

COMPARATIVE STUDY AND REVIEW OF PRINCIPLES FOR DASHBOARD DESIGN

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Abstract - The continuous increase of data leads to information overloading which is a known phenomenon and thus becomes essential to deal with. Dashboards are used to manage this overload since they are considered very useful tools in Business Intelligence (BI) as they use concepts like scorecards to assist employees and stakeholders to make appropriate and quick decisions and to improve performance. In the corporate sector, dashboards can be utilized to visualize Key Performance Indicators (KPI's) which play a crucial role in understanding the business. However, many software vendors do not utilize the capabilities and effectiveness of dashboards but instead they emphasize on data visualization mechanisms for marketing purposes. Therefore, this study aims to compare various types of dashboards and the tools utilized to create them based on various factors, to help in making effective data driven decisions and hence increase business performance. Thus, this study gives important insights about when and why a particular type of dashboard and BI tool should be opted, depending on the business scenario and use-case.

Key Words: Dashboard, Balanced Scorecard, Decision Making, Performance Measurement, Key Performance Indicators.

1. INTRODUCTION

The ubiquity of dashboards makes them worthy of study since there is a huge potential for good impact. They are interesting and are very diverse resulting in various options and contexts. These dashboards are democratizing, shifting and diversifying with rapid increase in their use. They can be used for more than single screen reports and simple monitoring [1]. Compared to different visualization mechanisms used for presenting and exploration, the challenges of single page reading, monitoring and tracking of data, coordination of views can be handled together by a dashboard. Factors like contextuality for representations and display, literature and framing should be very well considered when designing a dashboard. The impact dashboards can have on future research is recognized, keeping in mind distinct visualizations it can offer [2].

A two-way approach is used in understanding the dashboard design and the tools utilized for their effective implementations. Major dashboard designs are explored and studied to categorize and review them based on various important factors. Also, a review on major tools used by dashboards for effective implementation of reports to be generated was also conducted. The review allows to categorize and build characterization of dashboards and tools on different factors like consistency, monitoring etc., Thus, these two approaches helps to broaden and contribute to an unaddressed space in the study of dashboards. Certain critical and essential factors for dashboard implementations were identified that can be helpful in choosing the suitable one for the requirements specified. This study hopes to add value to the community and also inspire them to embrace dashboards for further research and development on dashboard technologies with greater impact.

2. SIGNIFICANCE OF DASHBOARDS

This study defines dashboard as “a display or visualization of the highly important information which is used to fulfill necessary objectives, which is consolidated and displayed on a single screen so that all the necessary information can be monitored at once”. Dashboards are an information display which is predominantly visual that is used to monitor current scenarios at a glance so that a timely response can be given and hence are single-paged, glanceable visuals of data [2]. Wexler et al. [3] portrays it as a visual display of data, which is used to facilitate understanding, and monitor conditions, which entails narrative visualizations and infographic elements. Through the dashboard design and the domain review survey, it is clear that the term ‘dashboard’ is widely used to refer to many different types of entities, and not just used by the visualization community. The different visualization technologies and ubiquitous data, which is available to the public, has enabled the adoption of dashboards to new domains.

As a result, the concept of dashboards has evolved from single reporting screens to interactive interfaces having multiple views and a variety of purposes. These interfaces provide decision support and monitoring but also include motivation, learning and communication. Dashboards easily cope with the complex and diverse market data in this business-driven information age [3].

Some of the factors that managers mention which drive the need for dashboards are:

- Inadequate organization of many parts of data which is potentially relevant in decision making.
- Managerial biases in making decisions and processing information
- Consequent demands for marketing accountability, since many companies aim to grow to the top while keeping down the costs
- Requirement of inter-departmental integration while reporting the performances and during resource allocation.

Hence, dashboards are proposed to help in effective decision making and to be a support mechanism for measuring the consumption levels and life cycles of products. For people who are not experts in decision making, the correct visualization of data becomes crucial which emphasizes the importance of a tool like dashboard to achieve the same.

3. TYPES OF DASHBOARDS

There are three major types of dashboards that we consider for comparison in our study:

- Strategic
- Tactical
- Operational

3.1 Operational dashboard

An operational dashboard is a tool that is majorly used on operational level in a company and thus provides detailed insights to monitor business processes that change often and also to track the KPI's and Key metrics constantly for the current performance. In comparison with the other types of dashboards, the data involved here updates more often and thus the dashboard should be able to deliver monitoring and tracking the process frequently. Thus, this type of dashboard is designed in a way that the viewer can always monitor the recent progress, even on a minute-by-minute basis and thus always have an updated view every time throughout the day. For instance, a dashboard on a bike would provide the

viewer with immediate information and performance of the organization.

3.2 Strategic dashboard

A strategic dashboard is a tool that is used at the highest level of a company to manage the strategic aspects and thus are mainly used by executives. These dashboards are frequently connected with balanced scorecard methodology where in strategic level management performance improvises business processes and provides better outcomes. The data updates are less frequent when compared to operational dashboards but occurs on a recurrent basis [4]. The executives may view this dashboard once a day which would provide a great assistance to the executives to measure the KPI's and stay ahead of all throughout the business. Thus, this type of dashboard is majorly used in the case of achievement of predefined goals i.e., monitoring the relevant KPI's. For instance, a dashboard for a sales unit would focus on the trends and changes in the sales and the results accordingly.

3.3 Analytical dashboard

An analytical dashboard is a tool that provides in-depth analysis over large content of data to make complex decisions. Analytical dashboards discover the trends and also predict the possible outcomes to make appropriate business decisions. The data in this type of dashboard can be updated infrequently but needs to be precise and accurate [4]. Thus, this type of dashboard is commonly used within BI tools as they are developed by data Analysts. These dashboards provide an opportunity to drill down and get a more detailed view into the business activities. The results obtained from an analytical dashboard can be filtered and used to establish target strategies and goals for a strategic dashboard. For instance, comparing sales trends for a period of time and giving anomalies.

The Table 1 includes a curated set of business and technical questions that are answered with respect to each type of dashboard, thus making it easy to pick the suitable choice in every scenario

Table 1: Choice of dashboard based on critical business requirements

Criterion	Operational Dashboards	Strategic Dashboards	Analytical Dashboards
Business problem that is trying to be solved	Time sensitive data and data awareness	Organizational KPI's	Deeper insights or trends
Gaps in performance	Intra-daily performance	Monthly or quarterly performance	Weekly performance, issues in performance

Dashboard users	Managers and users involved in business	Directors; Executives	executives; data analysts; Business analysts
Goals to be achieved	Tracking against goals and employee awareness	Strategic goals (achievement of KPI targets)	Analytics goals (visibility into key process)
State of the data infrastructure	Excelsheets, databases, web APIs	Data warehouse, databases, Excelsheets, web APIs	Data warehouses, database
Data latency requirements	Time sensitive or real time, low latency	Incremental updates, requires accurate, timely information	Accurate data, high latency
Data storage and number of data sources	In multiple applications and systems.	Set of visualizations or numerous sources of data in a single dashboard	Multiple sources of data in a single dashboard or Set of visualizations

4.3 Power BI

Power BI provides analytical business services which enables end-users to create their own reports without depending on any Information Technology personnel or any database administration. Power BI provides both cloud-based and desktop-based BI services which are known as Power BI administrations and Power BI desktop respectively. It has various capabilities such as data discovery, data preparation methods, and interactive dashboards. It can be used to load custom visualizations which is the main advantage of Power BI [8].

This tool initially gathers data from various sources. Then, Business Analytics Tools (Power BI Designer) are used to create and design dashboards according to the requirements. Finally, the dashboards which are created are sent to the clients through mobile apps and web browsers. The analysis of major BI tools are as outlined in Table 2 below.

Table 2: Analysis of various BI tools

Tool	Advantages	Limitations
MicroStrategy	<ul style="list-style-type: none"> -An administrative cost-effective tool -Can access data on cloud. -Easy to maintain and use. -Can access Big Data solutions. -Design of reports in real-time is possible. -Multiple mediums like mobile, web and distribution services can be used to deliver different reports created. -Advanced, predictive analytics. 	<ul style="list-style-type: none"> -Version control -Parallel development is difficult -User must be well versed in SQL. -Difficult to write manual queries

4. TOOLS UTILISED FOR DASHBOARDS

Among the various BI tools which exist in the industry, three major ones namely, MicroStrategy, Tableau and Power BI are considered in this study.

4.1 MicroStrategy

MicroStrategy (MSTR) is an enterprise BI application software vendor. MSTR supports highly formatted reports, thresholds, alerts, scorecards, interactive dashboards and automated distribution of reports [5].

In this tool, the data is first gathered from various data warehouses and databases. Next, the analytical server (MicroStrategy Intelligence), which is optimized, is used for reporting, querying and for OnLine Analytical Processing (OLAP) [6]. Finally, dashboards are created, administration is carried out and dashboards are sent to the subscribed users.

4.2 Tableau

Tableau is a data visualization tool which is also interactive, that can be used to create effective visualizations in the form of worksheets, dashboards which in turn are used to gain important business insights and increases performance. Non-technical users can easily create dashboards that are very insightful and customized [7].

In this tool, the first stage includes the collection of data from different sources. Second stage involves the establishment of connections between the application server and the different data sources. In stage three, dashboards are created using gateway/load balancer. Finally, dashboards which are created is sent to the clients.

Tableau	<ul style="list-style-type: none"> -Easy to use interface. -Easy third-party integration. -Dashboard reports are supported on various platforms. -Good services provided to customers. - Development is low-cost. 	<ul style="list-style-type: none"> -Data Extraction initially. -Inclusion of all statistical features not present. -Can't replace Financial Reporting Applications.
Power BI	<ul style="list-style-type: none"> -Affordable. -Better report analysis abilities. -Broader variety of reporting capabilities. 	<ul style="list-style-type: none"> -MS Excel control clients benefit the most. -Difficult to deal with large number of data sources -Granularity is not taken into account

study is subject to some specific limitations. This study involved exploring the dashboards and the tools used indirectly i.e., through literature and instances. No dashboard designer or user has been consulted and thus it may not include some potential design considerations and challenges that the actual system in use faces. The characteristics examined in this study are distinct and diverse but need not be considered as a representative sample.

This study anticipates that exploring other use cases and other dashboards will reveal new categories and more insights. Moreover, the dimensions and categorizations may apply on other visualization mechanisms too. Future research can attempt to clearly define this for dashboards alone. This study should be considered as a good foundation step for characterization and use of types of dashboards in user scenarios and also for the tools utilized to create them.

Table 3: Analysis of different BI tools on weighted features

	Weight	MicroStrategy	Tableau	Power BI
Data sourcing	20%	8	9	7
Cost	15%	7	8	8
Reporting	15%	9	7	8
Deployment	8%	9	8	8
Visualization and filtering	15%	8	9	6
Administration	4%	8	7	9
Usability	20%	8	9	8
Mobility	3%	9	9	8

5. COMPARITIVE ANALYSIS

By comparing different types of dashboards, it can be concluded that there are sufficient advantages of identifying the type of dashboard and tool to be used based on the business requirement that is targeted.

Comparison of different tools also led to analyze the following factors as mentioned in the Table 3.

Similarly, the objectives while creating dashboards are to ensure planning, consistency, monitoring and communication. The most functional and salient features, different purposes of the dashboards with respect to its different types are described in Table 4.

With the help of this study, based on the weightage considered for various features, it can be concluded that MSTR is the best tool for reporting and deployment purposes and Tableau is the best for data visualization. However, this

Table 4. Dashboard Features and Purpose

TYPE	PURPOSE				FEATURES	
	Consistent	Monitor	Analysis	Communication	Visual Features	Functional Features
Strategic	Improves business procedure, Tracking KPI's	Monitoring the performance of organization	Improve the planning for the future scope of organization		Fits single screen, Overlay of grids	Graphs (bar, pie, gauge), Time horizon

Analytical	The standardization of the service	The performance of management is self-monitored, understanding employee's performance and analyzing the trend over a period of time to summarize the information.	Improvement in decision making of the departments	Operational level can be communicated from this type	Fits single screen	Graphs (historical, Fusion, bar, gauge chart), Drag and drop, Drill down, Scenario analysis, Alert mechanisms
Operational	The consistency of analysis and speed increases and transparency of information maintained	Monitor activities, individuals and group information and also detect relevant information	Analyzes user's information and also learns the analytics and the effects.	Performance feedback provided along with extraction of information of entire team at one place.	Fits single screen	Graphs (line, bar, pie, Network, gauge, trend), Table, Filter, Badge, Alert mechanisms

6. CONCLUSIONS

At first glance, dashboards, customized visualizations with graphs, grids and charts, can seem comparatively simple and may seem to have very few technical challenges. This simplicity can be highly deceptive since creation of dashboards demand highly sound technical knowledge and data warehousing concepts. Dashboards are very important in this world which is greatly data driven. Numerous organizations, businesses and end-users rely on dashboards to gain insights and to take decisions. Some dashboard designers focus on a single tool to deliver all requirements which fails to satisfy user needs.

Hence by diving into the comparison among various types of dashboards, their features, the different tools used to create them and by choosing appropriately, one can arrive at insightful results which play a major role in business performance, growth, effective monetary utilization and gain.

7. REFERENCES

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