we have **Ad-hoc Reporting**, which allows reports to be created by end users by adding or removing dimensions/expressions from the datasets. **Ad-hoc query** is useful when end users need to create queries on their own for questions that cannot be solved by predefined queries. **Cloud Services** refers the capability to perform data analysis using a cloud version of the software.

When it comes to visualize data, the more we can visualize data in different ways, the more data visualization becomes interesting and attractive. Thus, we chose the **Data Visualization variety** feature.

Data Integration refers the capability to integrate with several different data sources. The higher the number of supported data sources, the better. **Dashboard Designer** is the functionality for creation of customized business dashboards from scratch. Those panels will contain the graphs and charts selected by the end-user.

Interactive visualization enables data exploration manipulating chart images, colour, brightness, size, shape and motion of visual objects in BI dashboards.

Mobile capabilities are a great advantage, as by making use of mobile devices capabilities, it is possible to perform Data Analytics anywhere and anytime, increasing consequently productivity.

Natural language queries are a trend and mean that software can query data also by semantics and natural language inputs.

OLAP stands for Online Analytical Processing. It enables us to perform quick queries and calculations from different measures/dimensions such as, sales figures, budgets and quantities sold. That in different degrees of detail and according to the end user needs.

Predictive Analytics ensures the tool can analyse data and forecast trends and events.

Real-time Analytics is related to performing analyses on data in real time, as data streams are arriving.

Real-time collaboration allows team members to share dashboards and reports not just for visualization but also for edition.

Report customization allows the generation of formatted and interactive reports. With **Report Scheduling** we can schedule the generation and distribution of reports.

5 COMPARATIVE ANALYSIS

Based on the technical specifications of the Self-Service BI and Analytics platforms available on

the market and analysed according to the criteria defined in Section 4, we built a comparative table on the availability of respective capabilities, taking into account their characteristics.

The following table is intended as an aid to selecting the most suitable "Self-Service" platform to an organization, depending on its needs. It reveals what each tool can perform and shows an option that fits into the particularities of organizations. It is worth mentioning that we focused on the free versions of each tool. Thus, the paid capabilities are not checked in the table.

Table 1: Functionalities considered to be essential for a BI and Analytics solution.

Functionalities / Criteria	Self-Service BI and Analytics Platforms				
	Pentaho	Power BI Free	Metabase	QlikView	Tableau Public
Access Control and Security	✓	✓	✓	✓	✓
Ad-hoc reporting		✓	✓	✓	✓
Ad-hoc query		✓	✓	✓	✓
Cloud Services		✓			✓
Data Visualization variety	✓	✓	✓	✓	✓
Data Integration	✓	✓		✓	✓
Dashboard Designer		✓	✓	✓	✓
Interactive Visualization		✓	✓	✓	✓
Mobile capabilities		✓		✓	✓
Natural Language Query		✓			
OLAP	✓	✓		✓	✓
Predictive Analytics	✓	✓		✓	✓
Real-time Analytics					✓
Real-time Collaboration			✓		
Report customization		✓	✓	✓	
Report Scheduling					

We can see in Table 1 that all tools are able to deliver "Data Visualization" and "Access Control and Security". However, Security, depending on the required data confidentiality degree, is compromised for Power BI Free and Tableau Public, as all the visualization works must be published and public to the entire web. We should clarify that they remain checked in Table 1 for the referred tools because the access to the Self-service BI software and its original workbooks remain restricted to the user who created the project.

Pentaho is a consolidated open-source product on the market. However, it lacks most free features when compared to the other tools here under evaluation.

Power BI showed to be the most complete free option, not offering just "Real-time collaboration". In addition, the "Real-time Analytics" feature refreshes the data visualization only every 30 minutes.

Metabase revealed to be more for data visualization and lacks many features, but the tool has seamless connection to third party tools to compensate those missing capabilities.

Qlikview also presents a very complete set of free features and misses just "Cloud Services", "Natural Language Query", "Real-time Analytics", and "Real-time Collaboration".

Tableau Public lacks just in three free features. Among them is "Report customization and scheduling", what causes surprise, as such functionality, except for the scheduling feature, is easily found at no cost in several other free tools.

All the solutions work at least in 8 different languages, can connect to at least 11 types of data sources, and none of them offers scheduling for the Report Customization and Schedule functionality. The cloud services offered by the free versions of Power BI and Tableau are designed to allow mainly visualizations of the work done locally on a desktop.

As for "Mobile capabilities", Power BI Free offers a mobile application for visualizations, while QlikView and Tableau Public allow the same but just through mobile web-browsers and the dashboard and/or reports need some pre-configuration to be displayed correctly on mobile devices.

From the tree tools with more functionalities checked in Table 1, Power BI Free stands out in features such as "Ad-hoc Reporting" and "Predictive Analytics" due to its higher easy-of-use compared to the other tools, being the only one to feature "Natural Language Query" at no cost. Tableau is overall so powerful as Power BI, but its user interface is less intuitive. QlikView seems to be less "self-service", once it looks more traditional and technical than the other two mentioned tools, being so naturally less intuitive and requiring end users already more used to Data Analytics.

6 CONCLUSIONS AND FUTURE WORK

We can conclude Self-Service BI and Analytics tools can cause a significant positive impact inside SMEs by empowering line-of-business end users to take important decisions based on queries and data analyses made by themselves. Further, it also saves time for the organization's Information Technology

(IT) teams, who would have otherwise to still spend a considerable length of time with basic Analytics for the referred end users. Instead, these teams can focus on other tasks that will permit the organization to achieve more strategic goals.

The selection process of the best suited "Self-Service" platform to an organization will depend on many factors like the available financial, human and material resources. However, the vision that the top managers have to the organization will be also essential for that, once the SMEs should understand that the investment of time to learn how to use those platforms means higher likelihood of new business opportunities and profits, even if they have to pay for training resources, consulting and licenses.

From our analysis, we conclude that Self-Service BI and Analytics are gaining more and more space on the market as they have evolved in features and quality. From the 5 tools analysed, we cannot define which one exactly occupy the first position in our top 5, because that also depends on an enterprise's requirements.

Considering just the number of free features, we could conclude that Power BI Free, QlikView and Tableau Public are ahead and have more to offer at no cost for SMEs. However, if we had considered paid capabilities, that tool ranking would naturally change, as all tools, except for Metabase, would have nearly all functionalities checked in our comparative table.

As future work, we intend to perform a comparative analysis of other relevant Self-Service BI and Analytics solutions to make available a wider set of them for choice by the SMEs according to their requirements. Additionally, an experimental evaluation by watching them in production in a real enterprise environment.

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