BUSINESS INTELLIGENCE DEVELOPMENT WITH POWER BI APPLIED IN NONCONVENTIONAL TECHNOLOGIES

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ABSTRACT: Regardless of the type and size of the organization in which we operate, it is essential for us to know what solutions to choose in order to use them knowingly and capitalise their potential to the full capacity. Joint reporting, collecting and organizing large data volumes (Big Data) in order to automate and streamline the decision-making are possible by means of Business Intelligence (BI) systems. The use of BI enables the construction and implementation of complementary strategies, whose implicitly result is competitive advantages. This concept was applied in nonconventional technologies, namely electrical discharge machining.

KEYWORDS: Business Intelligence, Big Data, electrical discharge machining.

1. INTRODUCTION

This paper emphasizes the main analysis services and capabilities (including obtaining of statistical data) that Power BI APP can perform in order to support sustainable business development strategies. The practical part of the paper presents the functionalities of this application in order to obtain statistical data resulting from a particular nonconventional machining, electrical discharge machining (EDM).

Power BI was introduced by Microsoft in September 2013 as Power BI for Office 365. The first edition of Power BI was based on Microsoft Excel modules: Power Query, Power Pivot and Power View [1].

Over time, Microsoft has added numerous additional features, such as Questions & Answers, Enterprise-level Data Connectivity, and Power BI Gateway Security Options. Officially, Power BI was released to the public on July 24, 2015. In March 2016, Microsoft launched an additional service called Power BI Embedded on the Azure cloud platform, one of the main strengths of the product being the ability to upload custom visualizations.

Microsoft POWER BI mainly uses Power Pivot functionalities, where Power Pivot is a feature of Microsoft Excel. This functionality is available as an add-in in Excel 2010 and 2013 and is included natively in Excel 2016 [2].

PowerPivot is a local instance of Microsoft Analysis Services Tabular embedded directly in an Excel spreadsheet. This enables the user to build a ROLAP model in PowerPivot and use pivot tables to explore the model once it is built. This enables Excel application to act as a BI Self-Service platform, implementing special professional expression functions in order to query the model and calculate advanced formulas in Excel and represent them in special dashboards [3].

PowerPivot primarily uses DAX (Data Analysis Expressions) as a programming language, although the model can be queried through MDX in an expression needed to specify a range of rows.

DAX expressions allow a user to create data model based functions which can synthesize and aggregate millions of rows of data from a table within a few seconds. DAX expressions resolve T-SQL queries. PowerPivot uses the SSAS Vertipaq compression engine to keep the data model in memory on the client's computer [2, 3].

Basically, this means that PowerPivot acts as an Analysis Services Server instance on the local workstation.

2. ADVANTAGES OF BUSINESS INTELLIGENCE SOLUTIONS

A very short but fitting definition is: “Business Intelligence is essentially timely, accurate, high-value, and actionable business insights, and the work processes and technologies used to obtain them [4].”

At its core, BI aims at understanding the facts - and the relationship between the facts - in a way that guides decision-making and actions to be taken in this respect. From a technological perspective, BI is a set of techniques and tools used to transform raw data into business-specific information (Figure 1) [5].

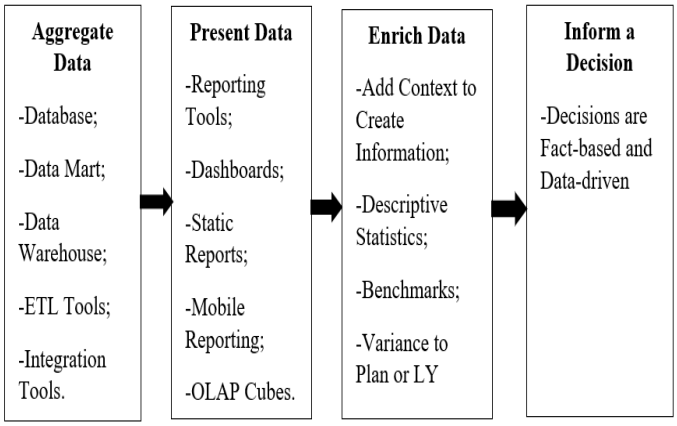

Figure 1. What is BI? (Source: Schwartz, M. 2011)

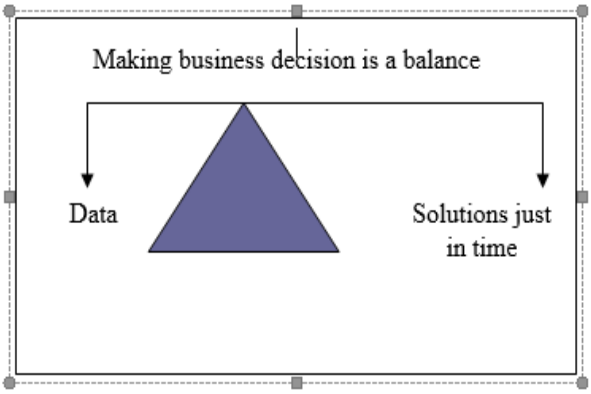

Figure 2. The balance between data and solutions

The facilities of Power BI solutions are as follows:

- Increasing the productivity - the goal of traditional methods of data collection (output) is to create reports based on filtering and analyzing a certain amount of data (input) within a certain amount of time (not enough for small and medium enterprises) (Figure 2);
- Increasing sales and obtaining market information - using Customer Relationship Management (CRM) solutions enables an intelligent customer data collection, thus generating a better understanding of the phenomenon by means of tables and charts [6];
- Achieving the organization objectives – enables an effective information management, together with a proper implementation of the identity and access management;
- Increasing the return on investment - by increasing strategic awareness, faster reporting, reducing operating costs / reducing overall spending, and access to quality data and information, BI can positively influence the return on investment of the company;
- Streamlining the consumer behavioural analysis - one of the main benefits of investing in BI is to increase the company's ability to analyze consumer purchasing trends [7];
- Improving the visibility of the company - implementing and streamlining the control procedures on the various important processes – by means of BI - will improve the visibility of these processes and make it possible to identify the elements that require improvement.
- Transforming data into useful business information - through condensation, contextualization, computation, categorization and correction processes - facilitating the creation of important connections between various activities / fields that might otherwise seem independent.

The main benefits of using BI solutions are: eliminating assumptions - managers have the option of "making the best estimate" or "going with the sense of intellect"; obtaining accurate, real-time updated data, or teaching and forecasting means, thus eliminating the need to guess or estimate; getting quick answers to specific queries - they enable quicker decisions without having to read a large number of paper printed reports; getting important reports by any member of the organization that has been granted access to company data [8]; obtaining statistical situations regarding the behaviour of the customers; identifying simple and cross selling sales opportunities; simplifying the processes for identifying the elements that need to be modified in order to increase efficiency (including industrial processes); increasing efficiency - obtaining pertinent information involves identifying and using a large number of data sources. Subsequently, the results obtained (and the opinions generated) following the process of information processing must be discussed (from the point of view of fairness) and communicated to the managerial structure (or staff industrial engineers) [9]; obtaining information on actual manufacturing costs - provides opportunities to make changes in the production flow in order to obtain higher returns; obtaining real-time inventory status - automatic input and output management, as well as inventory elaboration; obtaining statistical information on the past, present and future of an organization.

This tool can be used in all the fields where large volumes of data (Big Data) are available, including in the nonconventional processing field. Big Data has specific characteristics that affect information security: variety, volume, velocity, value, variability, visualization and veracity (Big Data 7 V's). The security and privacy challenges cover the entire Big Data lifecycle (Figure 3) [10]. So, the use of Power BI is not limited to the economic field, as data volumes may have various sources, such as the industrial field, e.g. nonconventional technologies.

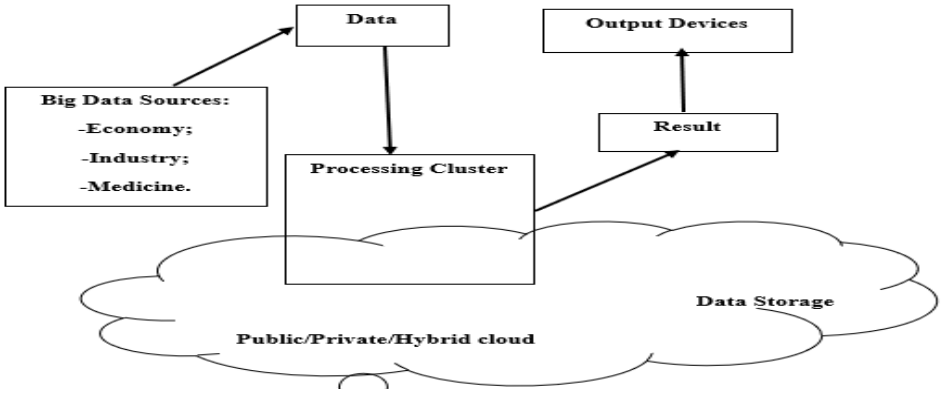

Figure 3. Big Data Lifecycle (Source: adapted from Cloud Security Alliance, 2013)

3. SPECIFIC FEATURES REGARDING THE USE OF POWER BI

Power BI is a business analysis service for visualizing and analyzing all data in a single location, Microsoft aiming to bring business information to all stakeholders.

By means of Power BI, users can: focus more rapidly on data that must be provided to end-users; meet the increasing needs of the customers; reduce the time spent on infrastructure maintenance and report development; focus on increasing demand for real-time and streaming data sources; implement solutions for data management and security for cloud and on-premise data sources; use data visual exploration through a simple and secure connection; easily provide models and data reports to end-users; share reports with other users [11].

Power BI is a SaaS offering that enables all users to easily connect to any of their data, create live dashboards and reports, and explore data through interactive visualisations at any time. With Power BI, all the data of a user can be made viewable in a single location, no matter where they are, enabling a consolidated view of business operations.

Power BI includes two applications. The first is Power BI Desktop, a visual data exploration and reporting tool. The second is a set of native, interactive mobile applications for Windows, iOS and Android devices, providing secure and live access to Power BI dashboards from any device [6].

Moreover, Power BI can be used with a set of REST APIs which enable developers to integrate client and web solutions or to build custom visualisations.

The Power BI tool is designed to help organizations make the most of their data, no matter their location - locally or in the cloud, making available to users: pre-built reports and dashboards for popular SaaS solutions; real-time dashboard updates; secure, live connectivity to the data sources, on-premises and in the cloud; intuitive data exploration using natural language query functionality; commitments and availability similar to Azure, through integration with other Microsoft products and cloud services, including Azure Data Warehouse, Azure Stream Analytics, Azure Machine Learning, and Office 365.

The Power BI service provides a simple and intuitive experience in data interaction process. From creating and sharing dashboards to exploring and enhancing reports, Power BI facilitates engaging with data from heterogeneous sources, fuelling business decisions in a faster and more responsive way [9].

Power BI allows for extensive and consolidated viewing of key information regardless of the location where the underlying data is stored. The individual components and their capabilities are further shown in Figure 4.

Live dashboards - A Power BI Dashboard consists of a set of data visualisations or charts from one or more reports that facilitate the collection of information without the need for prior analysis. An advantage of Power BI is that dashboards are live. For example, when visualization in a dashboard is connected to a real-time data source, the visualization updates are performed continuously, enabling faster information. A dashboard may contain visualizations from several reports (Figure 5) [1].

Dashboards can be customised, allowing adding or "pinning" any chart from any report. They also allow adding an image (e.g. a company logo) from an Excel file. Setting up a dashboard is simple, especially when the data comes from popular SaaS

offerings like Dynamics CRM, Google Analytics, Marketo, Salesforce, ZenDesk and many others. Once connected to a SaaS solution, Power BI displays data in pre-built dashboards and reports optimized for this solution so that exploration can start in a very short amount of time.

In Power BI, dashboards are not only used for viewing purposes - they are interactive tools. If there is information on a dashboard that requires thorough examination, the underlying reports can be accessed in order to get the details. Interesting and useful information can be pinned to a dashboard for easier access.

Interactive Reports - With an easy-to-use interface, Power BI enables the creation of complex interactive reports. A report is represented by a set of charts, also known as visualizations, based on the same dataset.
There are several options: constructing a report from scratch, selecting a pre-authorized report (such as a report generated in Power BI Desktop), or applying a default report for a given dataset.

Reports can be customized - for example, by modifying visualizations in an existing report or by adding new visualizations. If it is required to highlight different aspects of the operations, using the same data, reports can be generated whenever necessary using a single dataset [1, 6].

Reports represent the "foundation" of dashboards. Once a report contains the desired visualizations, the report or a subset of its content can be pinned to a dashboard for easy viewing. Reports can also be shared with other individuals in an organization and consumed on both desktop computers and mobile devices.

Data visualization - Dashboards and reports are built using visualizations or charts. Power BI offers a wide variety of visualization options, enabling you to present data in a compelling and visually appealing manner.

There are an increasing number of available visualizations that can be applied to any dataset. These include: comparison charts (bars, lines, basic area and waterfall charts), composition charts, mixed comparison and composition charts (stacked charts) based on percentage values, as shown in Figure 6.

Moreover, Microsoft has provided its users with the source code for Power BI visualizations, while enabling customised visualizations to be built, thus offering unlimited possibilities for data displaying. Once a set of visualizations is created, you can filter within a report in order to retrieve new information. Using slicers enables filtering visualizations on the same report page so that it displays exactly what is needed. When visualization is placed on a dashboard, this acts as a report [9].

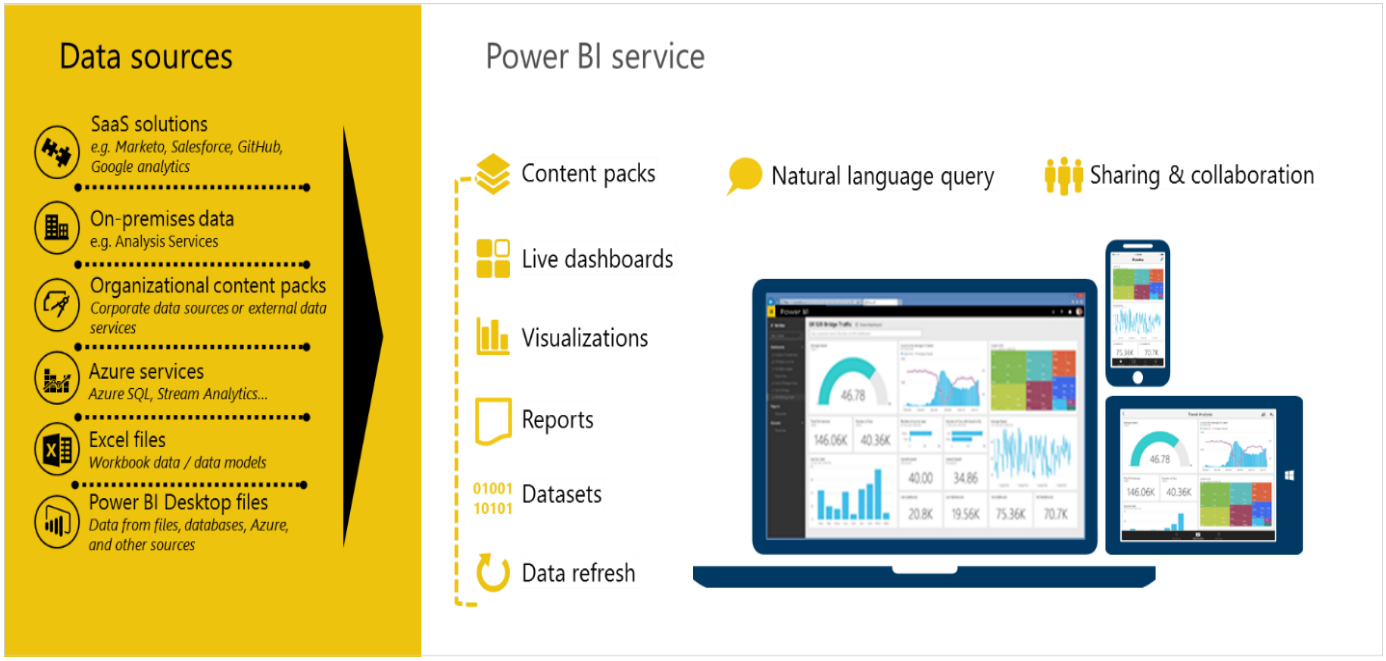

Figure 4. Power BI overview (Source: https://powerbi.microsoft.com)

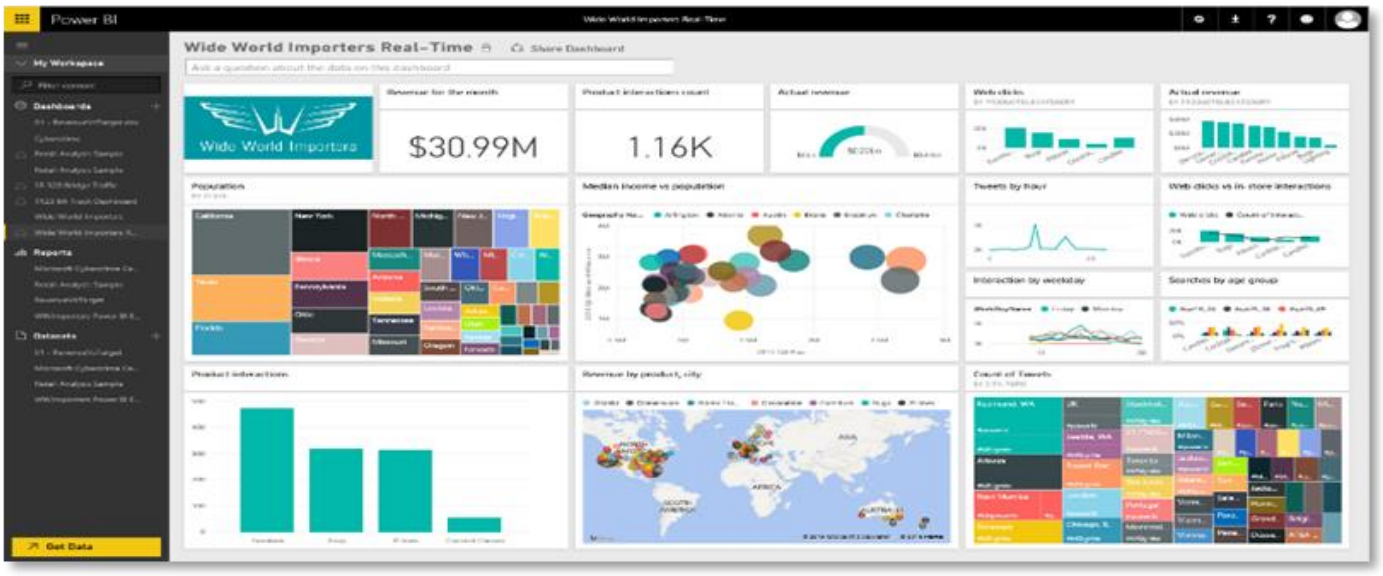

Figure 5. Sample Power BI dashboard (Source: https://powerbi.microsoft.com)

Figure 6. Charts for data visualization (Source: https://powerbi.microsoft.com)

Mobile Applications - Power BI supports live secure dashboard access, on any device, through native interactive applications for Windows, iOS and Android. For the improvement of the visualization, the dashboard interface is optimized for smaller displays. Setting favourites facilitates the access to specific visualization patterns. Applications include several mobile devices specific features that are used to zoom in and out the visualizations.

In order for the solutions to be successfully integrated in the context of management change, they enable: setting up the alerts and generating specific notifications when data exceeds or falls below certain thresholds; capturing snapshots of a report or visualization and introducing annotations using highlight functions; implementing a collaborative management, by SMS or e-mail.

Data Query - also known as Q & A - is a unique feature of Power BI that enables querying of data phrased in English. Q & A enables filtering, sorting, aggregating, grouping and displaying data based on key words in the question asked. Even the smallest searches can quickly find answers by asking questions the same way any other person would do. The query can be used by typing a question in the Q & A text box at the top of any dashboard. Power BI then generates a chart to answer the question using the data in the underlying reports. Subsequently, the chart can be pinned on the dashboard and modified by asking a number of questions. Because a dashboard may contain charts from several datasets, the questions may involve data from any of the existing datasets.

The way a data model is set up has an important impact on the Q&A usability. Questions and

Answers provide the best results when data models have been configured with the natural phrasing. For example, each table in the data model should correspond to a single entity with a simple name, ideally using a single word and avoiding abbreviations and acronyms [6, 9].

Power BI data sources - Power BI integrates with a wide range of data sources, including both cloud and on premises solutions. Using a wide variety of data sources, it enables a quick and easy connection to SaaS solutions, on premises data saved in SQL Server Analysis Services, Azure services, and Excel and Power BI Desktop files. By means of REST APIs, it enables the connection even to custom data sources such as corporate data or external data services (for example, a SaaS solution specific to industrial applications that is not yet integrated with Power BI). One of the benefits of Power BI is that it provides access to all data from a single location, no matter where they are. This hybrid approach offers a number of advantages, such as: fast time of understanding through direct connections to popular SaaS solutions; secure, available, on premises connectivity, such as SQL Server Analysis Services tables; represents a scalable BI solution that does not require the movement of any data to the cloud [1].

SaaS Solutions - Any organization may save an increasing amount of information in the cloud without linking it to local databases existing on the computers of the company. With Power BI, users can connect directly to popular SaaS solutions and get even more value from the cloud services they already use. In this respect, no previous configuration of the system is required. Users can start exploring data immediately after entering existing SaaS solution credentials in the Power BI interface (Figure 7). Beyond facilitating the access to data, Power BI does not require a high level of user experience, simplifying the access through ”solution” specific content packages and automatic data refresh. These packages include pre-configured dashboards, reports, datasets, embedded queries, and metadata. With these default cloud data, Power BI users must never start from scratch - when a user connects to a SaaS solution, their pre-built dashboards and reports are automatically loaded, ready for use and customization. The data is updated automatically. For example, in case a user owns a Salesforce account and wants to use these data in Power BI, he/she accesses Salesforce data through Power BI with Salesforce credentials. Once Power BI connects to Salesforce, the user is asked to specify his/her job positions (sales manager / sales representative). Subsequent to this operation, Power BI automatically stores Salesforce data in a pre-built dashboard that displays data in a manner adapted to the specified job position. Subsequently, the user can customize both the dashboard and the underlying report to fit his/her specific needs. Salesforce is just one example of the SaaS solution connectivity that Power BI provides. The technological tracking sheet is a primary evidence document that can be used in various applications: risk analysis in project management, assessment of the student's situation according to the score obtained, implementation and evaluation of surgical technologies, Gantt Charts, Task Dependencies, Employee Workload Management, the analysis of certain parameters specific to various industrial processes, etc.

4. TECHNOLOGICAL TRACKING SHEET. CASE STUDY

Power BI can also be used for industrial applications, such as EDM technology. This technology tracking sheet, specific to an EDM process, includes information on: capacity of condensers from relaxation generator [nF]; initial electrode mass [g]; final electrode mass [g]; workpiece diameter [mm]; initial workpiece mass [g]; final work piece mass [g]; obtained roughness [μm]; electrode volume [m^3]; volumetric relative wear [%]; productivity [mm^3/min]. Three situations S1, S2 and S3 respectively, were analyzed, with the same Cu/steel couple of materials according to Table 1, at application of dynamic customer matrix [12].

Table 1. Analysed situations

S1	TECHNOLOGICAL TRACKING SHEET - Cu 99.5 / Steel D3, microslots, U_o=100 V
S2	TECHNOLOGICAL TRACKING SHEET - Cu 99.5 / Steel D3, microslots, U_o =100 V, P_{cus}=100W
S3	TECHNOLOGICAL TRACKING SHEET - Cu 99.5 / Steel D3, microslots, U_o =100 V, P_{cus}=70W

Situation 1 was carried out for an ignition voltage, U_o of 100 V, zero consumed power on ultrasonic chain P_{cus}, electrode length of 10 mm, electrode thickness of 0.5 mm and a machining time of 20 minutes, according to Table 2. The parameters of situation 2 are identical to those from situation 1, except for the P_{cus} power, which was 100 W, according to Table 3. The parameters of situation 3 are identical to those in situation 1, except for the power, which has the value of 70 W, according to Table 4.

The data have been imported in Power BI, using a folder with CSV extension, according to figure 8. Figure 9 illustrates the ways to select the types of charts what are to be used (the Visualizations window) and the fields what are to be represented (Fields list).

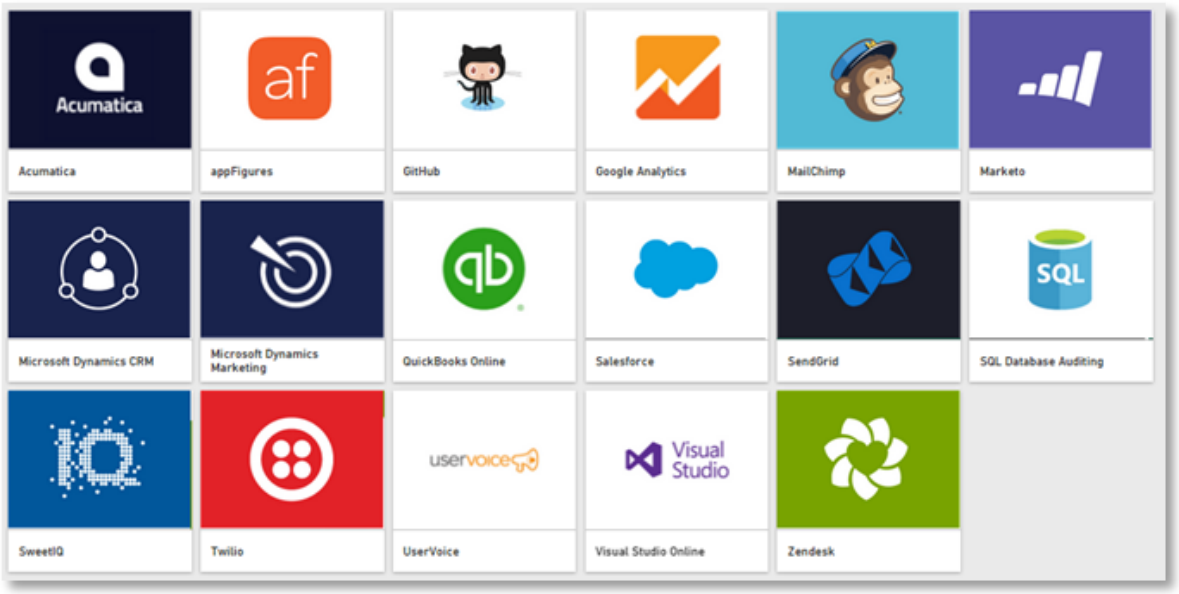

Figure 7. Charts for data visualization (Source: https://powerbi.microsoft.com)

Table 2. Situation I

Capacity [nF]	Initial electrode mass [g]_S1	Final electrode mass [g]_S1	Piece diameter [mm]_S1	Initial piece mass [g]_S1	Final piece mass [g]_S1	Roughness [µm]_S1	Electrode volume [mm3]_S1	Piece volume [mm3]_S1	Volumetric wear [%]_S1	Productivity [mm3 / min]_S1
3.3	0.937	0.9361	30.12	117.415	117.4132	0.1	0.10078	0.229299	44.0	0.011464968
6.6	0.938	0.9365	30.12	120.915	120.9115	0.2	0.16797	0.44586	37.7	0.022292994
9.9	0.949	0.9470	30.12	120.582	120.5767	0.3	0.22396	0.675159	33.2	0.033757962
13.2	0.945	0.9428	30.12	105.686	105.6790	0.5	0.24636	0.89172	27.6	0.044585987
16.5	0.907	0.9045	30.12	106.476	106.4673	0.6	0.27996	1.10828	25.3	0.055414013
19.8	0.906	0.9032	30.12	105.433	105.4225	0.8	0.31355	1.33758	23.4	0.066878981
23.1	0.896	0.8930	30.12	103.402	103.3899	0.9	0.33595	1.541401	21.8	0.077070064

Table 3. Situation II

Capacity [nF]_S2	Power_S2	Initial electrode mass [g]_S2	Final electrode mass [g]_S2	Piece diameter [mm]_S2	Initial piece mass [g]_S2	Final piece mass [g]_S2	Roughness [µm]_S2	Electrode volume [mm3]_S2	Piece volume [mm3]_S2	Volumetric wear [%]_S2	Productivity [mm^3 / min]_S2
3.3	100	0.938	0.9370	30.12	118.4170	118.4142	0.2	0.111982	0.356688	31.4	0.017834
6.6	100	0.937	0.9353	30.12	121.9150	121.9091	0.3	0.19037	0.751592	25.3	0.03758
9.9	100	0.935	0.9325	30.12	121.5854	121.5760	0.4	0.279955	1.197452	23.4	0.059873
13.2	100	0.932	0.9287	30.12	106.6920	106.6781	0.6	0.369541	1.770701	20.9	0.088535
16.5	100	0.928	0.9244	30.12	106.4845	106.4662	0.8	0.403135	2.33121	17.3	0.116561
19.8	100	0.924	0.9209	30.12	106.4429	106.4199	1	0.347144	2.929936	11.8	0.146497
23.1	100	0.9198	0.9165	30.12	105.4140	105.3848	1.1	0.369541	3.719745	9.9	0.185987

Table 4. Situation III

Capacity [nF]_S3	Power_S3	Initial electrode mass [g]_S3	Final electrode mass [g]_S3	Piece diameter [mm]_S3	Initial piece mass [g]_S3	Final piece mass [g]_S3	Roughness [µm]_S3	Electrode volume [mm3]_S3	Piece volume [mm3]_S3	Volumetric wear [%]_S3	Productivity [mm3 / min]_S3
3.3	70	0.935	0.9340	30.12	117.4030	117.4001	0.05	0.111982	0.369427	30.3	0.018471
6.6	70	0.9373	0.9355	30.12	120.9140	120.9080	0.1	0.201568	0.764331	26.4	0.038217
9.9	70	0.9483	0.9460	30.12	120.5760	120.5671	0.14	0.257559	1.133758	22.7	0.056688
13.2	70	0.945	0.9420	30.12	105.6410	105.6280	0.24	0.335946	1.656051	20.3	0.082803
16.5	70	0.907	0.9042	30.12	106.4790	106.4628	0.28	0.31355	2.063694	15.2	0.103185
19.8	70	0.906	0.9032	30.12	105.4430	105.4220	0.38	0.31355	2.675159	11.7	0.133758
23.1	70	0.895	0.8920	30.12	103.4130	103.3870	0.45	0.335946	3.312102	10.1	0.165605

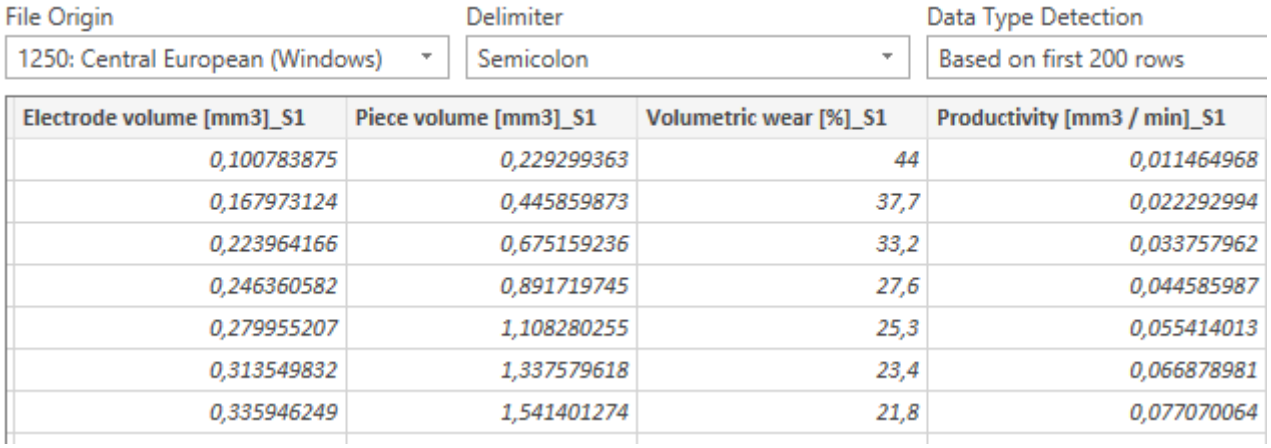

Figure 8. Import of a CSV folder in Power BI

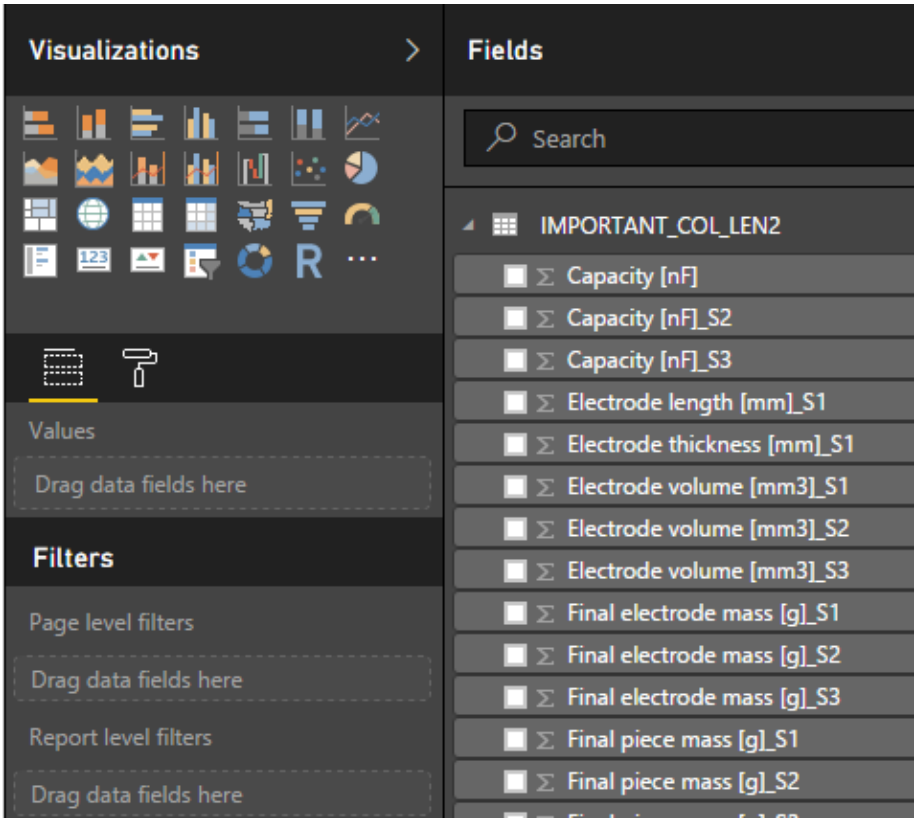

Figure 9. Power BI tools window

It has to be mentioned that all the data from tables 2-4, have statistical character, being the results of more than 30 tests with the same working mode, which were further processed by BI instruments. Figures 10 shows the variation of mass electrode related to data presented above, which is in strong connection to microEDM precision, one of the utmost requirement of this machining mode. Analyzing the global situation, it can be observed that mass variation is relative low with higher values at more intense energy modes, which is in agreement to the demands of this type of machining.

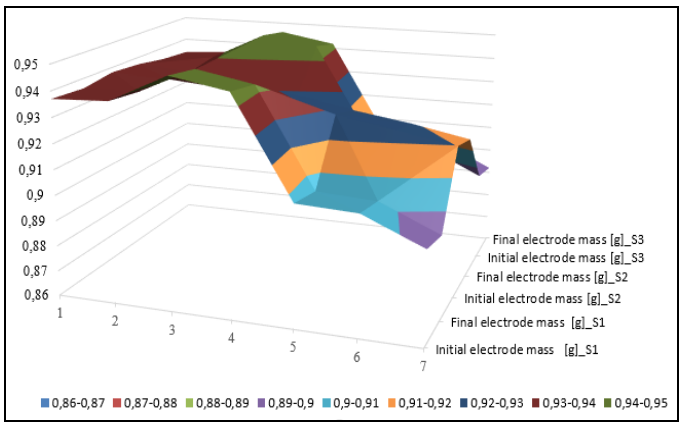

Figure 10. Electrode mass variation

The chart of Roughness - Productivity (fig. 11), enables the association of EDM parameters determining roughness and machining rate in order to create a balance between those two. Maximum productivity is obtained in situation 2, with highest value of P_{cus} power, followed by situation 3 (lower P_{cus}) and 1 (no ultrasonic aiding). At mirror finishing (Ra under 0.2 µm), the values of productivity are very low, in favour of the parameters of roughness and precision.

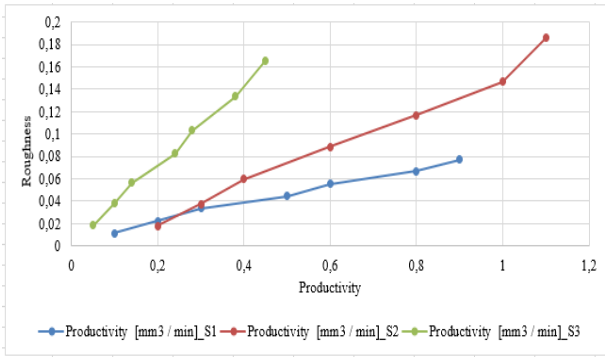

Figure 11. Chart of Roughness – Productivity

5. CONCLUSIONS

Power BI provides interactive visualizations with automatic services capabilities using business intelligence in which end-users can create reports and dashboards on their own without depending on a specialist in this field or on the data base manager. Power BI provides cloud-based business intelligence services, known as Power BI Services, along with a desktop-based interface called POWER BI DESKTOP. This application provides data storage capabilities, including processing thereof, data discovery and dashboards creation.

Using BI solutions, the time required to extract data and create reports is very short, which is very appropriate for the fields characterized by a large number of input (data) parameters influencing the processes, like at nonconventional technologies.

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