Power BI v/s Tableau v/s Cognos: A Data Analytics Research

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Abstract: *Data Science now a days is being used in almost all the fields of IT and Computer Engineering. With the technological revolution, data went from expensive, difficult to find and collect to abundant, cheap, but incomprehensible. It is arduous to store, understand and analyze increasingly larger volumes of data with traditional software's. This is where Big data comes into play. Big data is used for predictive analytics, analyzing user behaviour or other data analytics processes to bring value to data. This paper presents a research survey done in the field of Data Visualization Tools which ease the understanding of various data sets by representing them graphically or pictorially, no matter how big the data set is. Data Visualization is the process of transforming data into charts, images, graphs and even videos that explain the numbers and allow us to gain insights from it. Using Data Visualization tools in order to analyze the data is the new era of development. In this paper, three popular Data Visualization tools are taken into consideration, namely: Power BI by Microsoft, Tableau by Salesforce and Cognos by IBM. This research work provides knowledge about Data Analytics and aims to find out why Power Bi and Tableau are more popular in people whereas Cognos is not, and what advancements/changes do Cognos need in order to increase its reach.*

Keywords: Data Analytics, Data Visualization, Power BI, Tableau, IBM Cognos Analytics

1. Working with Data Analytics

Mainly there are five major steps in analyzing any data set. These are as following:

Step 1) Ask the Right Questions-Before we start collecting data, we need to first understand what we want to do with it. Take some time to think about a specific business problem we want to address or consider a hypothesis that could be solved with data. From there, we'll create a set of measurable, clear, and concise questions that will help answer that. Starting with a clear objective is an essential step in the data analysis process. By recognizing the business problem that we want to solve and setting well-defined goals, it'll be way easier to decide on the data we need.

Step 2) Data Collection-This brings us to the next step: data collection. Now that we have a solid idea of our questions, it's time to define from what data we need to find those answers. As a starting point, we'll want to determine if the data is readily available within our organization-like within employee survey results or annual performance reviews in the HR case. Then, ask ourselves: do we have all the data we need or will we also need to externally source it? If it's the latter, we may decide to run an experiment or conduct another survey. Whatever we choose, the end goal of this step is to make sure to have a complete, 360-degree view of the problem we want to solve.

Step 3) Data Cleaning- We've collected and combined data from multiple sources. Great. But it's not yet, its time to roll up our sleeves and dive into it. That's because raw data is seldom usable in its current form. We'll often find flaws within it, like missing values. While seemingly minor, these can actually be quite pernicious: even the tiniest inaccuracies can skew our results. Here's where we'll spend some time polishing the data to ensure it's in tip-top shape. This process, called data cleaning, consists of amending or removing incorrect or superfluous data, as well as checking for incompleteness or inconsistencies. For instance, we might clean spaces in front of letters or symbols or remove duplicates. This is a vital step-because ultimately, the accuracy of our analysis will depend on the quality of our data.

Step 4) Analyzing The Data-We now have a wealth of data. We've spent time cleaning it up. It's as organized as it'll ever be. Now we're ready for the fun stuff. In this step, we'll begin to slice and dice our data to extract meaningful insights from it. Using the techniques and methods of data analysis, we'll look for hidden patterns and relationships, and find insights and predictions.

Step 5) Interpreting The Results By Visualising The Data: After we've interpreted the results and drawn meaningful insights from them, the next step is to create visualizations by selecting the most appropriate charts and graphs. For visualising we would need tools provided by various companies like Power BI, Tableau, Cognos Analytics, Google Data Studio etc. These tools will now help us in making the charts, graphs and mapping the regions. We can create dashboards, presentations which our stakeholders would use using these tools. But pretty visualizations aren't all that are needed here. If we want our valuable discoveries to be implemented, we need to be able to present it to decision-makers and stakeholders in a manner that's compelling and easy to comprehend. The best way to do this is through what's called data storytelling, which basically means turning our data into a compelling narrative.

2. Introduction to Data Visualization

Data visualization is the practice of translating information into a visual context, such as a map or graph, to make data easier for the human brain to understand and pull insights from. The main goal of data visualization is to make it easier to identify patterns, trends and outliers in large data sets. The term is often used interchangeably with others, including information graphics, information visualization and statistical graphics.

Figure 1: Depicting various charts in Data Visualization

Data visualization is one of the steps of the data science process, which states that after data has been collected, processed and modeled, it must be visualized for conclusions to be made. Data visualization is also an element of the broader data presentation architecture (DPA) discipline, which aims to identify, locate, manipulate, format and deliver data in the most efficient way possible.

Data visualization is important for almost every career. It can be used by teachers to display student test results, by computer scientists exploring advancements in artificial intelligence (AI) or by executives looking to share information with stakeholders. It also plays an important role in big data projects. As businesses accumulated massive collections of data during the early years of the big data trend, they needed a way to quickly and easily get an overview of their data. Visualization tools were a natural fit.

Visualization is central to advanced analytics for similar reasons. When a data scientist is writing advanced predictive analytics or machine learning (ML) algorithms, it becomes important to visualize the outputs to monitor results and ensure that models are performing as intended. This is because visualizations of complex algorithms are generally easier to interpret than numerical outputs.

Data visualization provides a quick and effective way to communicate information in a universal manner using visual information. The practice can also help businesses identify which factors affect customer behavior; pinpoint areas that need to be improved or need more attention; make data more memorable for stakeholders; understand when and where to place specific products; and predict sales volumes. Other benefits of data visualization include the following: the ability to absorb information quickly, improve insights and make faster decisions; an increased understanding of the next steps that must be taken to improve the organization; an improved ability to maintain the audience's interest with information they can understand; an easy distribution of information that increases the opportunity to share insights with everyone involved; eliminate the need for data scientists since data is more accessible and understandable; and an increased ability to act on findings quickly and, therefore, achieve success with greater speed and less mistakes.

The increased popularity of big data and data analysis projects has made visualization more important than ever. Companies are increasingly using machine learning to gather massive amounts of data that can be difficult and slow to sort through, comprehend and explain. Visualization offers a means to speed this up and present information to business owners and stakeholders in ways they can understand.

3. History of Data Visualization

The concept of data visualization is not new. Moreover, it has been around for centuries. The earliest and most obvious examples of data viz projects are maps. Then you have the pie chart which first showed up in the early 19th century. A few decades later, Charles Joseph Minard used statistical graphs in order to map Napoleon Bonaparte's Russian campaign of 1812, combining multiple metrics: the number of troops, temperature, distance, directions, and more.
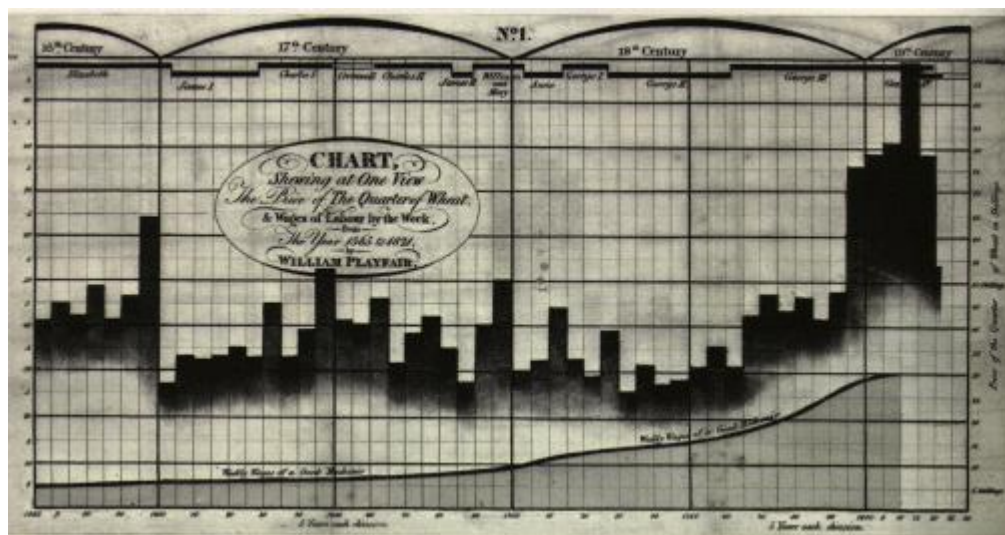

Figure 2: Histogram graph of past visualizing the data

Other notable milestones in the history of data visualization include but are not limited to works of Nicole Oresme, Joseph Priestly, and William Playfair. All of them greatly contributed to the data viz progress. Oresme was one of the greatest thinkers of the Middle Ages, and it could be said that he invented bar charts in the 14th century, although it was Playfair who later gave the bar chart the form we know today. Priestley, in his chart of biography, used a timeline with bars to compare multiple persons' life spans. Playfair is also credited with the first use of area charts.

To learn more about the data visualization history, explore the biggest known milestones Michael Friendly and Daniel J. Denis from York University featured in their book "Milestones in the History of Thematic Cartography, Statistical Graphics, and Data Visualization: An Illustrated Chronology of Innovations. "

Figure 3: Map of firsts

The idea of visualizing data kept evolving over time, and with the advent of computers and rapid growth of technologies, the discipline definitely took a quantum leap forward. Nowadays, even massive amounts of data-and big data itself-can be processed by dataviz software at a very high speed, opening up new exciting opportunities in the field of data analytics and business intelligence.

4. Data Visualization Tools

Data visualization tools provide data visualization designers with an easier way to create visual representations of large data sets. When dealing with data sets that include hundreds of thousands or millions of data points, automating the process of creating visualization, at least in part, makes a designer's job significantly easier.

These data visualizations can then be used for a variety of purposes: dashboards, annual reports, sales and marketing materials, investor slide decks, and virtually anywhere else information needs to be interpreted immediately.

The best data visualization tools on the market have a few things in common. First is their ease of use. There are some incredibly complicated apps available for visualizing data. Some have excellent documentation and tutorials and are designed in ways that feel intuitive to the user. Others are lacking in those areas, eliminating them from any list of "best" tools, regardless of their other capabilities.

The best tools can also handle huge sets of data. In fact, the very best can even handle multiple sets of data in a single visualization. The best tools also can output an array of different chart, graph, and map types. Most of the tools below can output both images and interactive graphs. There are exceptions to the variety of output criteria, though. Some data visualization tools focus on a specific type of chart or map and do it very well. Those tools also have a place among the "best" tools out there.

Finally, there are cost considerations. While a higher price tag doesn't necessarily disqualify a tool, the higher price tag has to be justified in terms of better support, better features, and better overall value.

There are dozens, if not hundreds, of applications, tools, and scripts available to create visualizations of large data sets. Many are very basic and have a lot of overlapping features. But there are standouts that either have more capability for the types of visualizations they can create or are significantly easier to use than the other options out there.

Seeing the current trend in the industry there are 3 most popular visualization tools in the market: Power BI (Version 2.78.5740.861), Tableau (Version 2019.1.8) and Cognos Analytics (Version 11.0.10).

5. Gartner Magic Quadrant

Gartner, Inc, officially known as Gartner, is a Stamford, Connecticut-based technology research and consulting company. The company's products and services include research, executive programs, consulting, and conferences. Gartner clients include large corporations, government

agencies, technology companies, and the investment community. In 2018, the company reported that its client base consisted of over 12, 000 organizations in over 100 countries. Founded in 1979, Gartner has over 15, 000 employees located in 100+ offices worldwide.

Figure 4: Gartner logo

Gartner Magic Quadrant (MQ) is a series of market research reports published by IT consulting firm Gartner that rely on proprietary qualitative data analysis methods to demonstrate market trends, such as direction, maturity and participants.

It basically demonstrates the market research and trends in the current scenario. Their analyses are conducted for several specific technology industries and are updated every 1–2 years: once an updated report has been published its predecessor is "retired"

Gartner rates vendors upon two criteria: *completeness of vision* and *ability to execute*.

Completeness of Vision: Reflects the vendor's innovation, whether the vendor drives or follows the market, and if the vendor's view of how the market will develop matches Gartner's perspective.

Ability to Execute: Summarizes factors such as the vendor's financial viability, market responsiveness, product development, sales channels and customer base.

These component scores lead to a vendor position in one of four quadrants:

1) Leaders
Vendors in the Leaders quadrant have the highest composite scores for their Completeness of Vision and Ability to Execute. A vendor in the Leaders quadrant has the market share, credibility, and marketing & sales capabilities needed to drive the acceptance of new technologies. These vendors demonstrate a clear understanding of market needs, they are innovators and thought leaders, and they have well-articulated plans that customers and prospects can use when designing their infrastructures and strategies. In addition, they have a presence in the five major geographical regions, consistent financial performance, and broad platform support.

2) Challengers
A vendor in the Challengers quadrant participates in the market and executes well enough to be a serious threat to vendors in the Leaders quadrant. They have strong products, as well as sufficiently credible market position and resources to sustain continued growth. Financial viability is not an issue for vendors in the Challengers quadrant, but they lack the size and influence of vendors in the Leaders quadrant.

3) Visionaries
A vendor in the Visionaries quadrant delivers innovative products that address operationally or financially important end-user problems at a broad scale, but has not yet demonstrated the ability to capture market share or sustainable profitability. Visionary vendors are frequently privately held companies and acquisition targets for larger, established companies. The likelihood of acquisition often reduces the risks associated with installing their systems.

4) Niche Players
Vendors in the Niche Players quadrant are often narrowly focused on specific market or vertical segments. This quadrant may also include vendors that are adapting their existing products to enter the market under consideration, or larger vendors having difficulty developing and executing on their vision.

Gartner Critical Capabilities complement Magic Quadrant analysis to offer deeper insight into the products and services offered by multiple vendors.

Figure 4: Gartner's Magic Quadrant

Gartner's Magic Quadrant (2020) was mapped for various companies for Analytics and Business Intelligence. A scatter plot was formed between the Ability to Execute and Completeness of Vision which had various MNC's offering data analytics and BI tools. The results were as follows:

1) **Power BI** was at the top of them all. The reason analyzed behind this was the 'viral spread' of this software. It was provided at the community server and most of the people can use this BI software very easily and free of cost just by making a Microsoft Account. The features of this software were also relevant and more as compared to its opponents. The interface was very simple and easy to use. It was very similar to the present day IDE's.
2) **Tableau** was seen next to Power BI. With Google using it in it's data analytics courses, it was seen to be very popular among students. It showed uncertainty as it is backed by Salesforce. Tableau has various features but the issue that arose which made it came to the second place was the poor report delivery. Although it had most of the features which Power BI did but it could not be

everyone's favourite as it did not had a good user interface.
3) **IBM Cognos Analytics** was seen playing catch up in the graph. It was very much lagging behind all other tools. There were many reasons to it but the one above those all

was extremely high pricing i.e. $70. It has been seen that IBM Cognos charges very much as compared to its rivals Power BI i. e $20 and Tableau i. e. $35. Thus results in the Niche Players.

Figure 5: Gartner Magic Quadrant 2020 for various companies offering Data Visualization

6. Power BI

Microsoft Power BI is a suite that is a collection of business intelligence tools such as software services, apps and data connectors. It is a cloud-based platform used to consolidate data from varied sources into a single data set. These data sets are used for data visualization, evaluation, and analysis by making sharable reports, dashboards, and apps. Microsoft offers three types of Power BI platforms i. e. *Power BI Desktop* (a desktop application), *Power BI Service* (SaaS i.e., Software as a Service) and *Power BI Mobile* (for iOS and Android devices).

Power BI can be deployed both on-premise and on-cloud. It can also import data from local databases/data sources, cloud-based data sources, big data sources, simple Excel files, and other hybrid sources. Thus, Power BI, a leader amongst a lot of other BI tools proves to be an efficient and user-friendly tool for data analysis. It enables the users to consolidate data from multiple sources, make interactive dashboards, evaluate data, create informative reports and share it with other users.

Figure 6: Power BI logo

Features of Power BI:

1) **Range of Attractive Visualizations:** Visualizations i. e. the visual representation of data plays a central role in Power BI. It offers a wide range of detailed and attractive visualizations. You can create reports and

dashboards using as simple or as complex visualizations as you want to represent your data set with. There is also a library available for custom visualizations*.* In Power BI you can create visualizations such as: Stacked bar chart, Stacked column chart, Clustered bar chart, Clustered column chart, 100% stacked column/bar chart, Line chart, Area chart, Stacked area chart, Ribbon chart, Waterfall chart, Scatter chart, Pie chart, Donut chart, Treemap chart, Map, Filled map, Funnel chart, Gauge chart, etc.

2) **Get Data (Data Source):** Get Data feature lets Power BI users to select from a range of data sources. The data sources are anywhere in the spectrum from on-premise to cloud-based, unstructured to structured. New data sources are added every month. Some of the latest available data sources are as follows: Excel, Power BI datasets, Power BI dataflows, SQL Server, MySQL database, Analysis Services, Azure, Text/CSV, Oracle, PDF, Access, XML, JSON.

3) **Datasets Filtration:** Dataset is a single set of data created as a result of taking data from multiple data sources. You can use the datasets to create visualizations of different kinds. A dataset can be made of data taken from a single source like an Excel workbook or from more than a data source. You can filter the datasets and have smaller subsets containing only the important data and contextual relevance. Power BI provides the users with a wide range of in-built data connectors such as *Excel, SQL database, Oracle, Azure, Facebook, Salesforce, MailChimp,* etc. Users can easily connect to such data sources and create datasets by importing data from one or more sources.

4) **Customizable Dashboards:** Dashboards are a collection of visualizations offering meaningful information or insights into data. Typical dashboards in Power BI are composed of multiple visualizations as tiles. They are single pages from the reports. The dashboards are shareable as well as printable.

5) **Flexible Tiles:** A tile is a single block containing visualization in a Power BI dashboard. Tiles segregate each informative visualization properly to provide a clearer view. These tiles can be adjusted and the size can also be changed. Also, they can be placed anywhere on the dashboard as per the users' convenience.

6) **Navigation Pane:** The navigation pane has options of *datasets, dashboards, and reports.* Users can conveniently work in Power BI and navigate between datasets, dashboard they are working on, and reports they are creating.

7) **Informative Reports:** Reports in Power BI are a combination of dashboards having a different kind of visualizations relevant to a particular business topic. A report shows a complete and structured presentation of data represented in different ways and revealing important insights from the data. Users can easily share reports created on Power BI with other users.

8) **Natural Language Q & A Question Box:** The Natural Language Q&A i. e. question and answer box is a unique feature of Power BI. Using the Q&A box, a user can ask questions in natural language to search for data and information available in Power BI system. The cognitive engines of Power BI will search for the data or visualization or a part of the report that is been searched

for and return it to the user. The cognitive technology uses *rephrasing, autofill, suggestions* and other such techniques to fulfill the search requirements of users.

9) **DAX Data Analysis Function:** The DAX functions are the *Data Analysis Expressions* found in Power BI. These analysis functions are predefined codes to perform analytics specific functionalities on data. There are about **200 functions in the Power BI function library** as of now. The creators keep on adding new ones.

10) **Help & Feedback Buttons:** Help & feedback buttons are used for multiple setting options such as *downloading, asking for support and assistance, giving feedback to the Power BI support team,* etc.

11) **Great Collection in Content Packs:** Power BI offers content packs which contain *dashboards, data models, datasets, embedded queries,* etc. Users can directly use a collection of elements in content packs instead of looking for elements separately.

Summarizing all the features, we can conclude that Power BI is power packed with all the features. It has the best in class user interface which is why it is the most premium Business Intelligence tool in today's world. Like every coin has two sides Power BI too has some negatives also. The cons of Power BI are as follows:

Cons of Power BI:

1) **Table Relationships:** Power BI is good with handling simple relationships between tables in a data model. But, if there are complex relationships between tables, that is, *if they have more than one links between tables, Power BI might not handle them well.* You need to create a data model carefully by having more unique fields so that Power BI does not confuse the relationships when it comes to complex relationships.

2) **Configuration of Visuals:** In most cases, you might not feel the need to configure and optimize visualizations in Power BI. But even if you do, *Power BI does not provide many options to configure your visualizations as per your requirements.* Thus, users have limited options for what they can change in visuals.

3) **Rigid Formulas:** As we know, the expression language used to deal with data in Power BI is DAX. However, you can perform a lot of actions using the **DAX formula in Power BI**, it is still not the easiest language to work with. *Sometimes the formulas you create work well in Power BI, sometimes they don't.* You can concatenate up to two elements but concatenating more than two elements needs nesting statements.

4) **Handling Large Data Volumes:** Power BI has a limit of ingesting data at a time which is approximately 2 GBs of data. *If you wish to import and use data of even greater volumes, you need to extend your free version to a paid version of Power BI.* Also, users have reported that Power BI takes a little more than usual time or even hangs while processing millions of rows and columns of data.

5) **Complex to Understand and Master:** Usually, Power BI is the easiest to use BI tool if you are using it simply to import data and create reports. But Power BI is an entire suite having a lot of other interrelated tools. When the purpose of your use is more than just creating

reports in Power BI Desktop, you need to learn and master several other tools like *Gateways, Power BI Report Server, Power BI Services,* etc.

7. Tableau

Tableau is a powerful and fastest growing data visualization tool used in the Business Intelligence Industry. It helps in simplifying raw data in a very easily understandable format. Tableau helps create the data that can be understood by professionals at any level in an organization. It also allows non-technical users to create customized dashboards.

Data analysis is very fast with Tableau tool and the visualizations created are in the form of dashboards and worksheets. The best features of Tableau software are Data Blending, Real time analysis, Collaboration of data. The great thing about Tableau software is that it doesn't require any technical or any kind of programming skills to operate. The tool has garnered interest among the people from all sectors such as business, researchers, different industries, etc.

Figure 7: Tableau logo

Tableau connects and extracts the data stored in various places. It can pull data from any platform imaginable. A simple database such as an excel, pdf, to a complex database like Oracle, a database in the cloud such as Amazon webs services, Microsoft Azure SQL database, Google Cloud SQL and various other data sources can be extracted by Tableau.

When Tableau is launched, ready data connectors are available which allows you to connect to any database. Depending on the version of Tableau that you have purchased the number of data connectors supported by Tableau will vary.

The pulled data can be either connected live or extracted to the Tableau's data engine, Tableau Desktop. This is where the Data analyst, data engineer work with the data that was pulled up and develop visualizations. The created dashboards are shared with the users as a static file. The users who receive the dashboards views the file using Tableau Reader.

The data from the Tableau Desktop can be published to the Tableau server. This is an enterprise platform where collaboration, distribution, governance, security model, automation features are supported. With the Tableau server, the end users have a better experience in accessing the files from all locations be it a desktop, mobile or email.

Features of tableau:

1) **Tableau Dashboard:** Tableau Dashboards provide a wholesome view of your data by the means of visualizations, visual objects, text, etc. Dashboards are very informative as they can present data in the form of stories, enable the addition of multiple views and objects, provide a variety of layouts and formats, enable the users to deploy suitable filters. You even have the option to copy a dashboard or its specific elements from one workbook to another easily.

2) **Collaboration and Sharing:** Tableau provides convenient options to collaborate with other users and instantly share data in the form of visualizations, sheets, dashboards, etc. in real-time. It allows you to securely share data from various data sources such as on-premise, on-cloud, hybrid, etc. Instant and easy collaboration and data sharing help in getting quick reviews or feedback on the data leading to a better overall analysis of it.

3) **Live and In-memory Data:** Tableau ensures connectivity to both live data sources or data extraction from external data sources as in-memory data. This gives the user the flexibility to use data from more than one type of data source without any restrictions. You can use data directly from the data source by establishing live data connections or keep that data in-memory by extracting data from a data source as per their requirement. Tableau provides additional features to support data connectivity such as automatic extract refreshes, notifying the user upon a live connection fail, etc.

4) **Data Sources in Tableau:** Tableau offers a myriad of data source options you can connect to and fetch data from. Data sources ranging from on-premise files, spreadsheets, relational databases, non-relational databases, data warehouses, big data, to on-cloud data are all available on Tableau. One can easily establish a secure connection to any of the data sources from Tableau and use that data along with data from other sources to create a combinatorial view of data in the form of visualizations. Tableau also supports different kinds of data connectors such as Presto, MemSQL, Google Analytics, Google Sheets, Cloudera, Hadoop, Amazon Athena, Salesforce, SQL Server, Dropbox and many more.

5) **Advanced Visualizations (Chart Types):** One of the key features of Tableau and the one that got its popularity is its wide range of visualizations. In Tableau, you can make visualizations as basic as a: Bar chart, Pie chart and as advanced as a: Histogram, Gantt chart, Bullet chart, Motion chart, Treemap, Boxplot and many more. You can select and create any kind of visualization easily by selecting the visualization type from the Show Me tab.

6) **Maps:** Yet another important feature of Tableau is the map. Tableau has a lot of pre-installed information on maps such as cities, postal codes, administrative boundaries, etc. This makes the maps created on Tableau very detailed and informative. You can add different layers of geology on the map as per your requirements and create informative maps in Tableau with your data. The different kinds of maps available in

Tableau are *Heat map*, Flow map, Choropleth maps, Point distribution map, etc.

7) **Robust Security:** Tableau takes special care of data and user security. It has a fool-proof security system based on authentication and permission systems for data connections and user access. Tableau also gives you the freedom to integrate with other security protocols such as Active Directory, Kerberos, etc. An important point to note here is that Tableau practices row-level filtering which helps in keeping the data secure.

8) **Mobile View:** Tableau acknowledges the importance of mobile phones in today's world and provides a mobile version of the Tableau app. One can create their dashboards and reports in such a manner that it is also compatible with mobile. Tableau has the option of creating customized mobile layouts for your dashboard specific to your mobile device. The customization option gives the option for adding new phone layouts, interactive offline previews, etc. Hence, the mobile view gives Tableau users a lot of flexibility and convenience in handling their data on the go.

9) **Ask Data:** The Ask data feature of Tableau makes it even more favored by the users globally. This feature makes playing with data just a matter of simple searches as we do on Google. You just need to type a query about your data in natural language and Tableau will present you with the most relevant answers. The answers are not only in the form of text but also as visuals. For instance, if what you searched for is already present in a bar graph, the Ask data option will search and open the bar graph for you instantly. Such features make data more accessible to users who can easily dig deep into data and find new insights and patterns.

10) **Trend Lines and Predictive Analysis:** Another extremely useful feature of Tableau is the use of time series and forecasting. Easy *creation of trend lines* and forecasting is possible due to Tableau's powerful backend and dynamic front end. You can easily get data predictions such as a forecast or a trend line by simply selecting some options and drag-and-drop operations using your concerned fields. From this, we can conclude that tableau is a very useful tool loaded with user-friendly features and functionalities which helps us extract valuable information from raw data and analyze it using visualizations.

Cons of Tableau:

1) **Poor After-Sales Support:** On multiple message boards, users complain that Tableau software lacks proper after-sales maintenance. If a customer has a software performance problem, the support team doesn't settle the matter by investigating the problem's root and eliminating it. The best they do is to advise purchasing a feature, which will compensate for their software's shortcoming.

2) **Security Issues:** Since visualizing solutions manipulate some confidential data, the vendors draw special attention to security enhancement. Despite Tableau 's deep concern for information safety, it fails to provide centralized data-level security. It just allows establishing a row-level security, which stipulates that every user has his/her own account. A great number of accounts increases the chances that the system may be hacked.

3) **IT Assistance for Proper Use:** Although the software allows for certain ease in its routine application, Tableau still requires significant involvement of an IT department in its further configuration and basic functionality expansion. Many operations require the creation of SQL queries, which is impossible without using the services of a skilled developer. Even though untrained business users may leverage the solution, they can not get the best out of it without the assistance of IT.

4) **Poor Versioning:** Only recent Tableau versions support revision history, while for the older ones, software rolling back is impossible.

5) **Embedment Issues:** Although the vendor claims that its tool can be easily embedded into any business IT landscape, in reality, the solution's capabilities do not allow for a smooth embedment. Seamless Tableau's integration into a company's product is a real challenge from both the financial and technical points of view.

6) **Time-and Resource-Intensive Staff Training:** Basic use of the application does not demand hyper-focused knowledge in Tableau. However, the tool's visualization potential is nearly unlimited, while the learning curve is incredibly steep for non-analyst users. Getting to know all of the tool's capabilities without comprehensive employee training is nearly impossible. The learning part alone, on both the development and consumption side, may take weeks or months, before one can make the best use of the tool's functionality and get an immense benefit from it. At the same time, it increases the cost of ownership significantly.

8. IBM Cognos Analytics

Cognos is a business intelligence and performance management software suite sold by IBM. The software suite was designed to enable non-technical personnel in large enterprises to extract corporate data, analyze them and then produce reports that would help the business make informed decisions. The suite is composed of more than a dozen separate products, which were built on open standards to allow them to communicate with various third-party technologies, from multidimensional and relational databases to enterprise-grade software such as SAP and Oracle.

Figure 8: IBM Cognos Analytics logo

Cognos was originally the name of the company that created the Business Intelligence suite that is now named after it. The company was founded in 1969 by Alan Rushforth and Peter Glenister, and was originally called Quasar Systems Limited, which was then a consulting company working for the Canadian government. It shifted its focus to software sales in 1980 and renamed itself to Cognos in 1982, taken from the Latin word "cognosco," which means "knowledge from personal experience," a rather apt name for the type of industry the company was in. The company was later acquired by IBM on January 31, 2008, losing its independent existence but retaining its legacy in the software suite it developed, which also bears the same name.

Cognos is a Web-based, integrated business intelligence suite that provides a powerful toolset for mining, analyzing, scorecarding and monitoring of events, data and metrics. It allows a business to become top performing and analytics driven, giving it the capacity to actually predict or find market trends and then react to them with informed decisions. The software suite contains the following basic components:

Query Studio-allows for simple queries and self-service reports that answer all basic business questions

Cognos Connection-the Cognos Web Portal, the starting point for all functions provided in the suite

Report Studio-used to create management reports including maps, charts, lists and repeat functions

Event Studio-a notification tool which reports on enterprise events in real-time

Analysis Studio-used for analyzing and understanding information about a business event or action, identifies trends and helps users understand anomalies and deviations, also contains OLAP functionalities, among others

Features of IBM Cognos Analytics:

1) **Lower costs-**Reduces maintenance due to complete report coverage and a zero-footprint environment.
2) **Faster results-**Shortens reporting time due to seamless integration and adaptive authoring.
3) **Improved decision making-**Reports and dashboards present data in easily-understood formats.
4) **Ability to use a variety of charts-**Crosstabs, bar or 3D bar, pie or doughnut, line, gauge, funnel, scatter, dot density, waterfall, and so forth.
5) **Multiple export formats-**Excel, Portable Document Format (PDF), Extensible Markup Language (XML), Hypertext Markup Language (HTML), and Comma Separated Value (CSV).
6) Adaptive authoring automatically adjusts report layout when objects are added, moved, or removed.
7) Ability to work with data using familiar business terms.
8) Ability to create complex, multi-page layouts using different data sources.
9) High performance data access across all sources.
10) Complete connectivity regardless of environment.

Cons of IBM Cognos Analytics:

1) Total Cost of Ownership (TCO) is more significant than other tools
2) Minimal forecast capabilities
3) Investment in Cognos R&D by IBM is declining
4) Won't work smoothly with large data sets having many parameters
5) Cross-browser compatibility is often problematic

9. Flow of Data

Flow of data in Power BI

There is a specific sequence for data to pass through before getting reported in the end. Power BI like every other BI tool has its report server too called as Power BI Report Server.

It is basically a cloud based server with light report editing. It works on premises centralized hosting environment. Once the report is published and exported from the Power BI desktop, multiple users can access it if the owner allows them. Also all the people on the web server can view the dashboard or the visualization made by the host. Hence it is a data analysis and report creating tool on cloud server thus not limiting to only one person.

It has data source connections with limited modelling and the released versions are all behind the Power BI desktop.

For data cleaning Power BI has its very own Query editor named as Power Query. It is basically the heart of Power BI. With this editor, one can clean the data very easily using significant tools present in the toolbox provided at the top.
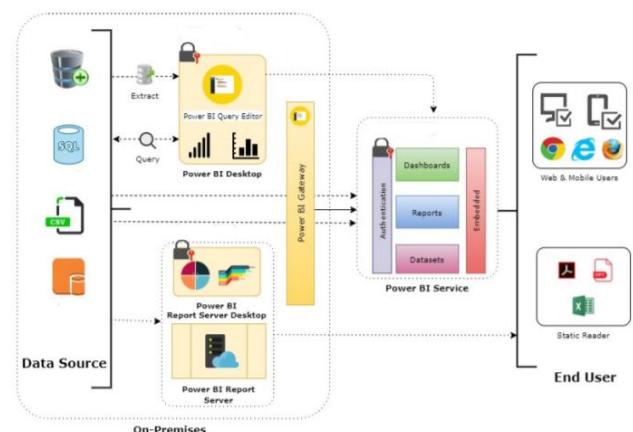

Figure 7: Flow of data in Power BI

Flow of data in Tableau

In tableau also there is a set format through which data needs to be passed before it reaches the end user. The report server of Tableau is named as Tableau Prep Builder and Conductor. This report server of tableau is responsible for combining, cleaning and shaping the raw data into useful one. It is used for scheduling, monitoring and managing the flaws of the data. All the flaws are removed before the data goes for visualization. The Tableau Desktop is used to transform the statistical data into interactive visual representation. All the data in the record form is made into charts and graphs using

Tableau Desktop. It is also used to build in reports to give insights to decision makers or the stakeholders of the company.

Now the Tableau Server Publishes, Shares and the admin checks the desktop content. The setup now grants permissions on workbooks and data sources.

Summarizing this, we can conclude that the Tableau desktop is responsible for the development of the report and the server is responsible for the sharing and collaboration on the web.
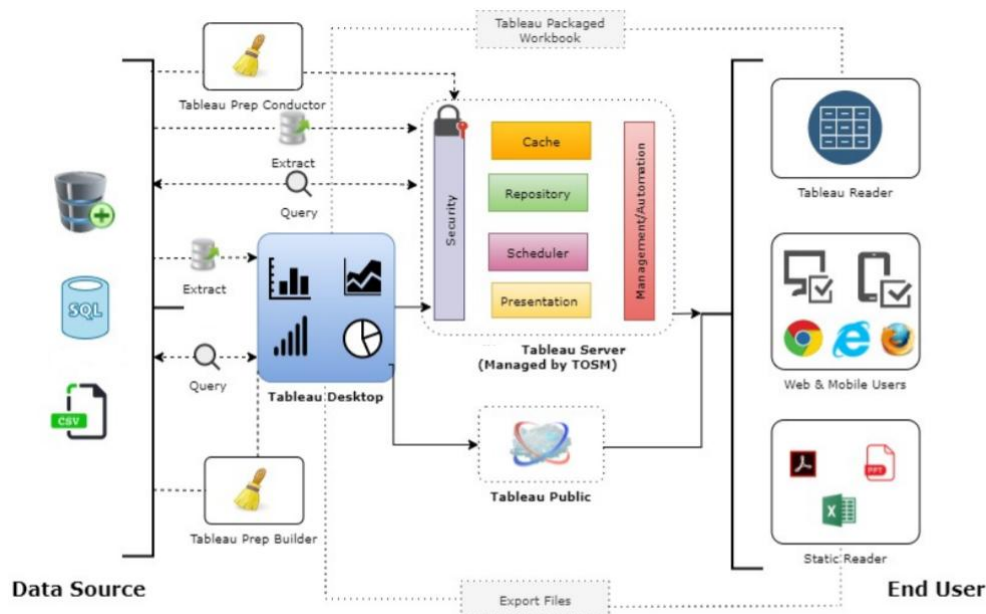

Figure 8: Flow of data in Tableau

Flow of data in Cognos Analytics

Cognos Analytics, an IBM tool for BI has a separate three-tiered architecture for the flow of data. These are basically **web, applications and data.** Each of these tires can be separated by a firewall.

In this web based interface (Cognos Analytics), the first tier is the web server. In that, we use compiled gateways for production systems. For improving the performance of

production systems we can change the gateway from the default to CGI gateway.
The second tier which comes is the tier of applications. The Server on this tier is referred to application server. It is basically the content Management Dispatcher of the whole data flow. It manages the applications and then dispatches for the delivery to be done at the end.

The third tier, or the final stage of this data flow is the database itself. Now the data gets compiled and loaded into the database and thus is ready for the work to be done on it.
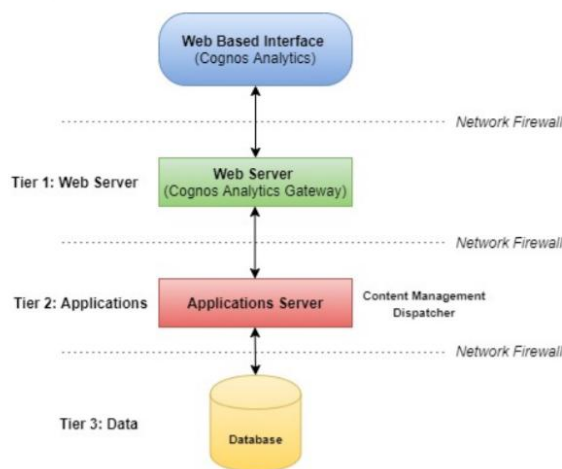

Figure 9: Flow of data in Cognos Analytics

10. Dashboards-The best tool for Data Visualization

A dashboard is a data visualization tool that tracks, analyzes, and displays KPIs, metrics, and critical data points. Dashboards empower technical and non-technical users to understand and leverage business intelligence to make more informed decisions. Users actively participate in the analytics process by compiling data and visualizing trends or occurrences, and uncovering an objective view of performance metrics that can be immediately understood. Dashboards feature visualized data via charts, tables, and gauges. Viewers use these visualizations to monitor the health of the organization against established goals and industry benchmarks.

Comparing dashboards of Power BI and tableau v/s IBM Cognos Analytics

Power BI and tableau
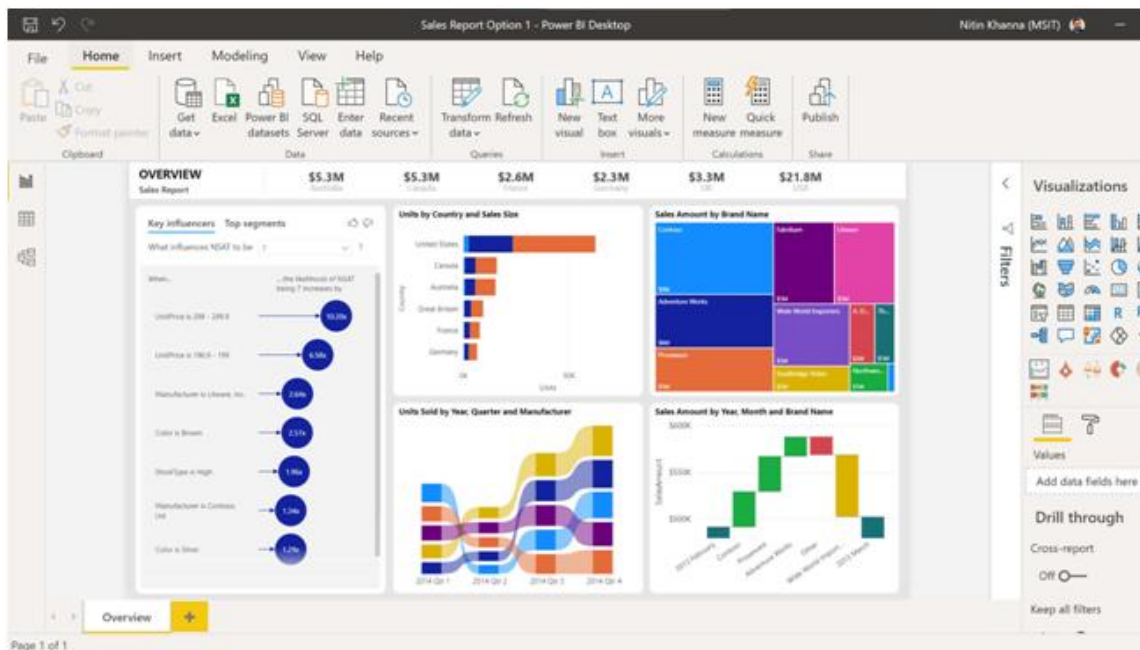
Dashboard of Power BI:

Figure 10: Power BI dashboard
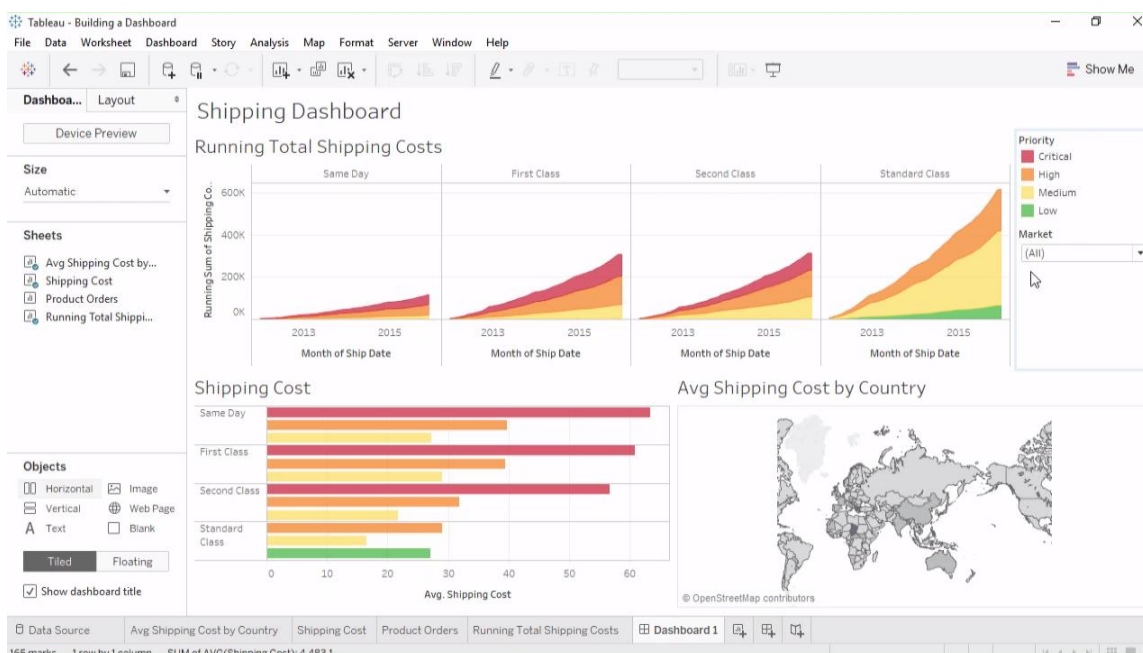
Dashboard of Tableau:

Figure 11: Tableau dashboard

The dashboard of Power BI and tableau are very simple, interactive and have sharing capabilities to foster collaboration.

IBM Cognos Analytics
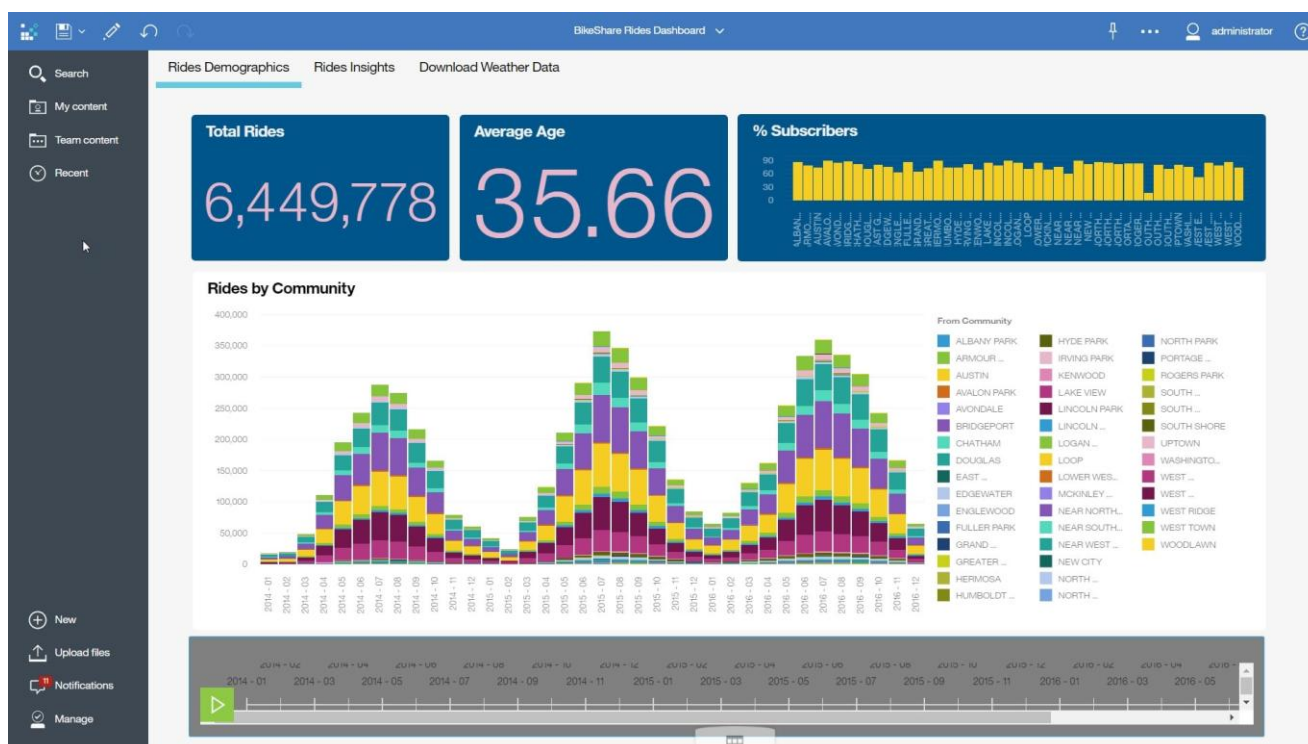
Dashboard of IBM Cognos Analytics:

Figure 12: IBM Cognos Analytics Dashboard

The dashboard offered by IBM Cognos Analytics is very much complicated. Most of the users find it difficult to understand. It has less features as compared to its rivals Power BI and Tableau.

IBM Cognos Analytics provides us a very different user interface and beginners find it very difficult to use. Once a person is familiar to this kind of dashboard, then it is easy to use this platform.

11. Conclusion-The Final Survey

Many Data Scientists have already done a lot in the field of data visualization. But as we know there is nothing like perfect tool. Every tool needs an upgrade over a period to make itself best in the era. So a survey was conducted for the students and faculty of TCA-Training and Development (An institution for Computer Sciences) to study the tools in a practical way. A questionnaire was made, which had both subjective as well as coded questions.

The subjective questions contained Accessibility (Ease of usage), Connecting to Data, Data preparation/Data cleaning, Security and General Feedback about all the three BI tools whereas the coded questions involved Visualization, Use of
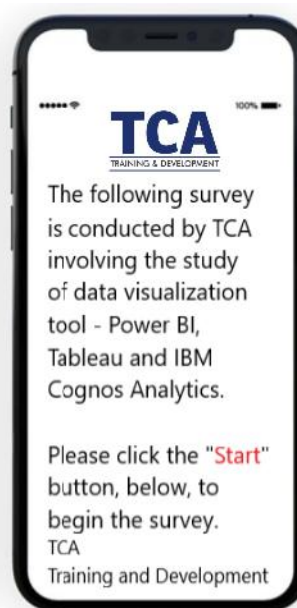
in-built features, Ease of development, Community Support and Project maintenance.

Figure 13: Survey page
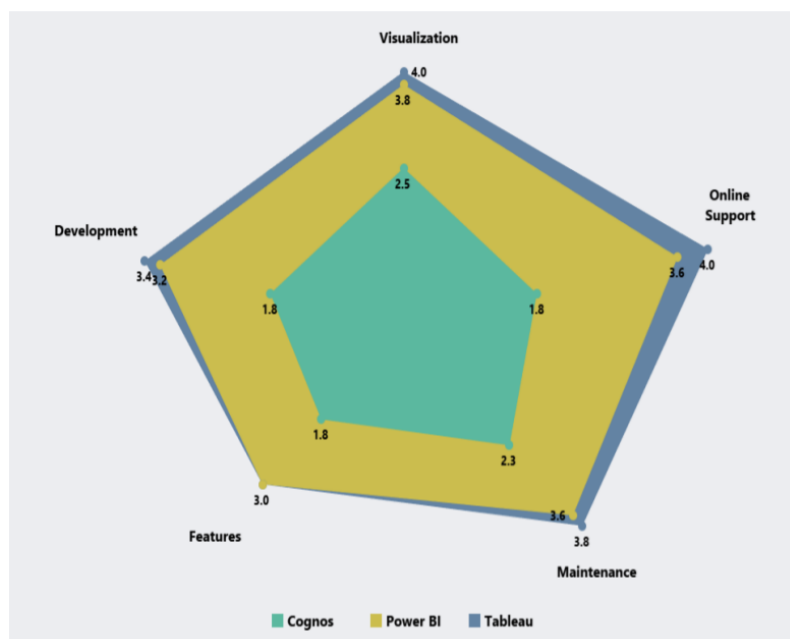
Survey Results

Figure 14: Results of the survey conducted

The results of this survey were aren't very surprising. They were also in accordance to the current trend in the industry. The results suggested that Power BI and Tableau were close in the areas of interest whereas IBM Cognos Analytics lagged behind. The results were very much familiar to the Gartner's Magic Quadrant which showed that IBM Cognos Analytics played a catch up and was in the Niche Players quadrant.

Responses for Power BI

1) **Accessibility (Ease of Usage):** The tool was found to be intuitive, and the online service had the same user-friendly permission management as other Office365 apps.
2) **Connecting to data:** Power BI was able to connect to the various data sources the user worked on.
3) **Data Preparation and Data Cleaning:** Power Bi itself provide data cleaning/prep tools via Power Query
4) **Security:** The tools security was found to be good. People could mask the data which they want to present as well so they found it secured.

Responses for Tableau

1) **Accessibility (Ease of Usage):** Tableau had a learning curve. Once someone understands how the software works, it is easy to use, has a large community to help with questions and a powerful tool for data visualizations.
2) **Connecting to data:** People loved the connectivity of this tool to various data sources. They used Excel, Data Extracts and MySQL.
3) **Data Preparation and Data Cleaning:** Many people been using Tableau Prep more and more and they find it's a pretty intuitive tool.
4) **Security:** Tableau has good security and so far, have not faced any issues with respect to security concerns.

Responses for IBM Cognos Analytics

1) **Accessibility (Ease of usage):** The UI of the tool feels outdated and has a steeper learning curve than more modern tools, such as Power BI and Tableau.
2) **Connecting to Data:** According to many users, it was fairly easy to connect the report to the database.
3) **Data Preparation and Data Cleaning:** Cognos does not offer much flexibility in preparation/Cleaning. All the work done before saves us huge time.
4) **Security:** Cognos should be secured as users have accessed it both in network and outside network.

Feedback of the survey

Power BI
1) Potential to grow since there are regular updates every month
2) Smooth integration with other Microsoft tools
3) Run script directly and import the resulting dataset
4) Cost-effective and easy to obtain a license

Tableau
1) Ease of creating Calculated fields and Parameters
2) Tableau Server and Tableau Online provides easy web access
3) Higher Cost as compared to alternatives
4) Time consuming as data preparation required before usage

IBM Cognos Analytics
1) Good for running Excel Reports
2) Development is time consuming
3) Tool is not intuitive

4)   Lack of Online Community

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