International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 9 Issue 3, March-2020, Impact Factor: 6.754

Developing Scalable Power BI Dashboards for Enhanced Data Analysis and Strategic Business Decision-Making

Uday Kumar Kalae

Independent Researcher, USA.

ABSTRACT

Scalable Power BI dashboards can be considered as the keys to allowing businesses to process large quantities of data without compromising performance or usability. The study investigates the concept development and design of scalable Power BI dashboards to effectively handle a large amount of data and retain their level of performance and usability. The case analyzes the key metrics, such as all sales, distribution, and product trends.

This study uses the interactive capabilities of Power BI and top-level analytics to reveal how firms can arrive at actionable findings to support decision-making. The article emphasizes the relevance of scalable dashboards in real-time data manipulations to allow companies to maximize sales operations and generally enhance the functioning of the business sector. The strategy is based on modeling data, performance management, and the incorporation of real-time analytics that facilitate data-oriented business advancement.

Keywords - ***Scalable Dashboards, Power BI, Data Visualization, Business Intelligence, Dashboard Optimization, Interactive Dashboards, Data Scalability, Advanced Analytics, Query Optimization***

I. INTRODUCTION

Data analytics has become a key element of strategic decision-making due to the growing amount of business data. Power BI dashboards are also an effective tool to analyze big data, allowing the business to obtain actionable data [1]. In their design, appropriately, these dashboards can deliver important visualizations that aid in decision-making that can be data-driven on a timely basis.

The greater the demand for the dynamic and interactive nature of data in organizations, the more it seems necessary to create scalable dashboards of Power BI to enable endless data exploration and efficiency in decision-making [2]. Scalable solutions are increasingly becoming necessary to ensure that the business is in a position to meet the demand that will keep changing without affecting their performance [3].

Problem Statement: The issue that is to be under consideration of this work is the difficulty in creating scalable Power BI dashboards, which could work with the large amount of data and ensure the best quality of performance, maximized responsiveness, and user-friendliness with respect to different applications.

Research Contribution: The research is valuable because it discusses the methods of making Power BI dashboards as scalable as possible, how to add some more sophisticated functions of analytics, and how to make sure that the dashboards become effective in addressing the business needs.

Objectives:

- To investigate the main issues that affect the design and development of scalable Power BI dashboards in efficient data analysis.
- To detect the best approaches and methods of optimization to improve the large-scale performance of Power BI dashboards.
- To test whether scalable Power BI dashboards affect business decision-making and data-driven strategies in different industries.

II. LITERATURE REVIEW

1. The role of Data Analytics in the Business Decision-Making

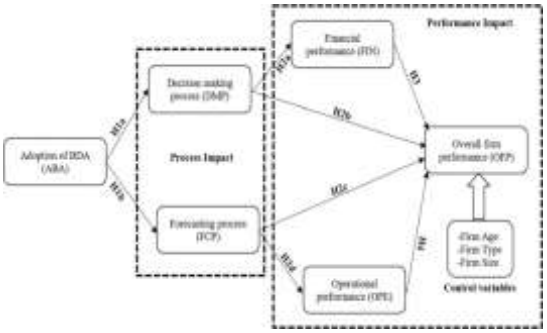

Fig. 1. Data analysis in Business Decision making

Data analytics has become central to the contemporary business decision-making process because it converts raw data to action insights [4]. As the volume of data is rising exponentially, businesses need new sophisticated tools to manage, process, and visualize complicated data. Evidence-based decision making allows organizations know the market trends, streamline their operations, and elevate customer experiences [5]. In the modern competitive environment, companies using the power of information are more prone to developing a competitive advantage. Analytic tools such as Power BI help in visualizing data, providing interactive dashboards to the stakeholders that will help in timely decisions that are supported by data [6]. Besides, these insights can enable businesses to make forecasts on future trends that can enhance both short-term and long-term plans. Those organizations that fail to utilize data analytics are likely to miss important opportunities or might be inefficient. The great significance of data analytics is universal since it is applicable to any type of industry, such as retail, finance, healthcare, and manufacturing, which explains its universal relevance and necessity [7]. Data analytics prevents them from being unresponsive by providing a clear visual representation of the key performance indicators (KPIs) that impact the decision-making processes at any level.

2. Power BI Introduction and Functionalities in Business Analytics

Fig. 2. Power BI in Business Analytics

Power BI is a business intelligence (BI) tool created by Microsoft that is recognized to enable the development of visually attractive and interactive dashboards, which are considered to be the most popular business intelligence tools [8]. It enables the user to link to different data sources, including databases, spreadsheets, cloud and even real-time data feeds. The capabilities of Power BI are the ability to create reports using drag and drop functionality, the ability to transform data using Power Query and the ability to model data using building block language known as DAX (Data Analysis Expressions) [9]. The tool provides numerous visualization options, such as bar charts, pie charts, and geographical maps that used as a versatile tool in various industries. Further, Power BI enables real-time data tracking, thus giving the user real-time data. This feature is essential in business organizations that demand constant updating, like e-business or banks [10]. Power BI is also integrated with other Microsoft applications, such as Excel and Azure, which adds to its usefulness to enterprises already integrated into the Microsoft cluster [11]. The software has a range of deployments, such as Power BI Desktop that is locally deployed, Power BI Service that is deployed to the cloud and Power BI mobile that is deployed on the go. Hence, making it a holistic solution in the process of data analysis and reporting at different levels of the organization.

3. Data Dashboard Scalability

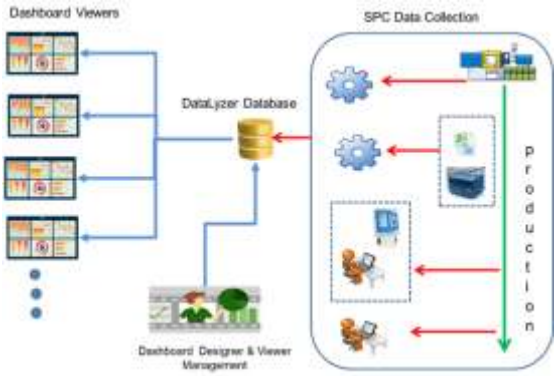

Fig . 3. Dashboard Production

Scalability is an important factor to consider when developing data dashboards, as companies require solutions that would be able to scale as the volume of data increases without losing performance [12]. The concept of scalability, in the framework of Power BI, means that dashboards will remain scalable in case data rises in size, complexity, or frequency. A scalable dashboard can effectively work with large data sets and have fast load times and respondent interact with users [13]. Scalability depends on a number of factors such as the storage mechanisms utilization over the clouds, the data models and query optimization. Power BI takes advantage of the strength of cloud computing, including Azure, in order to expand its data storage and processing capacity [14]. Scalability is not only the large amount of data that will be processed, but it is also the ability to adapt to the increasing number of users who log in to the dashboards. Dashboards provide more stakeholders with the means to make informed decisions and thus, the demand for the performance and access of the dashboard increases when the organization grows [15]. The need to have scalability in Power BI dashboards calls for close consideration of data structuring, report designing, and integration of functionality like direct query mode that enables flexible accessing of devices. Companies with a focus on scalability will be in a better position to manage further expansion, and their analytics infrastructure will retain its strength in the long term.

4. Best Practice in the Design of Dashboards.

The ability to design a powerful dashboard is not limited to the selection of appropriate visualizations, but the key to the successful design process is to grasp the target audience and understand their needs. It is recommended that the dashboard design should be user-friendly, plain, and transparent, as per best practices. Dashboards are better to prioritize the most significant metrics and word them in an easily comprehensible way [16]. The interface of Power BI is customizable, enabling users to create dashboards that show the pertinent KPIs to meet organizational objectives. Also, the reliance on the intuitive visualizations, including a trend in the form of line charts, comparison in the form of bar charts, and performance tracking in the form of a heatmap, makes the data readable and assimilable [17]. The other frailty worth taking into consideration is interactivity; the higher levels of information can be won by the ability of the user to drill down into particular information points or to filter the data on the basis of variables. Uniformity in design and layout is also a prerequisite to having a professional and unified dashboard. The second-best practice is the responsiveness and high speed of the dashboard, irrespective of the amount of data. It involves optimization of data models, application of the in-built performance analyzer of Power BI, and the consideration of the possibility of the use of cloud-based solutions to provide real-time data updates [18]. These best practices guarantee that dashboards are not only attractive to look at but also perform the decision-making process.

Literature Gap

Although much literature has been done regarding the benefits of data analytics, the role of Power BI in business decision-making processes, and scalability in dashboards, it is missing studies that specifically discuss methods of optimizing Power BI dashboards using large amounts of data. Despite the literature available on scalability, many papers were general and did not provide any detailed investigation of the design aspects and optimization techniques specific to Power BI. Moreover, studies about the practice of scalable dashboards in the real industry are also scarce. The research will fill these gaps through its exploration of the challenges and solutions that are unique to establishing scalable Power BI dashboards to support the growing complexity of data and strategic decision-making.

III. METHODOLOGY

A. **Data Collection**

Information is gathered in different organizational sources, including sales, customer behavior and the operational performance measures. The data shall be subjected to the preprocessing of Power Query in the power BI so as to clean

and reshape the data to have consistency and completeness. Power Query is an effective data preprocessing tool in Power BI that guarantees consistency and completeness of the data [19]. The inconclusive values may be treated by dropping them or substituting them with imputation strategies such as mean and median values. Outliers are identified and dealt with using the IQR method, which involves the calculation of the interquartile range (IQR) and the filtering of the data that cannot fall within reasonable limits [20].

B. Data Analysis

In-depth statistical procedures are used on the data. Namely, linear relationships between variables are evaluated with the help of the Pearson correlation:

$$r = \frac{n\sum XY - \sum X \sum Y}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}} \quad \text{----- (1)}$$

Key trends is detected, and the results of the business are predicted using regression models. As an example, a multiple linear regression will be employed to anticipate the sales with the help of various factors:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \epsilon \quad \text{----- (2)}$$

where Y is the dependent variable (sales), $X1, X2, \ldots, Xn$ are the independent variables, β0 is the intercept, β1, β2,…,βn are the coefficients, and ϵ is the error term.
Segmentation of the customers through behavior will be done using clustering algorithms such as K-means. The quality of clustering will be checked with the help of the Silhouette Score:

$$S = \frac{b - a}{max(a, b)} \quad \text{----- (3)}$$

In which a is the mean distance between a location and other locations in the identical cluster and b the mean distance between the location and the nearest cluster.

C. Dashboard Design and Development

The interactive dashboards will be developed in Power BI. The design will be developed with sophisticated functionality such as DirectQuery mode of accessing real-time data and Power BI Service of hosting on cloud to ensure that it will be able to scale as data increases [21].

D. Scalability Testing and Optimization

Scalability of the dashboards will be evaluated based on such performance metrics as query response time and dashboard load time. Performance will be maintained by using techniques like query optimization, compression of data, and incremental data refresh. These factors will be optimized, therefore the dashboards will support large datasets without affecting the performance.

IV. DESIGN AND DEVELOPMENT OF SCALABLE POWER BI DASHBOARDS

A. Scalable Dashboards Requirements

Scalable dashboards should be able to manage a growing data load and user load without being reduced to uselessness. Major demands are a healthy level of data model, which is able to process huge volumes of data, and has an efficient data retrieval process along with real-time data integration [22]. The use of dashboards should have an interactive feature allowing users to interactively explore the data. The scalable design should also have clear and concise visualizations whereby the dashboard is user-friendly and responsive as the data increases. Scaling of resource capacity to accommodate effective user demand and data growth with time requires cloud-based storage, such as Azure or Power BI Service, where the facility is likely to be constantly available.

B. Power BI Dashboard Architecture

Fig. 4. Architecture of Dashboard Development

A scalable Power BI dashboard architecture comprises data sources, data transformation layers, and the visualization layer. The sources of data can be either local or cloud-based, or a hybrid and are connected using Power Query. DirectQuery or Import mode is used to process the data, and data transformation is supported through Power BI Dataflows [23]. The graphical layer consists of the Power BI reports by which the insights are shown in the form of interactive charts, tables, and maps. Application of the Power BI Service enables a cloud application, which benefits the application by multiple users across regions. To achieve scalability, data models and relationships should be developed between proper data models and relationships.

C. Dashboard Development Process

Scalable dashboards are developed in a systematic manner.

- ➔ The first step is to specify business goals and select a major measure that should be visualized.
- ➔ Then, gather and format the information, clean it and format it to be analyzed. Prepare the dashboard design, simple and concise, and key metrics should be easy to access. Clean and transform the data using Power Query.
- ➔ Once the dashboard has been developed, add user interactivity such as filtering and drill-down functionality.
- ➔ Lastly, the dashboard is tested on its performance and usability, so that the dashboard can scale well as the data increases and users interact.

D. Performance Optimization Techniques.

DirectQuery helps in real-time access to data and aggregations to reduce the amount of data being queried to ensure high load times. Best practices in data modelling like minimizing the number of relationships and star schema design, could be helpful in enhancing the speed of processing. The further performance improvement is indexing and query optimization [24]. Power BI uses data compression algorithms that diminish the quantity of the data and incremental refresh, which guarantees that the data is loaded only with new or modified information. It is also important to monitor and optimize Dax formula and Power BI performance analyzer tools that identify and eliminate bottlenecks.

E. Interactive Featuring and Advanced Analytics Integration.

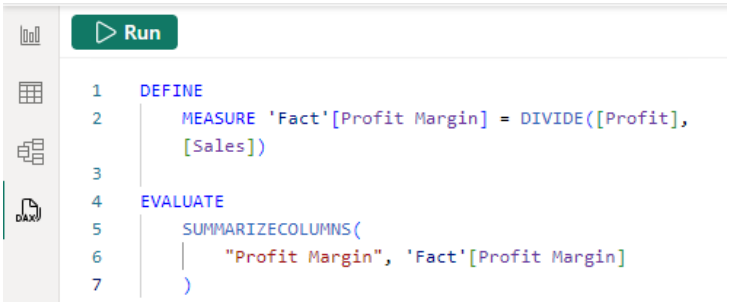

Fig. 5. DAX Query in Power BI

The interactive features are also necessary to capture users and explore the information dynamically. The Power BI is compatible with drill through, slicers and cross filtering features that enable users to further delve into data, as well as view different metrics. To support advanced analytics, it is possible to use machine learning models or R/Python scripts that will act as a predictor of trends or a data segment in Power BI [25]. Power BI also has a question-and-answer facility, which creates the possibility of querying it using natural language. Moreover, the features of data streaming in real time on dashboards have made users look at the latest in terms of information and the adoption of Power BI Embedded has enabled them to integrate the dashboards into other applications so that they can be accessible to more people.

V. RESULT AND DISCUSSION

Fig. 6. Monthly Revenue Trends

The Monthly Revenue Trends line graph represents the performance of sales with reference to three products (A, B, and C) in 12 months. Product A (blue) tends to have a steady growth, whereas Product B (orange) tends to fluctuate across the year. The product C (green) is just varying in terms of sales and there are large peaks and valleys. This graph assists the stakeholders in studying seasonal trends and the products that are more effective at particular seasons and the tendencies that influence product demand. By using this information, companies are able to plan marketing operations, modify stock levels and optimize sales projections, which will help them to align better with the dynamics of the market.

Fig. 7. Sales Breakdown by Region

The Sales Breakdown by Region pie chart provides the distribution of total sales within force of four geographical locations, which include: North America, Europe, Asia and Other. North America leads with 40 percent of total sales followed by Europe at 25 percent and Asia with 25 percent and the rest as the other category with 20 percent. It is a visual that enables businesses to snap a glimpse of the performance of sales in the regions and which shows areas of strong performance and where market expansion may be achieved. With the help of marking the areas of poor performance, the organizations will be able to modify their marketing and sales strategies, distribute funds better, and enter the perspective markets.

Fig. 8. Sales Performance Dashboard

The Sales Performance Dashboard can be interpreted as an interactive representation of the key performance indicators as Total Sales, Total Profit, and Total Orders. It is accompanied by the geographical map of sales in geographical regions and a monthly trend chart of sales and profit performance over time. The dashboard allows the user to navigate it, breaking down into certain segments such as geographic areas or product categories. Actionable insights can be used on the dashboard so that businesses can check performance, evaluate sales strategies, and make real-time decisions. It is a key instrument of both informed business processes or business performance optimization in any one of the departments.

TABLE 1: COMPARISON OF SCALABLE AND NON-SCALABLE DASHBOARD

Feature	Scalable Dashboards	Non-Scalable Dashboards
Data Handling	Handles large datasets	Performance decreases with increasing volume of data
Performance	Maintains fast load times	Slower load times and lag with more data
Flexibility	Integrating new data without data loss	Limited flexibility
User Access	Supports multiple users simultaneously	Performance decreases with multiple users
Data Refresh	Frequent data refresh without lag	Manual data refreshes which take time
Visualization	Optimized visualizations for complex datasets	Limited visualization for large datasets

DISCUSSION

Product A has been indicated as developing steady revenue over time, and Products B and C have recorded substantial variations that could be attributed to different market situations or the popularity of the product. The local sales analysis has shown North America as the leading market and equal participation of Europe and Asia. The Sales Performance dashboard provides interactive, real-time insights with which the sales can be further analyzed by product, region, and time. Such insights would enable businesses to streamline strategies, efficiently use resources and find ways to improve to achieve future growth.

LIMITATIONS

Data Accuracy: The analysis of the accuracy of input data that may include different noise and may influence the results in case some errors or inconsistencies are observed [26].

External Factors: The research concentrates on the internal data of sales only without factoring in the outside factors like changes in market, competition, or economic conditions that may affect the performance of the product and the sales in the region [27].

VI. CONCLUSION AND FUTURE RESEARCH

The study recognizes the importance of scalable Power BI dashboards that are essential in dealing with huge amounts of information without compromising performance and usability. The study shows that it is possible to use the interactive and analytical functions of Power BI to obtain actionable insights and improve both business processes by analyzing critical metrics such as total sales, regional distribution, and product trends. The conclusions reiterate the importance of scalable dashboards to provide real-time decisions as well as optimizing the sales approaches and business expansion. Finally, scalable dashboards can be useful in integration, as it allows businesses to remain competitive within an extremely dynamic business environment.

Further studies will discuss how to incorporate other sources of data, including customer sentiment analysis or external market trends, to improve the predictive ability of Power BI dashboards [28]. More data about the performance of the dashboard and decision-making could be optimized by investigating the role of machine learning and AI models in sales forecasting.

VII. REFERENCES

[1]. Widjaja, S. and Mauritsius, T., 2019. The development of performance dashboard visualization with power BI as platform. *International Journal of Mechanical Engineering and Technology (IJMET)*, *10*(5), pp.235-249.
[2]. Mehta, A., 2016. A Comparative Analysis of Tableau and Power BI: Choosing the Right Tool for Your Business Intelligence Strategy.
[3]. Pala, S.K., 2017. Advance Analytics for Reporting and Creating Dashboards with Tools like SSIS, Visual Analytics and Tableau. *International Journal of Open Publication and Exploration*, *5*(2), pp.3006-2853.
[4]. Parveen, S., 2017. Unlocking Power BI's Potential: Mastering DAX for Dynamic Data Analysis and Complex Calculations.

[5]. Deckler, G., 2019. *Learn Power BI: A beginner's guide to developing interactive business intelligence solutions using Microsoft Power BI*. Packt Publishing Ltd.
[6]. Sola, S.R., 2019. Data and Decision: Harnessing Bi With Power Bi, Oracle Bi, And Sql Technologies. *International Journal of Engineering Technology Research & Management*, *3*(10).
[7]. Sharma, V., 2017. Creating A Single Source of Truth: Data Governance with Power BI, SQL, And Effective ETL Processes.
[8]. Reddy, C.S., Sangam, R.S. and Srinivasa Rao, B., 2018, November. A survey on business intelligence tools for marketing, financial, and transportation services. In *Smart Intelligent Computing and Applications: Proceedings of the Second International Conference on SCI 2018, Volume 2* (pp. 495-504). Singapore: Springer Singapore.
[9]. Stodder, D., 2015. Visual analytics for making smarter decisions faster. *Best Practices Report, TDWI Research*.
[10]. Saif, I., 2017. Advanced Data Modeling in Power Bi: Best Practices for Performance Optimization and Data Integrity.
[11]. Wang, Y. and Byrd, T.A., 2017. Business analytics-enabled decision-making effectiveness through knowledge absorptive capacity in health care. *Journal of Knowledge Management*, *21*(3), pp.517-539.
[12]. Erik, S. and Emma, L., 2018. Real-Time Analytics with Event-Driven Architectures: Powering Next-Gen Business Intelligence. *International Journal of Trend in Scientific Research and Development*, *2*(4), pp.3097-3111.
[13]. Dunlop, N., 2015. *Beginning Big Data with Power BI and Excel 2013: Big Data Processing and Analysis Using PowerBI in Excel 2013*. Apress.
[14]. Kumari, R., 2017. From Spreadsheets to Stories: Creating Actionable Insights with Tableau and the Business Intelligence Lifecycle.
[15]. Olayinka, O.H., 2019. Leveraging predictive analytics and machine learning for strategic business decision-making and competitive advantage. *International Journal of Computer Applications Technology and Research*, *8*(12), pp.473-486.
[16]. Williams, S., 2016. *Business intelligence strategy and big data analytics: a general management perspective*. Morgan Kaufmann.
[17]. ARGHIR, D.C., Duşa, I.G. and Onuţă, M., 2019. Organizational development through Business Intelligence and Data Mining. *Database Systems Journal*, *10*(1).
[18]. Parthasarathy, K. and Ayyadurai, R., 2019. IoT-driven visualization framework for enhancing business intelligence, data quality, and risk management in corporate financial analytics. *International Journal of HRM and Organizational Behavior*, *7*(3), pp.27-42.
[19]. Scholtz, B., Calitz, A. and Haupt, R., 2018. A business intelligence framework for sustainability information management in higher education. *International Journal of Sustainability in Higher Education*, *19*(2), pp.266-290.
[20]. Smith, J. and Karan, D., 2019. From descriptive to predictive: emerging trends in data analytics for strategic business intelligence. *Revista de Inteligencia Artificial en Medicina*, *10*(1).
[21]. Stadler, J.G., Donlon, K., Siewert, J.D., Franken, T. and Lewis, N.E., 2016. Improving the efficiency and ease of healthcare analysis through use of data visualization dashboards. *Big data*, *4*(2), pp.129-135.
[22]. Grover, V., Chiang, R.H., Liang, T.P. and Zhang, D., 2018. Creating strategic business value from big data analytics: A research framework. *Journal of management information systems*, *35*(2), pp.388-423.
[23]. Bocevska, A., Savoska, S. and Milevski, I., 2017. BI Tools Analysis According to Business Criteria as Data Integration Possibilities, Hardware Specifi cation, Tools for Data Visualization and Comparison of Used Technologies.
[24]. Diong, B., Zheng, G. and Ginn, M., 2015, April. Establishing the foundation for energy management on university campuses via data analytics. In *SoutheastCon 2015* (pp. 1-7). IEEE.
[25]. Nwaimo, C.S., Oluoha, O.M. and Oyedokun, O.Y.E.W.A.L.E., 2019. Big data analytics: technologies, applications, and future prospects. *Iconic Research and Engineering Journals*, *2*(11), pp.411-419.
[26]. Dalal, A., 2018. Revolutionizing Enterprise Data Management Using SAP HANA for Improved Performance and Scalability. *Available at SSRN 5424194*.
[27]. Ilieva, G., Yankova, T. and Klisarova, S., 2015, September. Cloud business intelligence: contemporary learning opportunities in MIS training. In *CEUR Workshop Proceedings of the 2015 Balkan Conference in Informatics* (Vol. 1427, pp. 25-32).
[28]. Reshi, Y.S. and Khan, R.A., 2014. Creating business intelligence through machine learning: An Effective business decision making tool. In *Information and knowledge management* (Vol. 4, No. 1, pp. 65-75).