

RECOMMENDATION OF BUSINESS INTELLIGENCE TOOL

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Ramneet Chhina

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By

Ramneet Chhina

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North Dakota State University's regulations and meets the accepted standards
for the degree of

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SUPERVISORY COMMITTEE:

Kendall E. Nygard
Chair

Kenneth Magel

Dean Knudson

Fred Riggins

Approved:

03/30/2016
Date

Brian Slator
Department Chair

ABSTRACT

Business Intelligence (BI) is extremely vital for organizations for delivering useful information from the large volumes of data being collected. There are many BI tools available but no single tool is appropriate for every user's need. Project needs can differ within and across organizations so a process is needed to determine the right tools to use. If companies end up with the wrong tool their needs and problems are not addressed.

This research evaluates five tools from the Microsoft BI stack using an application that has been developed and recommends the best tool to use.

The tool recommended depends on the BI style most desired. It also depends on the skill of the users using the tool.

The application guides a team in comparing and selecting the correct tool. This is a start towards developing a full-fledged application that can be used across platforms in finding the right tools.

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CHAPTER 1. INTRODUCTION

This chapter highlights the Problem Description and describes the motivation behind the research conducted. The chapter closes with an outline of this paper along with its major research contribution.

1.1. Problem Description

The problem described in this paper is the need to develop a “decision-making application” that would guide a project manager, functional expert, power user or any other IT team member in comparing and selecting the correct Microsoft Business Intelligence Technology tool.

The application should meet the following objectives:

- Users should be able to rate features of the Business Intelligence (BI) tools based on how important those features are for their projects.
- Based on the user’s rating, the decision-making application should show the graphical representation of total scores for different tools from which a user has to choose.
- In addition to the features desired in the tool, the user can also use the skill level of the stakeholder who will be actually using the tool to determine the best tool for his/her needs.
- The decision-making application should list the different BI styles and each tool’s features to help the users with tool selection.

Business Intelligence (BI) is a process that collects and parses massive chunks of data and outputs specific and useful information which the organization can then use.

Initially Business Intelligence didn’t gain much traction in the industry. Organizations considered it to be optional and instead made decisions based on their instincts.

Organizations in the industry today use the data collected as part of their decision making process to improve the business. This data collected has to be refreshed continuously and meaningful information needs to be parsed from it. This up-to-date useful data is then used by senior management to drive the business.

Organizations collect large volumes of data. They use transactional systems and processes whose purpose is to quickly add new data, update it or delete it. These systems are not ideal for reporting as data is stored in a normalized form. This is where BI comes into the picture.

Using BI users can monitor the health of their business over a period of time. The process drives these systems rather than data. It also allows us to analyze data from different perspectives.

BI allows us to identify waste and it can detect fraud as well. It provides meaningful information to all the management levels to take the appropriate corrective action at each of these levels. It leads to better service, improved strategy, greater accuracy, faster delivery and enhanced decision-making. It allows us to perform advanced reporting and analysis on the data collected. We can even compare data to improve the business tactics. It also quickly notifies us about business exceptions.

All the data collected to do BI is stored in a data warehouse. It is populated from various data sources and it is structured so that it stores aggregated data easily. This aggregated data allows us to return information easily and quickly.

BI tools are computer programs that implement a particular BI technique [24]. The techniques are categorized three ways:

- Reporting and analysis tools: read data, process and format it into structured reports that are delivered to users. They are used primarily for assessment [24].
- Data-Mining tools: process data using statistical techniques, search for patterns and relationships, and make predictions based on results [24].
- Knowledge-management tools: store employee knowledge; make it available to whoever needs it. Their source is human knowledge [24].

There are many vendors providing BI platforms in the market today some of which have a great market share and an established track record. We are going to only consider the Microsoft BI solution for the purpose of this paper as it is the most popular business productivity suite and the most widely deployed information platform.

We are only going to consider Reporting and analysis tools from the Microsoft BI stack for analysis in this paper.

Companies need to select the proper reporting and analysis tools that can work best with their data and provide the relevant information whenever it's needed. Due to the large number of tools available in the market today, it's difficult to select the right one. But, no single business intelligence tool is appropriate for every user's need. Project needs can differ within and across organizations so a process is needed to determine the right tools to use. Microsoft provides a variety of tools, Microsoft Excel and Excel Services, Microsoft Power Pivot, Microsoft SQL Server Reporting Services (including Power View), and Microsoft SharePoint PerformancePoint Services, to address various reporting and analysis styles.

If companies end up with the wrong BI reporting and analysis tool, they not only pay high licensing costs, but also suffer loss as their objective of conducting business intelligence is

not fulfilled. Therefore, there is a critical need to evaluate and select the correct BI reporting and analysis tool based on project needs.

1.2. Motivation

Last year I worked as a SQL developer on a project in Montgomery, Alabama for the Alabama Department of Rehabilitation Services (ADRS). They were making use of the Microsoft BI solution platform and had created a data-warehouse for their BI analysis needs using SQL Server Integration services (SSIS). They had also built cubes using SQL Server Analysis Services (SSAS).

They wanted numerous reports generated on top of these data sources for their analysis purposes. I worked on building these reports for them using the different Microsoft BI tools available. Having not had prior experience working with any of these tools besides Excel, I was not aware of the pros/cons for each. I did not know the best tool to use to generate a particular report and had to toil with different tools before I found just the right one for my needs. While working with these different tools, I discovered the limitations and shortcomings of each. I was able to build a broader picture of the applicability of each tool for the different reports that were desired.

Discovering this valuable information on my own through my hit and trial approach, I wasted considerable time and resources which would have been otherwise spent on report development. If a tool was available where I could provide my specific report requirements and it could give me back the best possible tool to use, I would have been a lot more productive. Using such a tool, I would have been able to generate many more reports in the time-frame that I had and the client would have been even happier.

Such a tool would have been useful to me as a developer, and also to the power users and business users working on the project. Therefore, I believe careful selection of the BI tool is very critical and a tool which does this exact thing is a necessity for anybody working in the Microsoft BI world.

1.3. Research Question and Major Contribution

The main research question addressed by this paper is as follows: What approach should a user take to select the BI tool, and how will the “decision-making application” be built so that the user selects the correct BI tool based on the project needs?

There has been existent work done to address this research question. Microsoft and Hitachi Consulting have written two technical white papers to solve this problem.

The first paper authored by John Lauer, Jeff Nelson and Victor Rocca [1] applies to SQL Server 2008 R2. This white paper discusses five different BI reporting styles which are Self-Service Analysis, Business Reporting, Parameterized & Operational Reporting, Performance Monitoring and Scorecarding. It provides readers a practical guide on how to identify which tools best fit each of these styles.

The second paper authored by John Lauer, Scott Cameron, Jeff Nelson and Victor Rocca [2] applies to SQL Server 2012. This white paper discusses five BI reporting styles which are Self-Service Reporting and Analysis, Self-Service Data Mashups, Professional Reporting, Performance Monitoring (Dashboards) and Scorecarding. It helps business and IT decision makers select the right Microsoft reporting and analysis front-end tools based on these styles.

There are numerous other blogs on the internet where different experts have given their opinion as to which is the best tool to use in a particular situation and the pros/cons of using each.

Although all the authors [1] [2] did a very good job identifying the BI tools and comparing them based on different styles, no application was developed to help users do an analysis of these BI tools. Project needs can differ from company to company and from industry to industry. Project designers might want to consider a custom BI reporting style and see what tool best fits their needs. These papers discuss tool selection using case studies that were conducted which present the readers with a lot of textual information to navigate through to get the results that they require. Traversing a forty page paper to get the response required is not something ideally that readers would wish to do.

There are many applications developed on the market in other areas that take a user's input and recommend a solution based on the need. One such application is the Brooks shoe finder online tool that helps a user find the right shoe to fit their running style and feet. However, the application is not user friendly. It does not provide enough information for the user that would help when selecting the right pair of shoes. There is no quantitative data provided to user that would show why a particular shoe was suggested by the shoe finder tool [3].

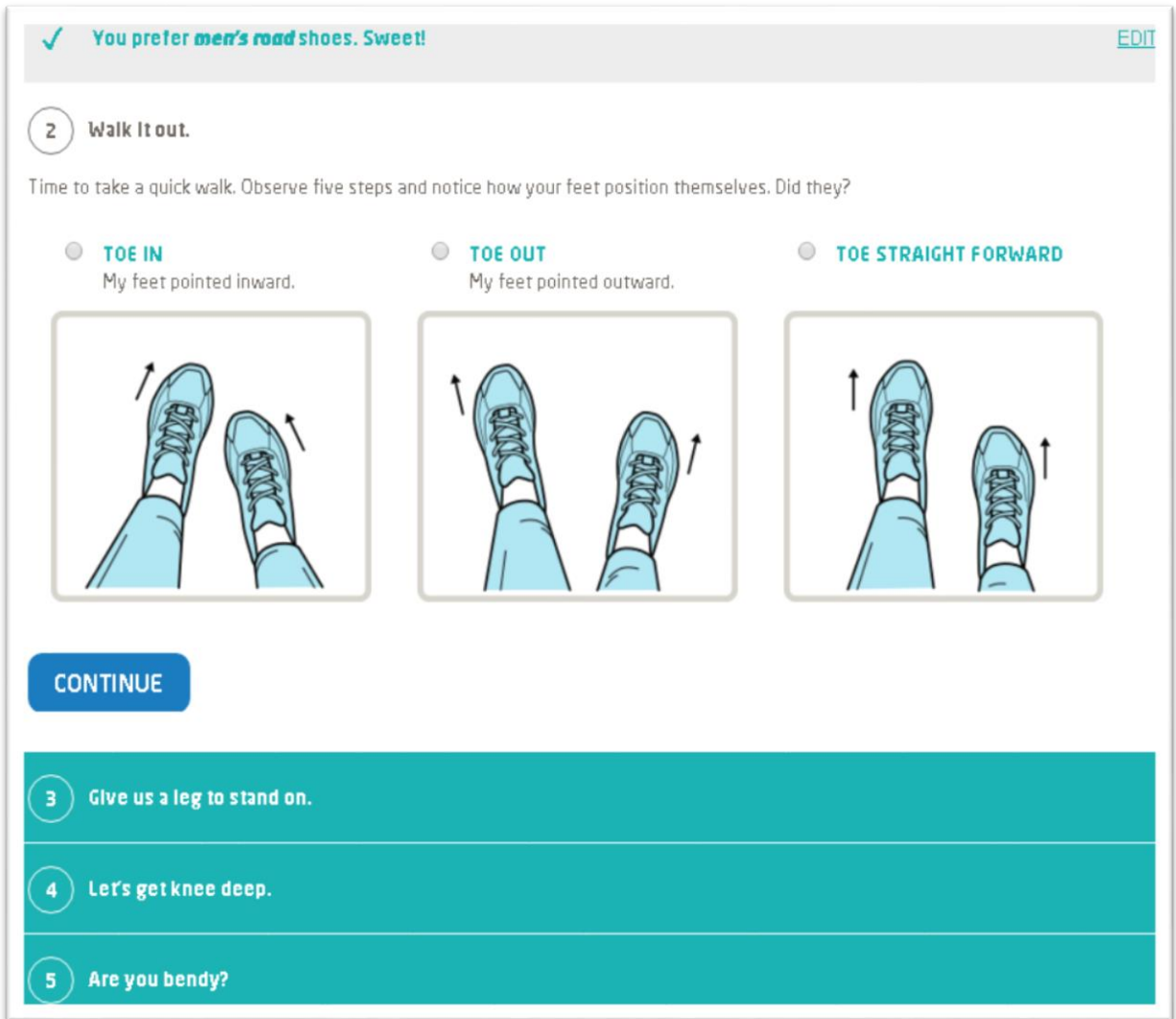


Figure 1.1. Brooks Shoe Finder Tool

Figure 1.1. shows the user interface for the shoe finder tool. A user selects different criteria by selecting the different options; however, there is no option for the user to rate the criteria by importance. The shoe finder tool has a database that stores all the different shoes. The tool returns the list of shoes to a user; however, the tool does not have an option for the user to compare the shoes to see what unique criteria they have among them.

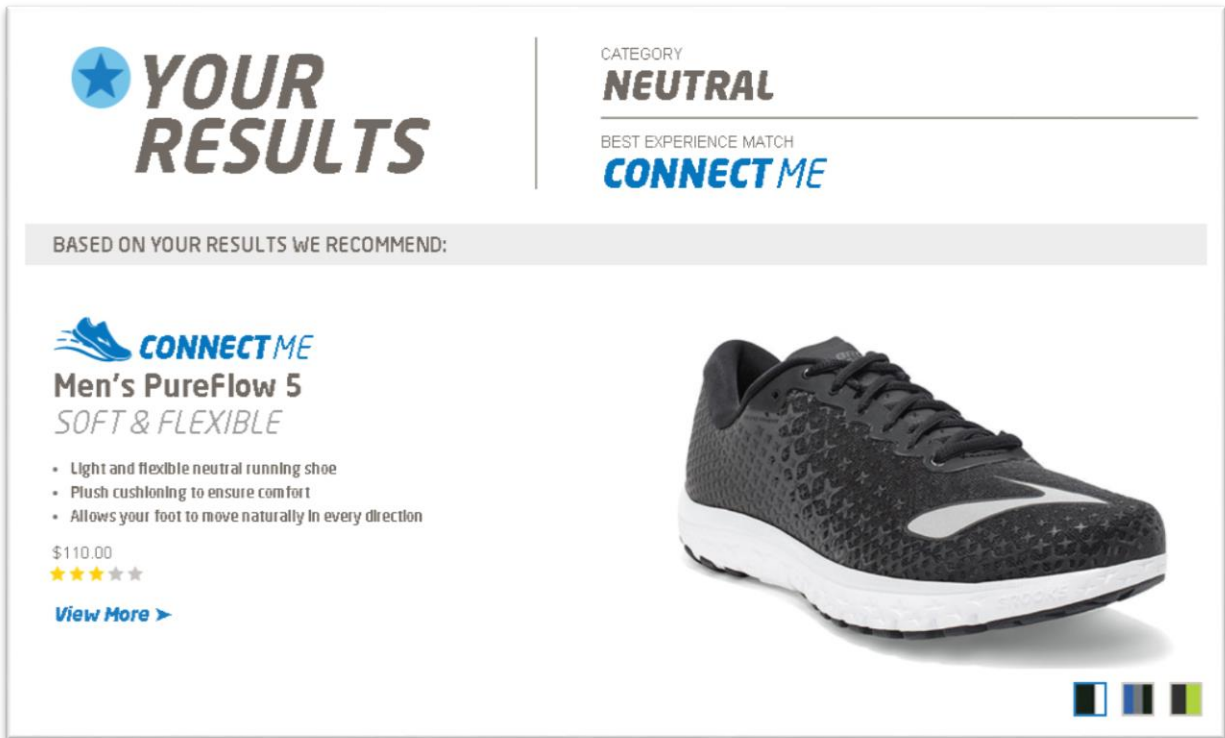


Figure 1.2. Result of Brooks Shoe Finder Tool

Figure 1.2. shows the results a user obtains when the user provides all the options. The result is not dynamic; the user has to go back and make changes to the selections that were made previously to obtain the new results.

The main idea in this research is, therefore, to develop an application that will guide a user in selecting the correct BI tool and that will serve as an informative decision-making tool for user. The idea is also to develop this application in such a way that it can be extended to compare multiple tools with different BI styles in the future.

1.4. Paper Organization

Excluding this chapter, the remainder of the paper is organized in the form of five chapters.

Chapter 2 focuses on the Business Intelligence Concepts and identifies the importance of the BI tool in the software industry.

Chapter 3 discusses five different BI tools. The chapter also highlights general guidelines that a user should keep in mind when selecting a BI tool.

Chapter 4 describes the approach taken to develop a decision-making application. The chapter begins by describing different styles that a BI tool can support. The chapter then discusses two different options from which a user can choose to select the best tool for his needs. The first option is selecting a tool based on the tool's total style score; and the second one is selecting a tool based on the user's skill set. The chapter also focuses on the functionalities provided in the application as well as the technology used.

Chapter 5 reports the Research Results and builds on the insights gained in Chapter 4.

Chapter 6 concludes the paper by summarizing the major result. In addition, several techniques are described for improving the decision-making tool and are intended as a guide for future researchers who wish to extend and build upon this paper.

CHAPTER 2. BUSINESS INTELLIGENCE

The chapter gives a background of Microsoft SharePoint which is the platform in which Microsoft Business Intelligence solutions are rendered. It also discusses the different Business Intelligence styles and briefly describes the need for a business intelligence tool.

2.1. SharePoint and Business Intelligence

Microsoft SharePoint is a software platform and a family of software products developed by Microsoft for collaboration, file sharing and document management. It can be used to provide intranet portals, social networks, extranets, websites, enterprise search, and business intelligence. It also has system integration, process integration, and workflow automation capabilities [4].

SharePoint evolved from projects codenamed “Office Server” and “Tahoe” during the Office XP development cycle. The first version to come out was Microsoft SharePoint Portal Server 2001 followed by Microsoft SharePoint Team Services (2002). This was followed by SharePoint 2003 which included Windows SharePoint Services 2.0 (free license) and Microsoft SharePoint Portal Server 2003 (commercial release). Then came a new version in 2007 which included Windows SharePoint Services 3.0 (free license) and Microsoft Office SharePoint Server 2007 (commercial extension). Next in line was Microsoft SharePoint Foundation 2010 (free) with Microsoft SharePoint Server 2010 (commercial extension for Foundation), and SharePoint Enterprise 2010 (commercial extension for Server). Finally we now have Microsoft SharePoint Foundation 2013 with Microsoft SharePoint Server 2013 [5].

This paper deals with only the 2010 versions of SharePoint and specifically the SharePoint Server 2010 edition. This edition has capabilities relating to BI integration. The BI components in this edition are the following:

- Office

- SharePoint Designer
- Visio
- Access
- Excel
- SharePoint
 - Chart Web Part
 - Analytics
 - Performance Point Services
- SQL
 - Reporting and Analytics
 - Power Pivot

We can combine publish Excel workbooks to SharePoint using Excel services in SharePoint. This allows all users to work with one copy of the data and it also provides versioning capabilities. Power Pivot provides two add-ins; one for Excel which is free and another for SharePoint. Adding PowerPivot to Excel allows users to work with large data sets in a tool that they are already familiar with. Power View is a new feature introduced in SQL Server 2012 Reporting services that is easily launched from within SharePoint itself. It allows users of all skill sets to create highly formatted reports using drag and drop techniques. SQL Server 2012 Reporting services is a great tool for automatic report generation and distribution. It creates pixel-perfect reports that can be printed and exported to Word, Excel, PDF, XML and HTML etc. PerformancePoint Services allow us to build dashboards and scorecards that pull data from different data sources like SharePoint lists, relational databases, OLAP cubes, and Excel

spreadsheets etc. Dashboards include reporting services reports, cube graphs, analytical charts, decomposition trees, Visio diagrams etc.

2.2. Business Intelligence Styles

A BI style describes how users want to interact with, present, and share information. These styles are defined in part by a user's or group of users' unique information needs, along with the organization's existing reporting capabilities, infrastructure, and skillsets of both business users and IT [2].

This paper discusses five different reporting and analysis styles:

- **Self-Service Reporting and Analysis** – Self-service reporting and analysis empowers users who don't have specialized skills to explore data and experiment with presenting information in a variety of ways. They can discover new insights, find persuasive ways to display data, and share their reports and presentations with colleagues without having to rely on IT or others [1].
- **Self Service Data Mashups** – Data Mashups are created by combining data from multiple sources: a data warehouse, reports, spreadsheets, web sites, and so on. After the data is coalesced, analysts will want to gain deeper insights by pivoting and drilling down into the information. These business users need to be able to work independently of IT because Data Mashups must often be performed quickly, or they may only be used for one-time analysis [1].
- **Professional Reporting** – Professional reporting is characterized by highly formatted reports that usually follow a pixel-perfect format and rendering style and are deployed to an IT managed environment that provides consistency, scalability, manageability, security, and automated distribution [1].

- Performance Monitoring (Dashboards) – This style describes dashboard-style reports that enable users to quickly and easily monitor the performance of their business. This style is catered to executive level or department leadership who require at-a-glance visibility on the health of the business, but it often also permits further investigation via interactivity [1].
- Scorecarding – Scorecarding is a style that describes highly summarized views with key performance indicators (KPIs) measured and scored against predefined targets such as a balanced scorecard. This style is generally a part of a performance management program, though it can also be used to measure operational performance [1].

2.3. Why do we need a Business Intelligence tool?

Information is extremely vital in all decision-making today. Information collected should be shared with every business unit and employee so they can do appropriate analysis and reporting on it and take appropriate corrective action. Back in the day this information was only shared with senior management. They could analyze and monitor how the business was doing and use this information to do decision-making.

Due to the vast quantities of data being collected, management is struggling to keep pace and they are finding it harder and harder to extract useful information from this data to run the business. Market changes more quickly today so decisions have to be taken even quicker. Management needs efficient processes and tools that keep the different business units in sync and working towards the same organizational goals.

Organizations these days expect all their employees to be aware of organizational goals. The expectation is that everyone needs to take ownership of managing their own unit or role. This is unrealistic though as users don't have sufficient time to parse through every organization

data source. Moreover most users don't even have access to this information that they could use for self-management.

Even the data that is collected is useless for decision making, its intended purpose, without a way of organizing and displaying it as meaningful information. Businesses need tools that can help them analyze this data. And when it comes to using this data, visualizations and Infographics are some of the best ways to present the data. Using Business Intelligence tools we can analyze the business and monitor its performance. These tools merge data from all the organizational data sources and extract useful information from it. These tools use various data visualizations to show the patterns, trends and problems that require attention. It allows management to set targets and objectives for different units and then monitor the progress over different periods. Using these tools the organization can do better and quicker forecasting and decision-making.

CHAPTER 3. SELECTING THE BUSINESS INTELLIGENCE TOOL

Selecting a BI tool is a complex task. It is challenging to say the least as data could come from a variety of sources. Moreover we also have to consider the skill set of the user base that will be using the tool. As a result it is a very time-consuming process to evaluate and select the different BI styles that meet a project's need. This chapter highlights some of the BI tools that provide clear, concise results using data and information integrated from various sources. A rigorous amount of effort is needed to be spent selecting the right tool when we're developing large enterprise level solutions. Customers are happy only when we deliver the product that meets their expectations.

3.1. Tool Options

For the purpose of this paper, we're considering the five tools that are part of the Microsoft BI stack for reporting and analysis.

Microsoft Excel 2010

Microsoft SQL Server 2012 PowerPivot

Microsoft SQL Server 2012 Reporting Services Power View

Microsoft SQL Server 2012 Reporting Services

PerformancePoint Services

3.1.1. Microsoft Excel 2010

“Microsoft Excel is the most widely deployed BI tool in the world for the self-service reporting and analysis style. Virtually all users are familiar with Excel, and this is a comfortable environment for analyzing data and developing reports quickly [2].

Excel can be used to explore data and create reports using SQL Server Analysis Services, SQL Server, and other data sources. In particular, Excel is an excellent tool to use to analyze

Analysis Services data because Excel PivotTables and PivotCharts make available all of Analysis Services features [1].

Excel reports can be distributed to others via email or published to SharePoint Server and viewed by using Excel Services in Microsoft SharePoint Server 2010. [2]”

3.1.2. Microsoft SQL Server 2012 PowerPivot

“SQL Server 2012 PowerPivot for Excel 2010 and SQL Server 2012 PowerPivot for SharePoint are new versions of complementary technologies that, combined with Excel 2010, enable managed self-service analysis. They provide for self-service data mashups and analysis, collaboration, and the ability to transition a PowerPivot workbook to an IT managed solution with minimal rework [1].

PowerPivot for Excel is available as a free add-in to Excel 2010. PowerPivot builds on top of Excel functionality and adds additional features to empower users to perform managed self-service analysis. With PowerPivot, users can easily collect, interact with, and manipulate data from a broad range of sources, as well as work with data sets far larger than the Excel 2010 limit of just over 1 million rows per sheet. PowerPivot can scale to millions and even hundreds of millions of rows. [2]”

3.1.3. Microsoft SQL Server 2012 Reporting Services Power View

“Power View, a new feature in SQL Server 2012 Reporting Services, enables users of all skill levels to explore their data and easily create highly formatted reports containing sophisticated visualizations [1].

Power View supports self-service analysis by empowering users to perform reporting and analysis tasks that previously required the skill set of a professional report developer. A user can

easily analyze data from PowerPivot or Analysis Services 2012 using drag-and-drop techniques [1].

Reports in Power View are created in an environment that is familiar and easy to use. It is an interactive web-based application launched from SharePoint Server 2010, and it uses the familiar Microsoft Office ribbon. [1]”

3.1.4. Microsoft SQL Server 2012 Reporting Services

“Microsoft SQL Server Reporting Services provides a complete, server-based platform designed to support a wide variety of reporting needs, enabling organizations to deliver relevant information where needed across the entire enterprise. Through a powerful report authoring and management environment, Reporting Services enables IT to create and manage both static and parameterized reports and provides a solid platform for delivering information throughout the organization. The same report can be made available via portal or automatically generated and distributed via Reporting Services [1].

The reports can be delivered via portal, file share, or email, or they can even be sent directly to a printer, and they can be generated as PDF, Excel, XML, comma-delimited text file, TIFF image, HTML or Microsoft Word formats. [2]”

3.1.5. PerformancePoint Services

“The PerformancePoint Services component of Microsoft SharePoint Server 2010 is a performance management tool that is used to create dashboards and scorecards. By providing flexible, easy-to-use tools for building dashboards, scorecards, reports, and key performance indicators (KPIs), PerformancePoint Services can help users across your organization make informed business decisions that align with companywide objectives and strategy.

PerformancePoint Services provides the ability to pull multiple types of data visualizations into a

single dashboard. Users can interact with Reporting Services reports, cube-based graphs, performance maps, decomposition trees and Microsoft Visio diagrams. [2]”

3.2. Guidelines for selecting the Business Intelligence tool

Before selecting a particular tool to use the user must be familiar with the functionality of the tool itself. The user should know the pros and cons as well as the nitty-gritty details. This should help in figuring out as to how the tool will fit into the existing business intelligence solution delivery model.

The user should take note of how the current process works without using any tools. If the current process is effective, then it will contribute towards the effectiveness of the tool being imported. Another factor to be considered is how the existing business intelligence solutions will be modified to incorporate the use of the new tool.

Some other questions of interest are:

What governance needs to be placed around the use of the new tool?

Who will be responsible for setting such governance?

Who will be responsible for selecting the tool for any given project?

Is there going to be a formal process in place to pick the responsible user?

Are the results of any such process going to be documented somewhere?

Are all the existing business intelligence solutions going to be migrated to use the new tool? If not all then which ones? Again who decides which ones and is there going to be a process for this as well?

Is senior management in favor of/against using a particular tool?

Most importantly we need to know the skill set of the user that is going to use the tool. The user could be the resource in IT that is using the tool to build the solution or an end-user

who is going to be using the tool directly to meet his/her reporting needs. This is an extremely important step in picking the right tool to use.

CHAPTER 4. RESEARCH APPROACH FOR DEVELOPING THE DECISION MAKING APPLICATION

This chapter is dedicated to the main research task of building a decision making application/tool that would guide an IT stakeholder in comparing and selecting the correct Microsoft Business Intelligence Technology tool.

To build this application, we'll first list out the different features that such an application should have and then group these into the appropriate BI style.

4.1. Features in the Business Intelligence Tool

Businesses today collect large amounts of data. In the past, only senior management was privy to data that could help them understand how the business was performing. Management needs efficient processes and tools that keep the different business units in sync and working towards the same organizational goals. Organizations these days expect all their employees to be aware of organizational goals. The expectation is that everyone needs to take ownership of managing their own unit or role. Businesses need tools that can help them analyze this data. And when it comes to using this data, visualizations and Infographics are some of the best ways to present the data.

The different features/characteristics considered for this paper are listed below.

These features have been assembled from the characteristics of the five different BI styles considered in the paper "How to Choose the Right Reporting and Analysis Tools to Suit Your Style" [1]. This paper does a really good job of identifying the different features that a tool belonging to a particular style should have. This paper is catered to the Microsoft BI stack and the tools that it provides which include the five tools being considered in this paper. Hence it is a

great source to use for getting a feature list that would be desired by users planning to use these tools.

Different BI Features

- Ability to be used by executives, managers, information workers, and analysts.
- Allows quick reports and data visualizations creation.
- Allows users to drill down, pivot, filter, and present the data in tables, charts, and other visualizations.
- Allows users to include their reports and visualizations in presentations or informally share them with other team members.
- Allows use of drag-and-drop report design interfaces.
- Allows information to be distributed on a regular basis.
- Allows analysis of large data sets.
- Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX).
- Allows access to enterprise, department, and external and personal data sources.
- Allows users to work independently of IT.
- Allows commonly used reports to be migrated to formal IT support and management.
- Allows data to be refreshed automatically.
- Allows creation of highly formatted reports.
- Allows reports to be frequently printed.
- Allows reports with parameterized filtering and sorting.
- Allows advanced report creation using SQL, MDX, or other query languages.
- Allows automatic distribution of reports via email.

- Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML.
- Allows reports to be embedded in line-of-business applications.
- Allows reports that provide an at-a-glance view of business performance.
- Allows reports provide a more holistic view of the business or business function by combining multiple types of content together.
- Allows data in multiple formats to be combined on one page.
- Allows users to perform root-cause analysis for data anomalies.
- Allows highly customizable and formattable dashboards.
- Allows highly interactive dashboards.
- Allows highly formatted printing for dashboards.
- Allows integration with non-corporate data sources for dashboards.
- Allows advanced visualizations for dashboards.
- Allows identification of KPIs and their monitoring against articulated targets.
- Allows reports that provide an overall score for an organization, department, or individual's performance.
- Allows reports that present business objectives and their related KPIs hierarchically and can be filtered to help determine root causes of outliers.
- Allows custom aggregations, weightings, and threshold configurations.
- Allows KPIs that drive navigation of other report styles in the dashboard.

All the features listed above are categorized into different BI styles. This categorization helps the users while rating the different features/characteristics. The features according to the styles are shown below.

This grouping again takes advantage of the paper “How to Choose the Right Reporting and Analysis Tools to Suit Your Style” [1]. This paper considers each one of our five tools and specifies the different features that each one has. These features and tools are grouped by the BI style that they belong to.

Different BI Features according to BI styles

- Self-Service Reporting and Analysis
 - Ability to be used by executives, managers, information workers, and analysts.
 - Allows quick reports and data visualizations creation.
 - Allows users to drill down, pivot, filter, and present the data in tables, charts, and other visualizations.
 - Allows users to include their reports and visualizations in presentations or informally share them with other team members.
 - Allows use of drag-and-drop report design interfaces.
 - Allows users to work independently of IT.
 - Allows analysis of large data sets.
 - Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX).
- Self Service Data Mashups
 - Allows access to enterprise, department, and external and personal data sources.
 - Allows users to easily drill down, pivot, filter, and format data.
 - Allows users to work independently of IT.
 - Allows analysis of large data sets.
 - Allows data to be refreshed automatically.

- Allows commonly used reports to be migrated to formal IT support and management.
- Allows advanced report creation using SQL, MDX, or other query languages.
- Professional Reporting
 - Allows creation of highly formatted reports.
 - Allows reports to be frequently printed.
 - Allows reports with parameterized filtering and sorting.
 - Allows information to be distributed on a regular basis.
 - Allows users to easily drill down, pivot, filter, and format data.
 - Allows analysis of large data sets.
 - Allows data to be refreshed automatically.
 - Allows advanced report creation using SQL, MDX, or other query languages.
 - Allows automatic distribution of reports via email.
 - Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML.
 - Allows reports to be embedded in line-of-business applications.
- Performance Monitoring (Dashboards)
 - Allows reports that provide an at-a-glance view of business performance.
 - Allows reports provide a more holistic view of the business or business function by combining multiple types of content together.
 - Allows data in multiple formats to be combined on one page.
 - Allows users to perform root-cause analysis for data anomalies.
 - Allows highly customizable and formattable dashboards.

- Allows highly interactive dashboards.
- Allows highly formatted printing for dashboards.
- Allows integration with non-corporate data sources for dashboards.
- Allows advanced visualizations for dashboards.
- Allows users to easily drill down, pivot, filter, and format data.
- Allows advanced report creation using SQL, MDX, or other query languages.
- Allows analysis of large data sets.
- Allows data to be refreshed automatically.
- Allows information to be distributed on a regular basis.
- Scorecarding
 - Allows analysis of large data sets.
 - Allows data to be refreshed automatically.
 - Allows information to be distributed on a regular basis.
 - Allows advanced report creation using SQL, MDX, or other query languages.
 - Allows identification of KPIs and their monitoring against articulated targets.
 - Allows reports that provide an overall score for an organization, department, or individual's performance.
 - Allows reports that present business objectives and their related KPIs hierarchically and can be filtered to help determine root causes of outliers.
 - Allows broad deployment and easy consumption and navigation with a browser.
 - Allows custom aggregations, weightings, and threshold configurations.
 - Allows KPIs that drive navigation of other report styles in the dashboard.

4.2. Business Intelligence Tool Evaluation

The next step in the approach is to list the different features that each BI tool provides.

This information is highly critical as it is then used to calculate the different scores for each tool.

This helps the user in identifying the right tool to use for their needs. Table 4.1. lists the features for each tool.

This list of BI tool features has been created from the different BI style descriptions and tool functionality descriptions considered in the paper “How to Choose the Right Reporting and Analysis Tools to Suit Your Style” [1]. This paper describes the functionalities that make up the different BI styles and the tools that are part of it.

Table 4.1. BI Tool Features

<u>Feature</u>	Business Intelligence Tools				
	<u>Microsoft Excel 2010</u>	<u>Microsoft SQL Server 2012 PowerPivot</u>	<u>Microsoft SQL Server 2012 Reporting Services Power View</u>	<u>Microsoft SQL Server 2012 Reporting Services</u>	<u>Performance Point Services</u>
Ability to be used by executives, managers, information workers, and analysts	✓	✓			
Allows quick reports and data visualizations creation	✓	✓			
Allows users to drill down, pivot, filter, and present the data in tables, charts, and other visualizations	✓	✓	✓	✓	✓

Table 4.1. BI Tool Features (continued)

<u>Feature</u>	Business Intelligence Tools				
	<u>Microsoft Excel 2010</u>	<u>Microsoft SQL Server 2012 PowerPivot</u>	<u>Microsoft SQL Server 2012 Reporting Services Power View</u>	<u>Microsoft SQL Server 2012 Reporting Services</u>	<u>Performance Point Services</u>
Allows users to include their reports and visualizations in presentations or informally share them with other team members	✓				
Allows use of drag-and-drop report design interfaces	✓	✓	✓	✓	✓
Allows information to be distributed on a regular basis				✓	✓
Allows analysis of large data sets		✓	✓	✓	✓
Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX)	✓		✓		
Allows access to enterprise, department, & external & personal data sources	✓	✓			
Allows users to work independently of IT	✓	✓	✓		
Allows commonly used reports to be migrated to formal IT support & management		✓			

Table 4.1. BI Tool Features (continued)

<u>Feature</u>	Business Intelligence Tools				
	<u>Microsoft Excel 2010</u>	<u>Microsoft SQL Server 2012 PowerPivot</u>	<u>Microsoft SQL Server 2012 Reporting Services Power View</u>	<u>Microsoft SQL Server 2012 Reporting Services</u>	<u>Performance Point Services</u>
Allows data to be refreshed automatically		✓	✓	✓	✓
Allows creation of highly formatted reports				✓	
Allows reports to be frequently printed				✓	
Allows reports with parameterized filtering and sorting				✓	
Allows advanced report creation using SQL, MDX, or other query languages		✓		✓	✓
Allows automatic distribution of reports via email				✓	
Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML				✓	
Allows reports to be embedded in line-of-business applications				✓	
Allows reports that provide an at-a-glance view of business performance					✓

Table 4.1. BI Tool Features (continued)

<u>Feature</u>	Business Intelligence Tools				
	<u>Microsoft Excel 2010</u>	<u>Microsoft SQL Server 2012 PowerPivot</u>	<u>Microsoft SQL Server 2012 Reporting Services Power View</u>	<u>Microsoft SQL Server 2012 Reporting Services</u>	<u>Performance Point Services</u>
Allows reports provide a more holistic view of the business or business function by combining multiple types of content together					✓
Allows data in multiple formats to be combined on one page					✓
Allows users to perform root-cause analysis for data anomalies					✓
Allows highly customizable and formattable dashboards	✓	✓		✓	
Allows highly interactive dashboards					✓
Allows highly formatted printing for dashboards				✓	
Allows integration with non-corporate data sources for dashboards	✓	✓			✓
Allows advanced visualizations for dashboards					✓

Table 4.1. BI Tool Features (continued)

<u>Feature</u>	Business Intelligence Tools				
	<u>Microsoft Excel 2010</u>	<u>Microsoft SQL Server 2012 PowerPivot</u>	<u>Microsoft SQL Server 2012 Reporting Services Power View</u>	<u>Microsoft SQL Server 2012 Reporting Services</u>	<u>Performance Point Services</u>
Allows identification of KPIs and their monitoring against articulated targets					✓
Allows reports that provide an overall score for an organization, department, or individual's performance					✓
Allows reports that present business objectives and their related KPIs hierarchically and can be filtered to help determine root causes of outliers					✓
Allows custom aggregations, weightings, and threshold configurations					✓
Allows KPIs that drive navigation of other report styles in the dashboard					✓

4.3. Business Intelligence Tool Selection

The next step is to calculate the total score for each BI tool from the user's selection.

Users can rate features on a scale of 0-5 where '0' indicates a least-important or not required feature and '5' indicates a very important feature that the user wishes the tool has.

In this study, the users assign ratings to the different features. Based on these user ratings, a total score is calculated. Based on this score calculation, the application shows a graphical representation (Bubble chart, Radar chart, Pie chart and Column chart) to demonstrate the total scores for the different BI tools.

Let's do an example of how total scores would be calculated for the different BI tools based on a user's feature selections. We will only consider three tools (Power View, Excel and PerformancePoint) for comparison to keep things simple. Let's assume that the user is only rating five features. Table 4.2. below lists the five features as well as the ratings provided by the user for each of these features:

Table 4.2. Total Score Calculation

Feature ID	Feature Name	User Rating (0-5)
1	Allows identification of KPIs and their monitoring against articulated targets	4
2	Allows reports that provide an overall score for an organization, department, or individual's performance	5
3	Allows users to drill down, pivot, filter, and present the data in tables, charts, and other visualizations	4
4	Allows KPIs that drive navigation of other report styles in the dashboard	5
5	Allows users to include their reports and visualizations in presentations or informally share them with other team members	5

The total score for any tool is the sum of the user ratings for all the features that it contains. We know that Power View only has **Feature ID 3** in its functionality. So its total score

would be 4. Excel has **Feature ID 3** and **Feature ID 5**. So its score would be $4+5 = 9$.

PerformancePoint has **Feature ID 1**, **Feature ID 2**, **Feature ID 3** and **Feature ID 4**. So its total score would be $4+5+4+5 = 18$.

Since Total Score (PerformancePoint) > Total Score (Excel) > Total Score (Power View), **PerformancePoint** would be the recommended tool to use for these features and user ratings.

These total scores for each tool are then used to plot a Bubble chart, Radar chart, Pie chart and a Column chart to graphically represent the appropriate tool to use.

Another consideration for selecting the right tool is the skill set of the user that is available in the organization to use the BI tools. Some tools need skilled IT personnel in the organization to set up and use them. There are also tools that need Power (Super) users while others can be authored by even the business folks.

The application plots a Point chart to show the appropriate user skill set required to use a particular tool.

4.4. User Decision

If the organization has a mature IT division with skilled personnel to handle any BI tool it makes the choice much simple. In that scenario the stakeholders can simply rate the features desired in individual projects and then the application would recommend the best tool to use simply based on the total scores calculated. The best tool recommended could require an IT user, a Power user or even a Business user but that would be a non-factor in this scenario as the organization has all of these. Therefore, in this case the organization can simply make the decision based on total tool score without considering user skill set.

Let's take the example discussed in the previous section. If the ratings above were provided by the users in this organization, then the application would clearly recommend

PerformancePoint as the tool to use for their needs based on total score. The skill set of users does not come into consideration and the organization can simply pick PerformancePoint as their BI tool.

On the other hand if an organization does not have a mature IT division to support all BI tools the choice gets a bit tougher. In this scenario the stakeholders can first use the **Recommended Tool by User Skill Set** tab in the application to see the best tools available for the skill set of the users that they have. Once they have this list of tools, they can go back to the **Recommended Tool by Features** section and simply rate the features desired. The application would provide the best tools to use based on their total scores. The users can check the total scores of the tools on their list of tools from the skill set tab. They can then easily pick the tool with the highest score from their list. This would be the best tool to use based on the skill set of the users that they have.

Let's take the example discussed in the previous section. If this organization only had Business users and Power users then the **Recommended Tool by User Skill Set** tab in the application would tell them that for that skill set the choice of tools is PowerPivot and Excel. Then if the ratings above were provided by the users in this organization, the application would clearly recommend Excel (Total Score 9) as a better tool than PowerPivot (Total Score 4).

4.5. Decision-making Application

The application is developed using Microsoft Silverlight which is a free web-browser plug-in and .NET framework using C# code. The input file to the tool is an XML file. The application has been developed using the Model View ViewModel (MVVM) design pattern.

4.5.1. Silverlight and .NET Framework

Silverlight is a cross-browser, cross-platform technology. It runs in all popular Web browsers, including Microsoft Internet Explorer, Mozilla Firefox, and Apple Safari, Google Chrome, and on Microsoft Windows and Apple Mac OS X [8].

Here are some of the advantages of using Silverlight [9][10]:

- Silverlight offers cross-domain support for applications
- It's lightweight its plugin is just a 1MB download and it is supported in windows XP and above
- It leads to greater user adoption and acceptance
- It has powerful data visualization capabilities
- It reduces the development, testing, maintenance, and support effort required to deliver a successful business application
- It reads data and updates the display, but it doesn't interrupt the user by refreshing the whole page.
- It easily integrates and migrates with existing Asp .Net web applications

.NET is a programming framework created by Microsoft that developers can use to create applications more easily. It provides language interoperability (each language can use code written in other languages) across several programming languages [11].

Using Silverlight with .NET framework we can write code in C#, VB, F#, IronPython, IronRuby or any other Common Language Infrastructure language. Common Language Infrastructure (CLI) is an open specification developed by Microsoft that describes executable code and a runtime environment that allow multiple high-level languages to be used on different computer platforms without being rewritten for specific architectures [12].

4.5.2. XML

Extensible Markup Language (XML) is used to describe data. The XML standard is a flexible way to create information formats and electronically share structured data. It operates on two main levels: first, it provides syntax for document markup; and second, it provides syntax for declaring the structures of documents [13].

Here are some of the advantages of using XML [14]:

- It is free, open and extensible.
- It can be used to describe and identify information accurately and unambiguously so computers can understand it easily.
- It allows sets of documents which are all the same type to be created and handled consistently and without structural errors, because it provides a standardized way of describing, controlling, or allowing/disallowing particular types of document structure.
- It provides a robust and durable format for information storage and transmission
- It provides a common syntax for messaging systems for the exchange of information between applications
- It can be manipulated programmatically
- It provides separation of form (appearance) from content

4.5.3. XAML

XAML (Extensible Application Markup Language) is Microsoft's variant of XML for describing a GUI. In previous GUI frameworks, like WinForms, a GUI was created in the same language that you would use for interacting with the GUI, e.g. C# or VB.NET and usually maintained by the designer (e.g. Visual Studio) [15]. Whether you're creating a Window or a Page, it will consist of a XAML document and a code behind file, which together creates the

Window/Page. The XAML file describes the interface with all its elements, while the code behind handles all the events and has access to manipulate with the XAML controls.

Here are some of the advantages of using XAML [16][17]:

- It is toolable. Because it's good old XML, it's really easy to parse and manipulate by any application
- It provides design/code separation
- It can be compiled, and it takes full advantage of the Longhorn graphics subsystem, helping developers to produce visual effects that once required Flash
- It is simple and straightforward, allowing us to create a user interface with very little code

4.5.4. Model View ViewModel (MVVM)

Model-View-ViewModel (MVVM) is a software architectural pattern. It abstracts a view's state and behavior. It is a great pattern to use with Silverlight and XAML. This is because the MVVM pattern leverages some of the specific capabilities of Silverlight and XAML, such as data binding, commands, and behaviors. It is similar to many other patterns that separate the responsibility for the appearance and layout of the UI from the responsibility for the presentation logic [18].

There are three core components in the MVVM pattern: the model, the view, and the view model. Each serves a distinct and separate role. The following illustration shows the relationships between the three components [19].

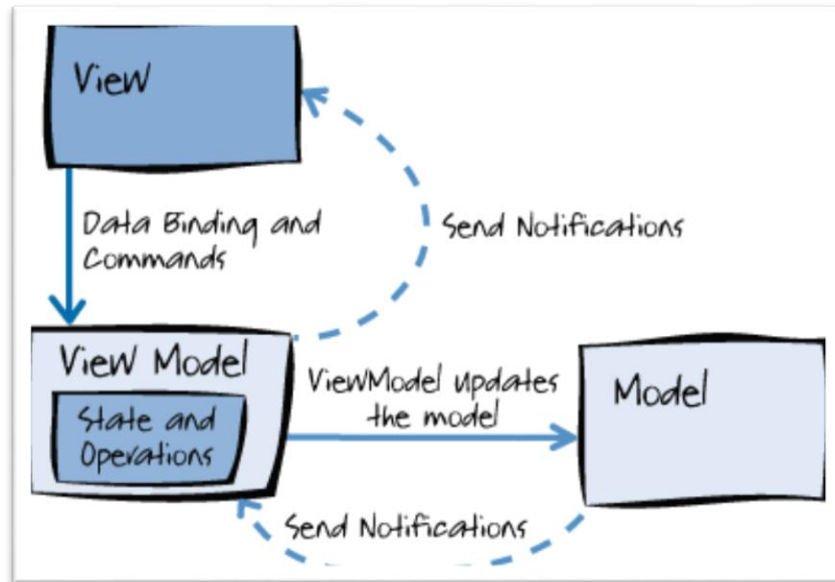


Figure 4.1. MVVM Pattern

The components are decoupled from each other, thus enabling:

- Components to be swapped
- Internal implementation to be changed without affecting the others
- Components to be worked on independently
- Isolated unit testing

The view is responsible for defining the structure, layout, and appearance of what the user sees on the screen. Ideally, the view is defined purely with XAML, with a limited code-behind that does not contain business logic. The model is an implementation of the application's domain model that includes a data model along with business and validation logic. The view model acts as an intermediary between the view and the model, and is responsible for handling the view logic. Usually the view model interacts with the model by calling methods in the model classes. The view model then provides data from the model in a form that the view can easily use. The view model retrieves data from the model and then makes the data available to the

view, and may reformat the data in some way that makes it simpler for the view to handle. The view model also provides implementations of commands that a user of the application initiates in the view [19].

Here are some of the advantages of using MVVM [19]:

- It provides separation of concerns. It provides a clean separation between application logic and the UI
- It is a natural pattern for XAML platforms
- It enables a developer-designer workflow. When the UI XAML is not tightly coupled to the code-behind, it is easy for designers to exercise the freedom they need to be creative and make a good product.
- It increases application testability. Moving the UI logic to a separate class that can be instantiated independently of a UI technology makes unit testing much easier.

4.6. Business Intelligence (BI) Tool Selector

The BI tool selector application takes advantage of all the technologies discussed in the previous section. The tool is coded in C# using the .NET framework and Microsoft Silverlight. The input file used in the tool is an XML file that is then parsed within the application. The input file lists the different BI styles and the different features considered in the tool. It also lists the different BI tools and the features that they provide. The tool has various UI tabs each coded in XAML. The entire tool is coded using the MVVM design pattern. The source code for the tool has a proper grouping for the Model, View and ViewModel components of the MVVM pattern. The application was developed in Microsoft Visual Studio Professional 2013 and Silverlight 5 developer runtime.

4.6.1. Business Intelligence (BI) Tool Selector Project Structure

Let's start by showing a snapshot of the different projects that make up the application:

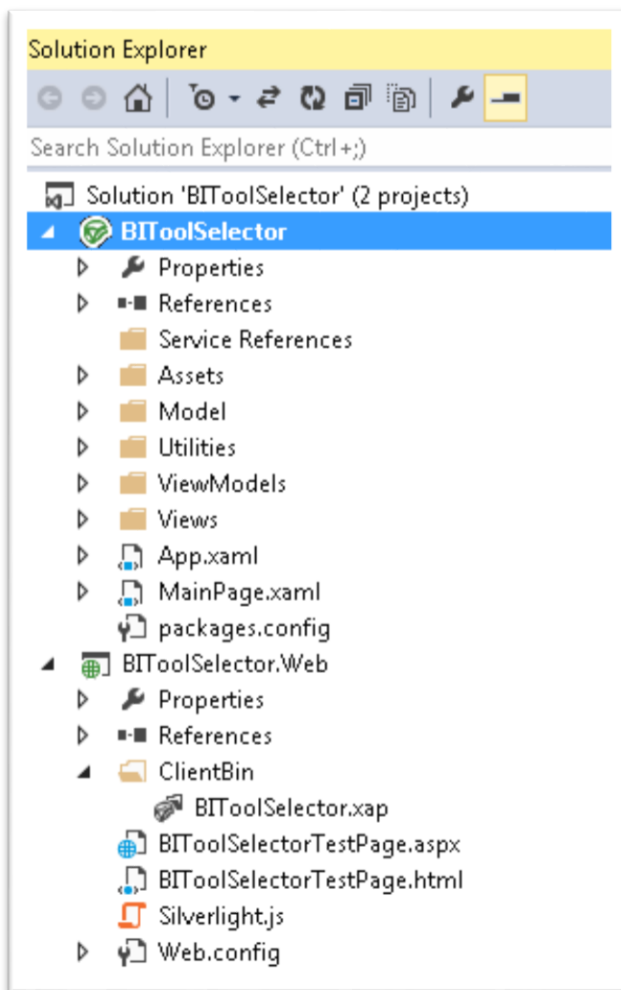


Figure 4.2. Solution Explorer MVVM Components

The application includes two projects: BIToolSelector and BIToolSelector.Web.

The BIToolSelector.Web is an ASP.NET Web Application Project to host the Silverlight application. This is the start-up project in the solution which basically means that this is the project that runs first when the application is launched. This includes the following main files:

- Silverlight.js – This is a JavaScript helper file that contains functions to initialize Silverlight plug-in instances and functions for determining the client's installed version of the plug-in.
- BIToolSelector.xap – This is the Silverlight application output file. This file is loaded in a test HTML or ASPX page to launch the application.
- BIToolSelectorTestPage.html – This is an HTML file that is used to configure and instantiate the Silverlight plug-in, which downloads and runs the Silverlight application. It checks first if the Silverlight plugin is installed on the client machine. If not it provides a web link to download it. It loads the BIToolSelector.xap file to launch the application.
- BIToolSelectorTestPage.aspx - This is the default startup page for the tool. It checks first if the Silverlight plugin is installed on the client machine. If not it provides a web link to download it. It loads the BIToolSelector.xap file to launch the application.
- Web.config – This is the configuration file for the web application.

The BIToolSelector project is the actual Silverlight project and it includes the various MVVM (Model, View and ViewModel) components as well as all the utility and project files.

The following is a breakdown of the main components in this project:

- AppManifest.xml - This is the application manifest file that is required to generate the application package.
- AssemblyInfo.cs - This file contains the name and version metadata that is embedded into the generated assembly.
- Assets – This folder stores all the asset files for the project. This includes images, layout styles, brush colors etc.

- Model – This folder contains all the classes that make up the Model piece of the MVVM pattern.
- Utilities – This folder contains all the utility files used in the project.
- ViewModels – This folder contains all the classes that make up the ViewModel piece of the MVVM pattern.
- Views - This folder contains all the classes that make up the View piece of the MVVM pattern.

4.6.2. XML Input File

Now let's take a deeper look at the XML input file used by the application. The file includes two basic sections. The first section lists the different BI styles and the different features considered in the tool. The second section lists the different BI tools and the features that they provide.

The following is a look at a small part of the first section of the file:

```

</XML version="1.0" encoding="UTF-8" />
<Features xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" >
  <Headers>
    <Header Name="Self-Service Reporting and Analysis">
      <Attributes>
    </Header>
    <Header Name="Self Service Data Mashups">
      <Attributes>
        <Attribute Name="Allows access to enterprise, department, and external and personal data sources" Id="9" Style="Self Serv
        <Attribute Name="Allows commonly used reports to be migrated to formal IT support and management" Id="11" Style="Self Ser
      </Attributes>
    </Header>
    <Header Name="Professional Reporting">
      <Attributes>
        <Attribute Name="Allows creation of highly formatted reports" Id="13" Style="Professional Reporting" />
        <Attribute Name="Allows reports to be frequently printed" Id="14" Style="Professional Reporting" />
        <Attribute Name="Allows reports with parametrized filtering and sorting" Id="15" Style="Professional Reporting" />
        <Attribute Name="Allows automatic distribution of reports via email" Id="17" Style="Professional Reporting" />
        <Attribute Name="Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML" Id="18"
        <Attribute Name="Allows reports to be embedded in line-of-business applications" Id="19" Style="Professional Reporting" /
      </Attributes>
    </Header>
    <Header Name="Performance Monitoring (Dashboards)">
    <Header Name="Scorecarding">
    <Header Name="Self-Service Reporting and Analysis, Self Service Data Mashups">
    <Header Name="Professional Reporting, Performance Monitoring (Dashboards), Scorecarding">
    <Header Name="Self-Service Reporting and Analysis, Self Service Data Mashups, Professional Reporting, Performance Monitoring (Das
    <Header Name="Self Service Data Mashups, Professional Reporting, Performance Monitoring (Dashboards), Scorecarding">
    <Header Name="Self-Service Reporting and Analysis, Self Service Data Mashups, Professional Reporting, Performance Monitoring (Das
  </Headers>

```

Figure 4.3. XML Input File - Attributes

The different features are grouped according to the particular BI style(s) that they belong to. Each feature is uniquely identified by an **ID**. It has a **Name** attribute that describes the feature and a **Style** attribute that lists the style that it belongs to. This section can be easily extended to include more features and styles by using the simple XML structure that has been defined. A new style would require a new **Header** element and the corresponding attributes/features that go with it. New features to an existing style would simply require additional **Attribute** rows under the appropriate style. Each new **Attribute** row needs to have a unique **ID** so that it can be uniquely identified.

The following is a look at a small part of the second section of the input file:

```

<Tools>
  <Tool Name="PerformancePoint" UserSkill="IT Authored" UserSkillScore="5">
  <Tool Name="Excel" UserSkill="Business User Authored" UserSkillScore="15">
    <AttribIds>
      <AttribId>1</AttribId>
      <AttribId>2</AttribId>
      <AttribId>3</AttribId>
      <AttribId>4</AttribId>
      <AttribId>5</AttribId>
      <AttribId>6</AttribId>
      <AttribId>8</AttribId>
      <AttribId>9</AttribId>
      <AttribId>24</AttribId>
      <AttribId>27</AttribId>
    </AttribIds>
  </Tool>
  <Tool Name="PowerPivot" UserSkill="Power User Authored" UserSkillScore="10">
  <Tool Name="Power View" UserSkill="Business User Authored" UserSkillScore="15">
    <AttribIds>
      <AttribId>3</AttribId>
      <AttribId>5</AttribId>
      <AttribId>6</AttribId>
      <AttribId>7</AttribId>
      <AttribId>8</AttribId>
      <AttribId>10</AttribId>
    </AttribIds>
  </Tool>
  <Tool Name="Reporting Services" UserSkill="IT Authored" UserSkillScore="5">
</Tools>

```

Figure 4.4. XML Input File - Tools

Each tool is uniquely identified by its **Name** attribute. The **UserSkill** attribute describes the skill-set of the user that can use the tool. The **UserSkillScore** attribute describes the score value granted to the tool based on the user base that can use it. Each tool element lists the various **AttributeId** elements. These are the unique feature **ID**'s that a particular tool supports. This section can be easily extended to include more tools by using the simple XML structure that has been defined. A new tool would simply require a new **Tool** element and the corresponding attributes/features that go with it. New features added to an existing tool would simply require

additional **AttributeId** rows under the appropriate tool. Each new **AttributeId** row needs to have the unique **ID** of the particular feature that the tool now supports.

4.6.3. General Interface Layout

The application has a consistent header which lists the name of the application tool. This header is visible on every application screen. The application also has a footer with the copyright of the developer. This again is visible on every application screen. Both the header and the footer together define the boundaries of the content area and give a good layout to the overall application.

The content area is divided into two parts: the top ribbon and the tabs underneath.

The top ribbon horizontally spans the entire screen and it hosts two functionalities. The first functionality is the ability to load the input file and the second is the ability to exit the application. This gives the users the ability to load a new input file or exit the application from any application screen.

The application take advantage of tabs to segregate the different functionalities provided. The goal is not to bombard the user with information overload. Tabs help to organize content, they are visually appealing and users are used to seeing them in files or folders in the real world to separate content [20]. The application provides the following tabs: **Recommended Tool by Features, Recommended Tool by User Skill, BI Tool Features, Tool Features by BI Styles, Compare Tools** and **Help**.

Recommended Tool by Feature is the tab that opens up by default. Every tab except the **Help** tab is blank until an input file is loaded. The users can use the **Help** tab at any time to see the instructions on how to use the application and also get an idea of the functionalities provided by each tab.

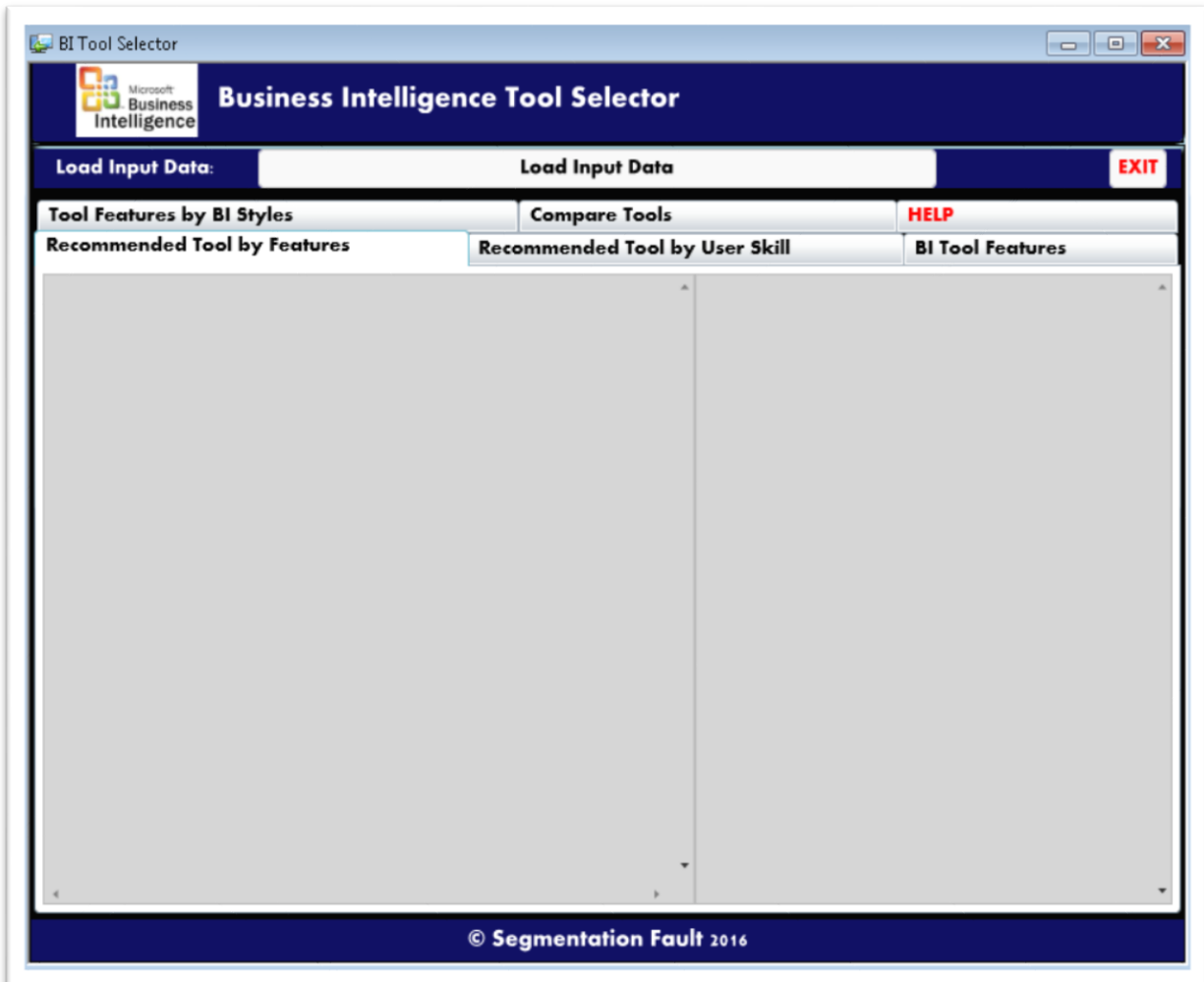


Figure 4.5. General Interface Layout

4.6.4. Application Tabs

The following is a brief description of the functionalities provided by each tab:

4.6.4.1. Recommended Tool by Features

This tab lets the user set the priorities for the different features that they are looking for. This tab also recommends the best tool to use based on the features selected in the form of data visualization charts.

Here is a high level view of the complete functionality in this tab:

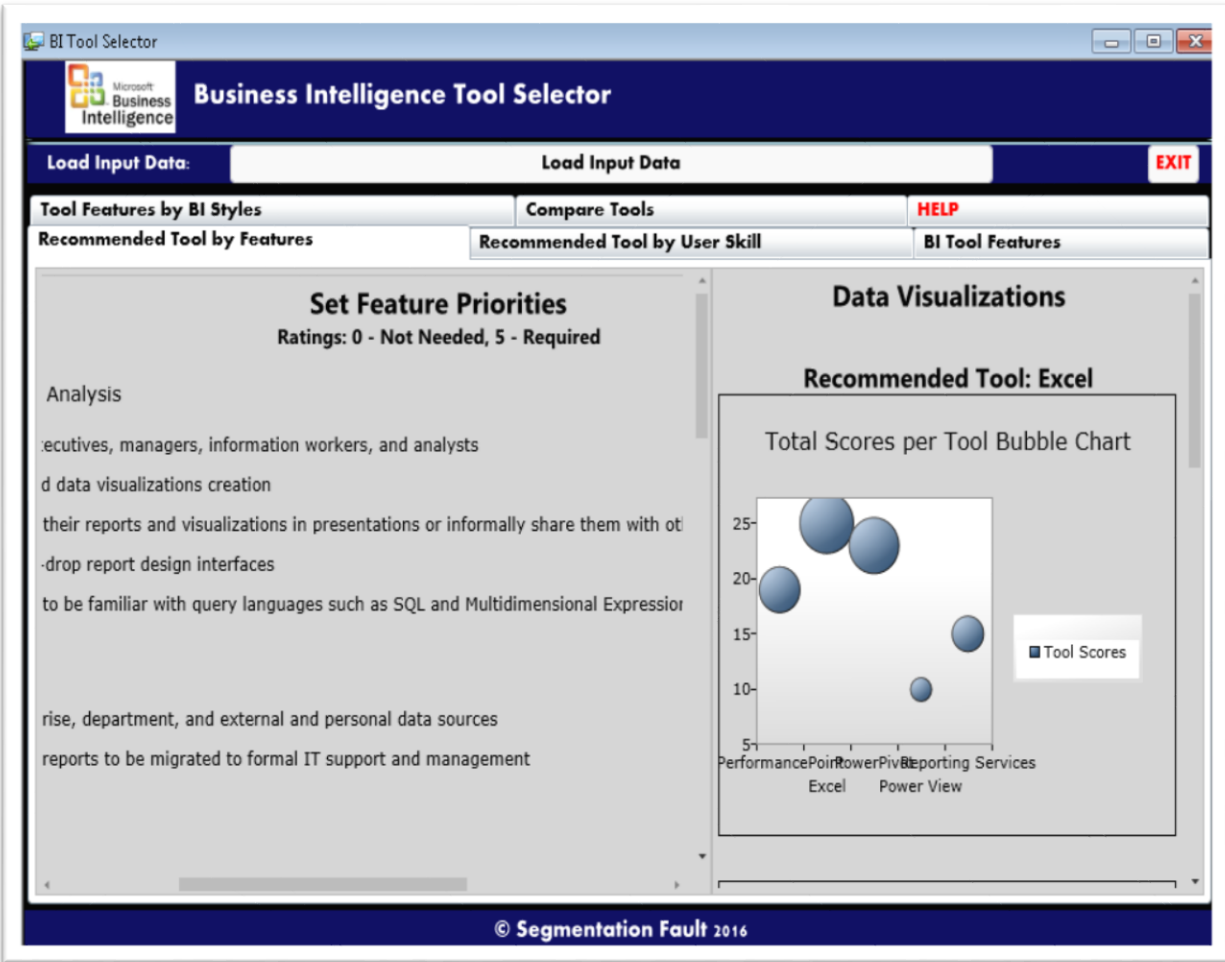


Figure 4.6. Recommended Tool by Features Tab

The left section lets the user set feature priorities and the right section shows the data visualization charts with the recommended tool to use.

Here is a detailed look at the feature priority section:

Set Feature Priorities

Ratings: 0 - Not Needed, 5 - Required

Self-Service Reporting and Analysis

- 4 ▾ Ability to be used by executives, managers, information workers, and analysts
- 4 ▾ Allows quick reports and data visualizations creation
- 3 ▾ Allows users to include their reports and visualizations in presentations or informally share them with other team members
- 1 ▾ Allows use of drag-and-drop report design interfaces
- 5 ▾ Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX)

Self Service Data Mashups

- 4 ▾ Allows access to enterprise, department, and external and personal data sources
- 3 ▾ Allows commonly used reports to be migrated to formal IT support and management

Professional Reporting

- 1 ▾ Allows creation of highly formatted reports
- 1 ▾ Allows reports to be frequently printed
- 0 ▾ Allows reports with parametrized filtering and sorting
- 2 ▾ Allows automatic distribution of reports via email
- 1 ▾ Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML
- 2 ▾ Allows reports to be embedded in line-of-business applications

Figure 4.7. Feature Priorities Section

The user can rate each feature between 0 (least important) and 5 (most important). The features are shown listed by their respective BI styles.

Here is a detailed look at the first part of the data visualization section:

The topmost part lists the recommended tool to use based on the feature ratings provided.

The first chart is a **Bubble Chart**. The x-axis has the different BI tools being considered. The y-axis is the total score computed for each tool based on the ratings selected by the user. The corresponding score for each tool is marked by a bubble on the chart.

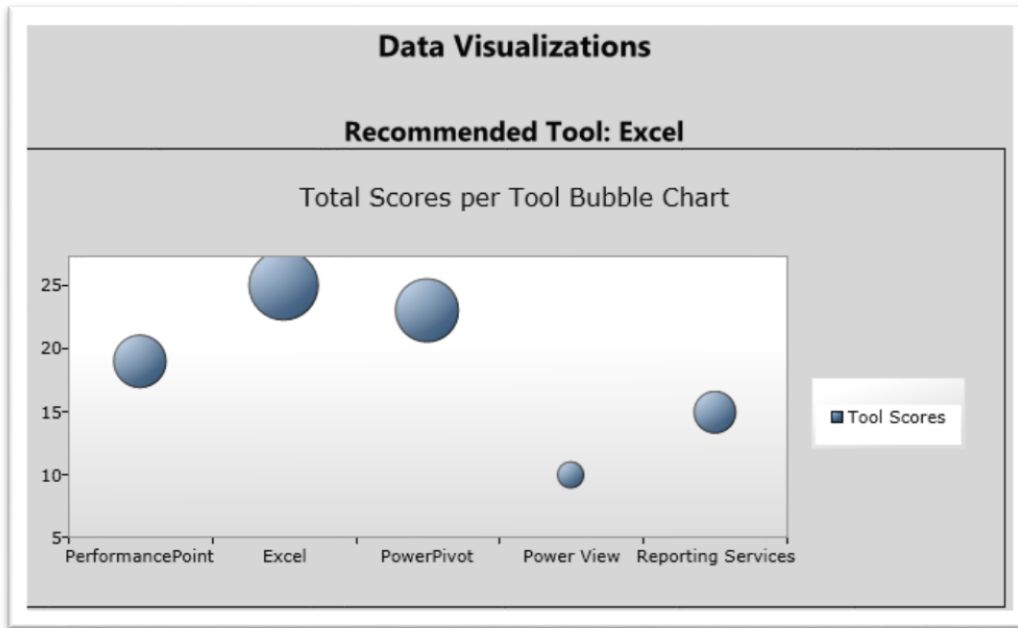


Figure 4.8. Bubble Chart

The second chart is a **Radar/Spider Chart**. It is a circular graph in which data is displayed in terms of values and angles. The X values define the angles at which the data points will be plotted. The Y value defines the distance of the data points from the center of the graph, with the center of the graph usually starting at 0 [21]. The different tools make up the X values. Five tools give the chart a Pentagon shape. The tool names are on each Axis which is the label at the end of each axis (spoke). There have to be at least three Axis to create a radar chart. In our case we have five Axis, one for each tool. The Y values are the total scores plotted for each tool based on user ratings. The corresponding score for each tool is marked by a point on the chart. Hovering over each point on the chart gives the tool name as well the score computed for that tool.

Note: Since the Silverlight toolkit does not contain a Radar Chart, a third-party tool called Visifire is used to create this chart.

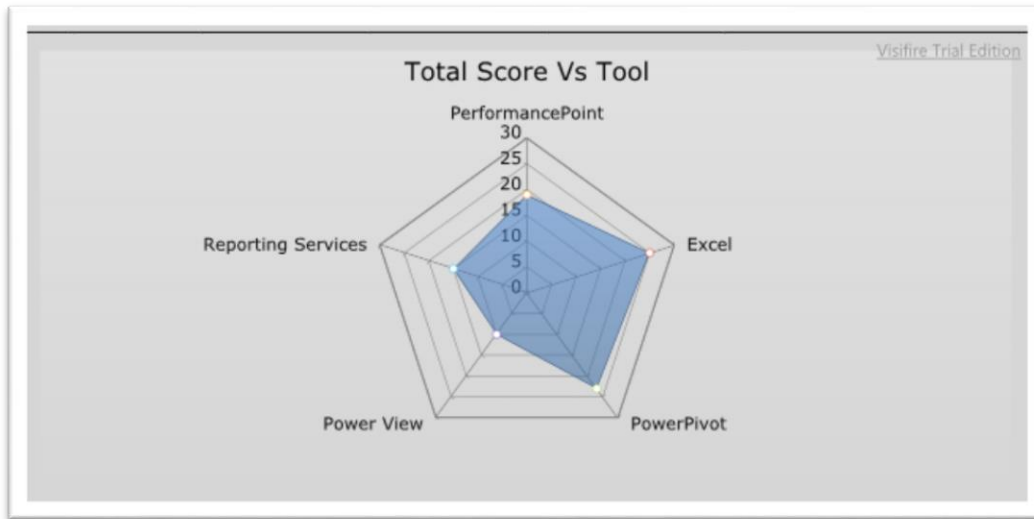


Figure 4.9. Radar/Spider Chart

The third chart is a **Pie Chart**. It renders Y values as slices in a pie. These slices are rendered in proportion to the whole, which is simply the sum of all the Y values in the series. They are used to visualize the proportional contribution (in terms of percentage or fraction) of categories of data to the whole data set [22]. The X values are the different BI tools being considered. The Y values are the total scores computed for each tool based on the ratings selected by the user. Each tool's slice is represented in a different color. The colors for each tool are shown besides the chart. Hovering over each slice in the pie gives the score for that tool as well as what percentage is that score of the total score for all tools.

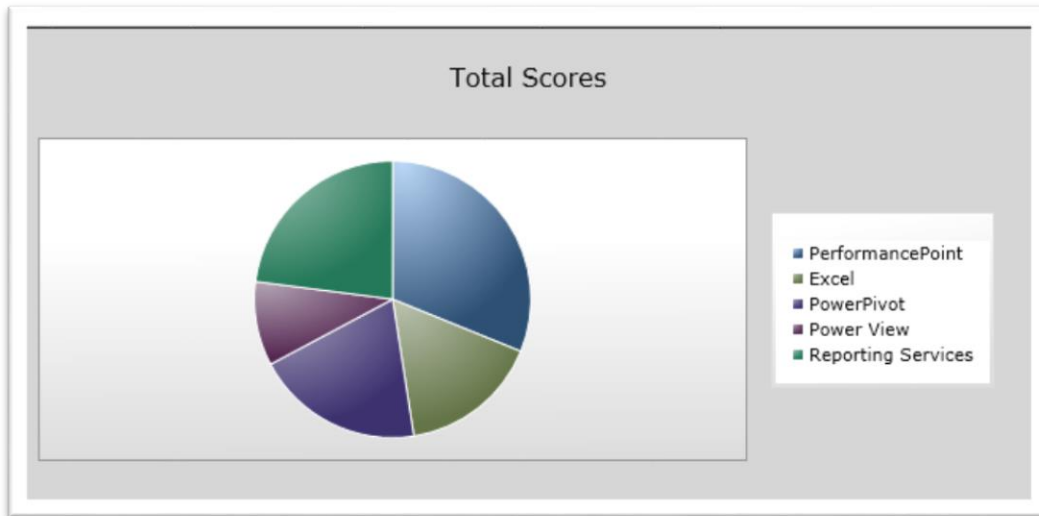


Figure 4.10. Pie Chart

The fourth chart is a **Column Chart**. It uses vertical bars (called columns) to display different values of one or more items. It is similar to a bar chart except that, here, the bars are vertical and not horizontal [23]. The x-axis has the different BI tools being considered. The y-axis is the total score computed for each tool based on the ratings selected by the user. The corresponding score for each tool is shown by a vertical bar on the chart.

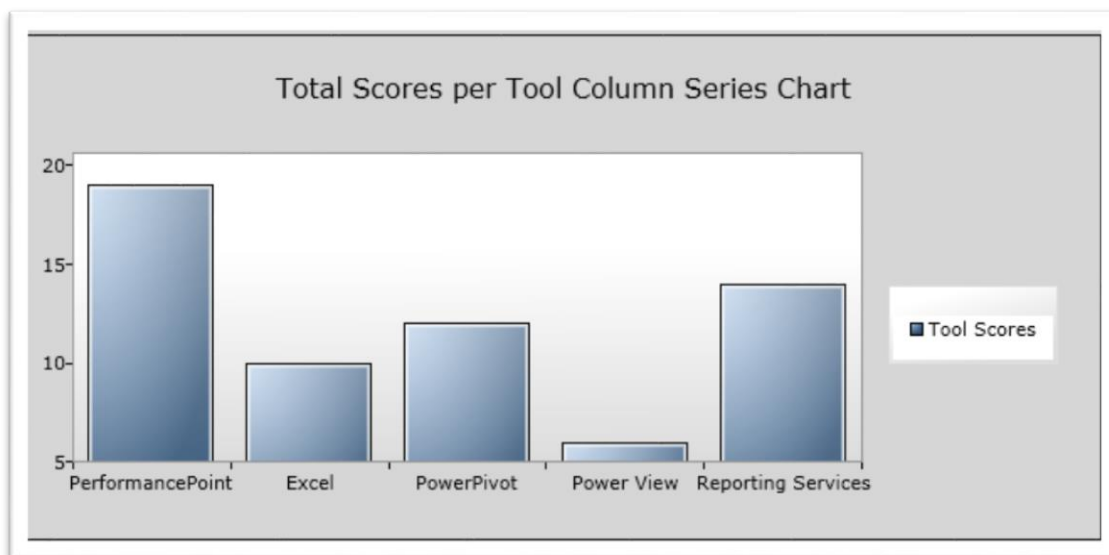


Figure 4.11. Column Chart

The application takes advantage of different types of charts and graphs to compare and contrast the different tools and recommends the best tool to use based on the ratings selected by the users.

4.6.4.2. Recommended Tool by User Skill

This tab recommends the best tool to use based on the skill set of the users using the tool.

The application makes use of a **Point Chart**. The x-axis has the different BI tools being considered. The y-axis lists the different user skill sets. The application computes a fictional score for each tool based on the skill set of the users using the tool. The corresponding user skill set required for each tool is marked by a point on the chart.

The user skill set specified denotes the minimum skill set required. So a tool requiring **Business User Authored** skill set can be used by Business users, Power users and IT users. A tool requiring **Power User Authored** skill set can be used by Power users and IT users. A tool requiring **IT User Authored** skill set can only be used by IT users.

Note: Since the Silverlight toolkit does not contain a Point Chart, a third-party tool called Visifire is used to create this chart.

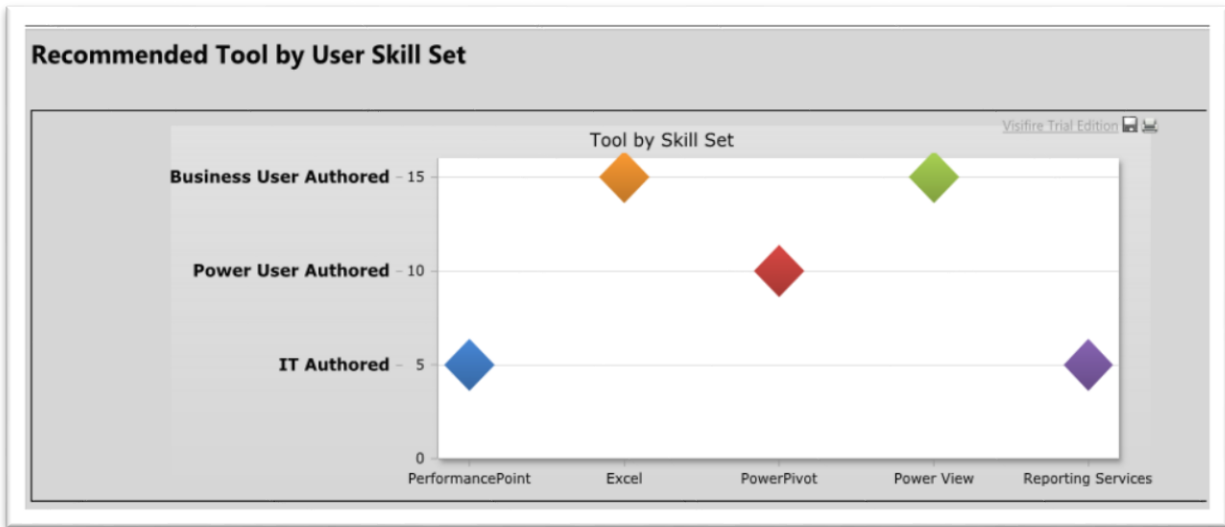


Figure 4.12. Recommended Tool by User Skill Tab

The application uses a Point Chart to recommend the best tool to use based on the skill set of the users using the tool.

4.6.4.3. BI Tool Features

This tab lists the different features provided by the five Business Intelligence tools. This tab provides the users with the functionality to view all the features that a particular tool provides. If a user wants to avoid rating the different features to decide on a tool, s/he can simply come to this tab to see the complete feature list for every tool and make their decision based on this knowledge.

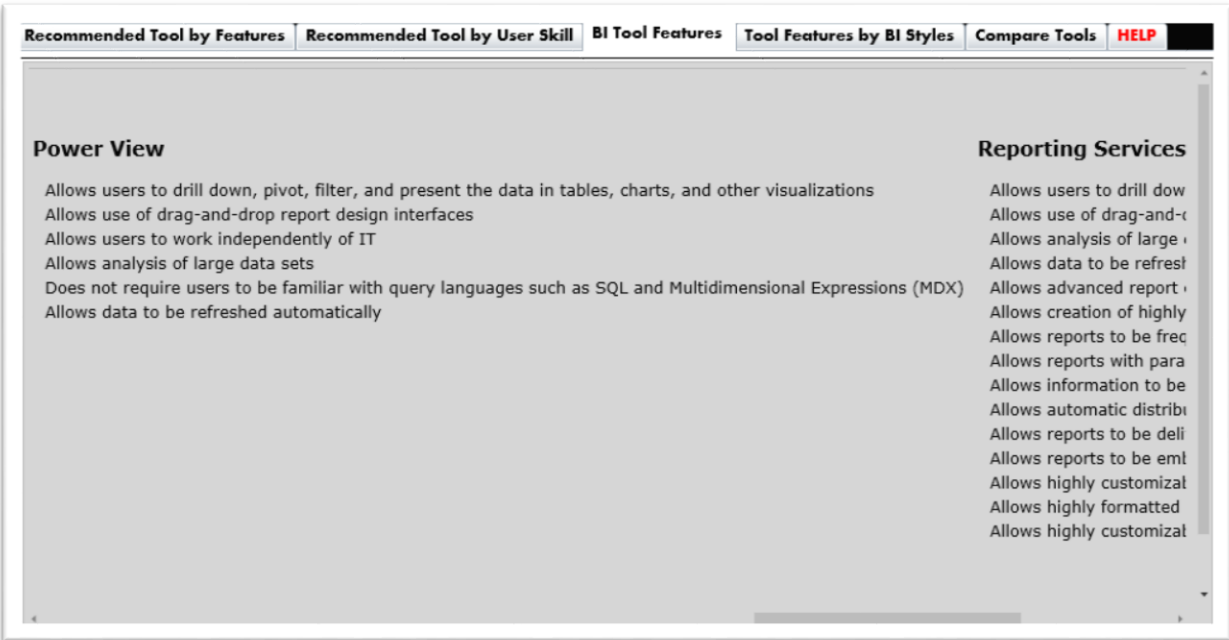


Figure 4.13. BI Tool Features Tab

The application lets the users scroll horizontally to view every tool’s feature list. The users can then decide on their tool based on this information.

4.6.4.4. Tool Features by BI Styles

This tab lists the different features handled in this Business Intelligence tool grouped by the different Business Intelligence styles. If a user wants to just view the different features according to their respective BI styles without having to be distracted by the rating choices and the data visualization charts, then they can simply use this tab to satisfy their needs.

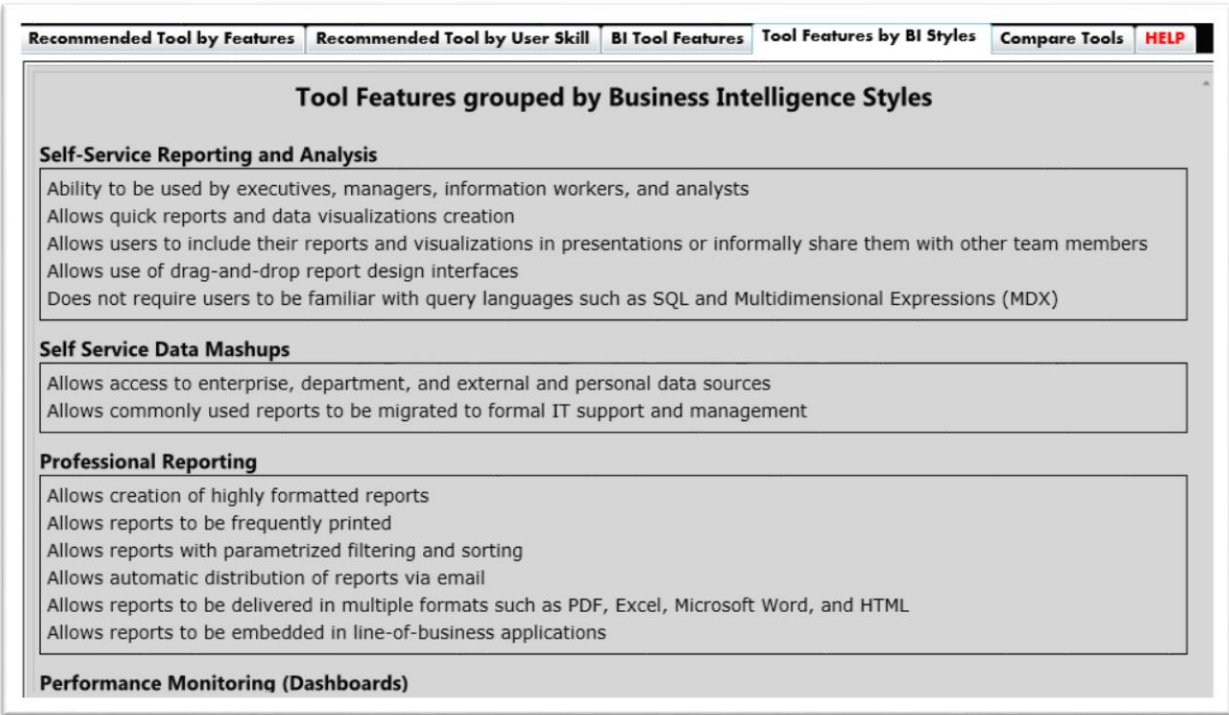


Figure 4.14. Tool Features by BI Styles Tab

The application lets the users scroll vertically to view all the BI styles and their respective features. There is no other information presented in this tab that would distract the user.

4.6.4.5. Compare Tools

This tab lets the user compare multiple tools against each other based on the features provided by them. If a user is having a tough time deciding between two tools, s/he can use this tab to compare the features provided by each of those tools. This tab lists the features shared by two tools as well as the unique functionalities provided by each. The user can then come to a decision based on the features desired by him/her and the functionalities provided by the tools.

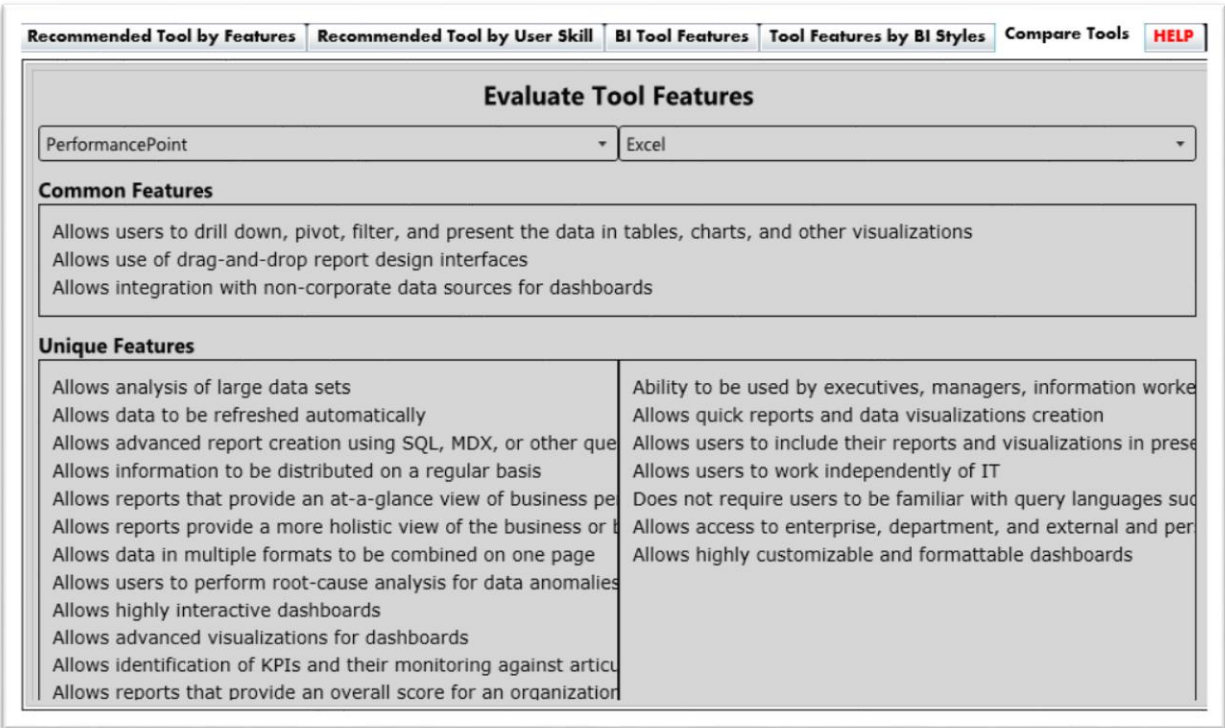


Figure 4.15. Compare Tools Tab

The application lets the users choose two tools from two dropdowns. It also lets the users scroll vertically to view all the features provided by a particular tool.

4.6.4.6. Help

This tab lists the instructions on how to use the application. It also gives a brief description of the functionalities provided by each tab.

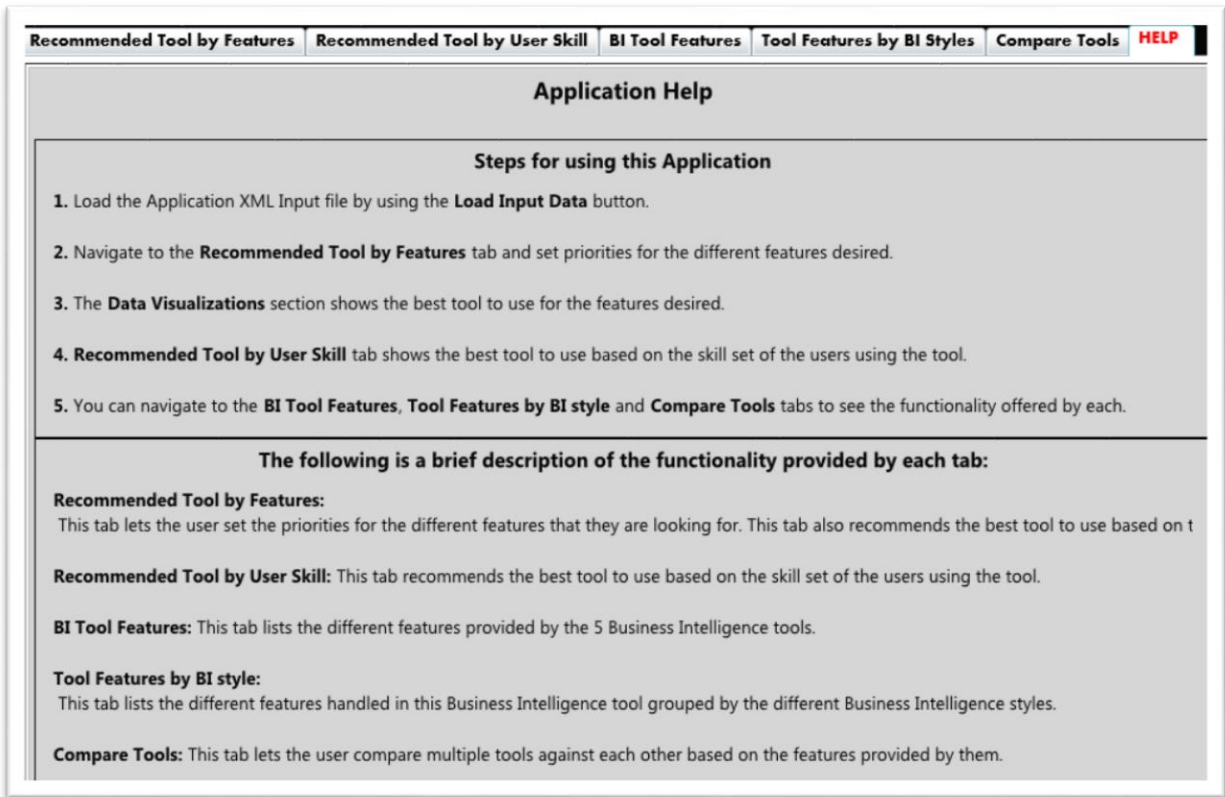


Figure 4.16. Help Tab

The application displays information in this tab at all times, even when no input file is loaded. This tab is available to the users with information all the time.

4.6.5. Real-Time Application

As soon as an input file is loaded the application presents results instantly to the user. It is dynamic as well and any change made by the users to the feature ratings automatically results in a refresh of results in real time.

CHAPTER 5. RESEARCH RESULTS

The users can use the application described in Chapter 4 to arrive at the best BI tool for their needs. There are two different criteria's to be considered while evaluating the different tools. The following are the two criteria's:

- Evaluation based on feature ratings provided by the user
- Evaluation based on the skill set of the users using the tool

5.1. Evaluation based on Tool Feature ratings provided by User

If feature ratings are being provided by the user, then three different scenarios can take place. These are:

- User provides ratings based on the BI style most desired
- User provides ratings randomly for the different features without a particular BI style in mind
- User accepts the default ratings assigned by the application to each feature

5.1.1. User provides Ratings based on BI style desired

If feature ratings provided by users are used to evaluate tools, we've discovered that the tool recommended depends on the BI style most desired.

The following table illustrates the different BI styles desired and the particular tool recommended to the users for each:

Table 5.1. Best BI Tool for each BI Style

<u>Business Intelligence Style</u>	Business Intelligence Tools				
	<u>Microsoft Excel 2010</u>	<u>Microsoft SQL Server 2012 PowerPivot</u>	<u>Microsoft SQL Server 2012 Reporting Services Power View</u>	<u>Microsoft SQL Server 2012 Reporting Services</u>	<u>Performance Point Services</u>
Self-Service Reporting and Analysis	✓				
Self Service Data Mashups		✓			
Professional Reporting				✓	
Performance Monitoring (Dashboards)					✓
Scorecarding					✓

Let's take each BI style and see the recommended tool suggested by the application.

5.1.1.1. Self-Service Reporting and Analysis

Let's take this scenario where a user is looking for a tool that supports just this BI style.

In this scenario the user would give high ratings to the features underneath the Self-Service Reporting and Analysis style and very low scores to all other styles.

Here's a sample user rating in this example:

Self-Service Reporting and Analysis

4 ▾ Ability to be used by executives, managers, information workers, and analysts

5 ▾ Allows quick reports and data visualizations creation

4 ▾ Allows users to include their reports and visualizations in presentations or informally share them with other team members

3 ▾ Allows use of drag-and-drop report design interfaces

5 ▾ Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX)

Self Service Data Mashups

1 ▾ Allows access to enterprise, department, and external and personal data sources

1 ▾ Allows commonly used reports to be migrated to formal IT support and management

Professional Reporting

1 ▾ Allows creation of highly formatted reports

1 ▾ Allows reports to be frequently printed

0 ▾ Allows reports with parametrized filtering and sorting

1 ▾ Allows automatic distribution of reports via email

0 ▾ Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML

1 ▾ Allows reports to be embedded in line-of-business applications

Performance Monitoring (Dashboards)

1 ▾ Allows reports that provide an at-a-glance view of business performance

0 ▾ Allows reports provide a more holistic view of the business or business function by combining multiple types of content together

Figure 5.1. Self-Service Reporting and Analysis Input

With this input the following is the tool recommendation from the application:

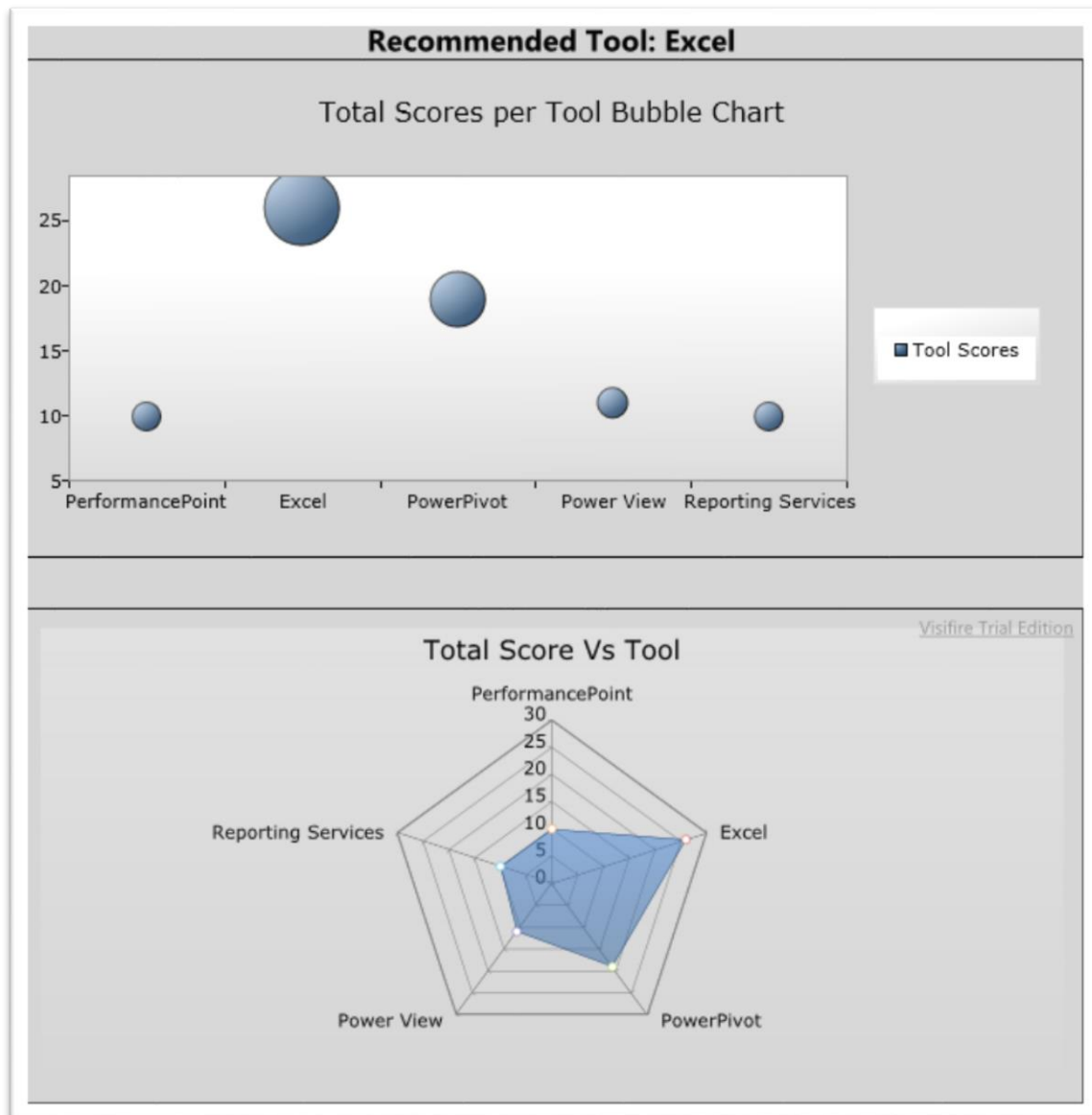


Figure 5.2. Self-Service Reporting and Analysis Tool Selection

The application recommends **Excel** as the tool to use.

5.1.1.2. Self Service Data Mashups

Let's take the scenario where a user is looking for a tool that supports just the Self-Service Data Mashups style. In this scenario the user would give high ratings to the features underneath this style and very low scores to all other styles.

Here's a sample user rating in this example:

Self-Service Reporting and Analysis	
1 ▾	Ability to be used by executives, managers, information workers, and analysts
0 ▾	Allows quick reports and data visualizations creation
2 ▾	Allows users to include their reports and visualizations in presentations or informally share them with other team members
1 ▾	Allows use of drag-and-drop report design interfaces
0 ▾	Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX)
Self Service Data Mashups	
4 ▾	Allows access to enterprise, department, and external and personal data sources
5 ▾	Allows commonly used reports to be migrated to formal IT support and management
Professional Reporting	
1 ▾	Allows creation of highly formatted reports
1 ▾	Allows reports to be frequently printed
0 ▾	Allows reports with parametrized filtering and sorting
1 ▾	Allows automatic distribution of reports via email
0 ▾	Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML
1 ▾	Allows reports to be embedded in line-of-business applications
Performance Monitoring (Dashboards)	
1 ▾	Allows reports that provide an at-a-glance view of business performance
0 ▾	Allows reports provide a more holistic view of the business or business function by combining multiple types of content together

Figure 5.3. Self Service Data Mashups Input

With this input the following is the tool recommendation from the application:

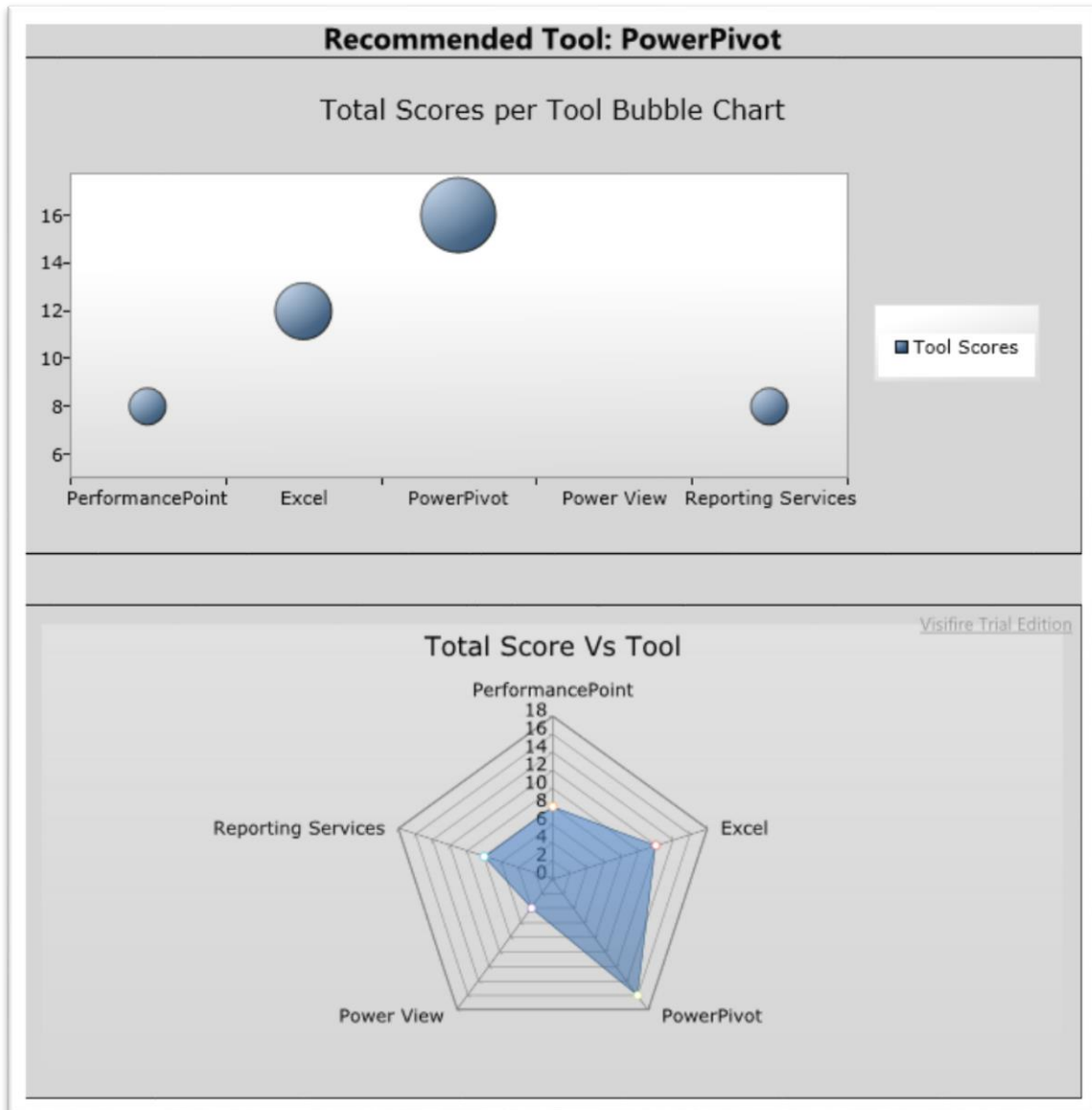


Figure 5.4. Self Service Data Mashups Tool Selection

The application recommends **PowerPivot** as the tool to use.

5.1.1.3. Professional Reporting

Let's take this scenario where a user is looking for a tool that supports just this BI style.

In this scenario the user would give high ratings to the features underneath the Professional Reporting style and very low scores to all other styles.

Here's a sample user rating in this example:

Self-Service Reporting and Analysis	
1 ▾	Ability to be used by executives, managers, information workers, and analysts
0 ▾	Allows quick reports and data visualizations creation
1 ▾	Allows users to include their reports and visualizations in presentations or informally share them with other team members
1 ▾	Allows use of drag-and-drop report design interfaces
0 ▾	Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX)
Self Service Data Mashups	
1 ▾	Allows access to enterprise, department, and external and personal data sources
0 ▾	Allows commonly used reports to be migrated to formal IT support and management
Professional Reporting	
4 ▾	Allows creation of highly formatted reports
4 ▾	Allows reports to be frequently printed
3 ▾	Allows reports with parametrized filtering and sorting
5 ▾	Allows automatic distribution of reports via email
5 ▾	Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML
3 ▾	Allows reports to be embedded in line-of-business applications
Performance Monitoring (Dashboards)	
1 ▾	Allows reports that provide an at-a-glance view of business performance
0 ▾	Allows reports provide a more holistic view of the business or business function by combining multiple types of content together

Figure 5.5. Professional Reporting Input

With this input the following is the tool recommendation from the application:

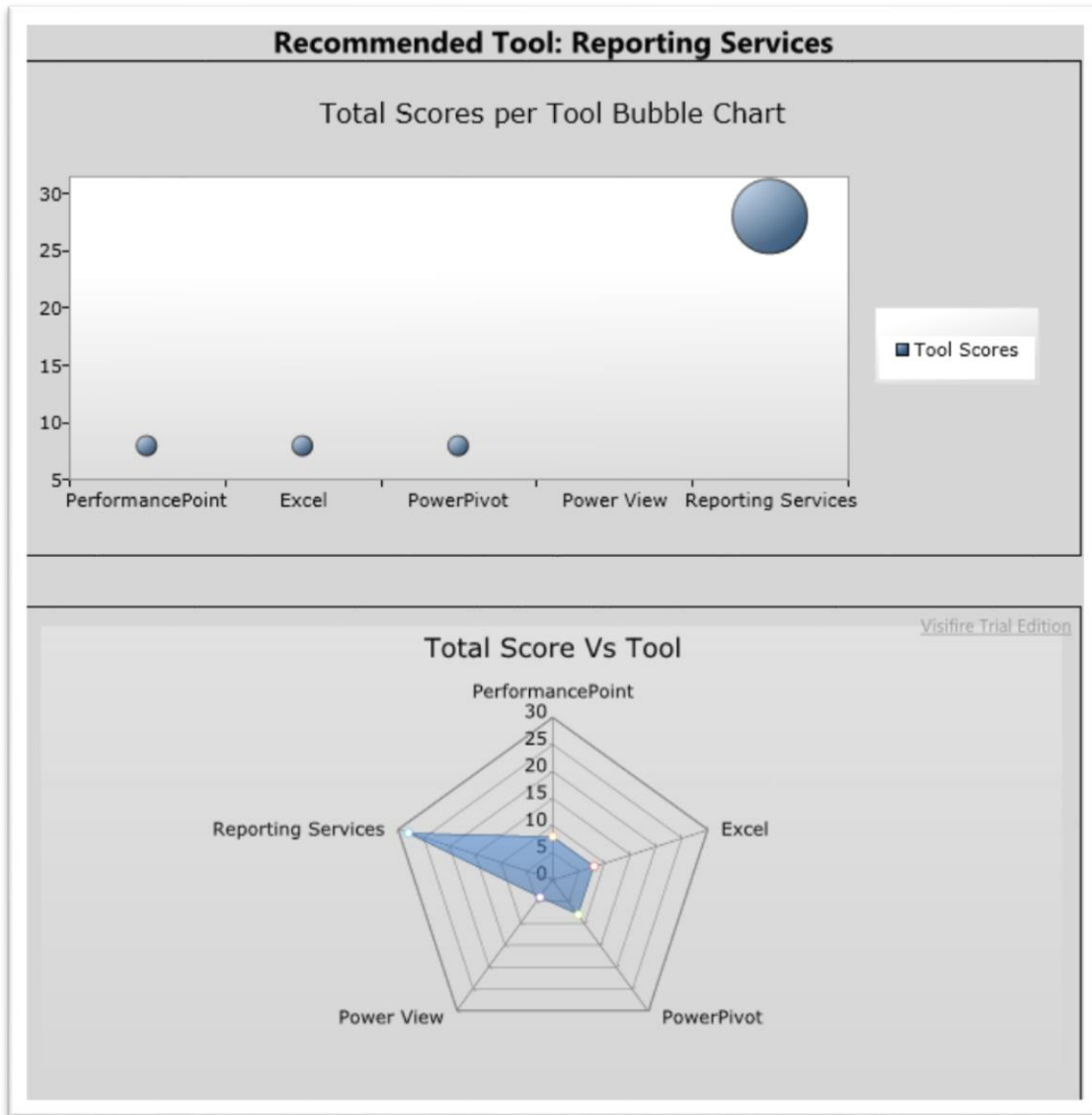


Figure 5.6. Professional Reporting Tool Selection

The application recommends **Reporting Services** as the tool to use.

5.1.1.4. Performance Monitoring (Dashboards)

Let's take the scenario where a user is looking for a tool that supports just the Performance Monitoring (Dashboards) style. In this scenario the user would give high ratings to the features underneath this style and very low scores to all other styles.

Here's a sample user rating in this example:

Professional Reporting

- 0 ▾ Allows creation of highly formatted reports
- 1 ▾ Allows reports to be frequently printed
- 0 ▾ Allows reports with parametrized filtering and sorting
- 0 ▾ Allows automatic distribution of reports via email
- 1 ▾ Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML
- 0 ▾ Allows reports to be embedded in line-of-business applications

Performance Monitoring (Dashboards)

- 4 ▾ Allows reports that provide an at-a-glance view of business performance
- 3 ▾ Allows reports provide a more holistic view of the business or business function by combining multiple types of content together
- 5 ▾ Allows data in multiple formats to be combined on one page
- 4 ▾ Allows users to perform root-cause analysis for data anomalies
- 4 ▾ Allows highly customizable and formattable dashboards
- 5 ▾ Allows highly interactive dashboards
- 3 ▾ Allows highly formatted printing for dashboards
- 3 ▾ Allows integration with non-corporate data sources for dashboards
- 3 ▾ Allows advanced visualizations for dashboards

Scorecarding

- 1 ▾ Allows identification of KPIs and their monitoring against articulated targets
- 0 ▾ Allows reports that provide an overall score for an organization, department, or individual's performance
- 0 ▾ Allows reports that present business objectives and their related KPIs hierarchically and can be filtered to help determine root c
- 1 ▾ Allows broad deployment and easy consumption and navigation with a browser

Figure 5.7. Performance Monitoring (Dashboards) Input

With this input the following is the tool recommendation from the application:

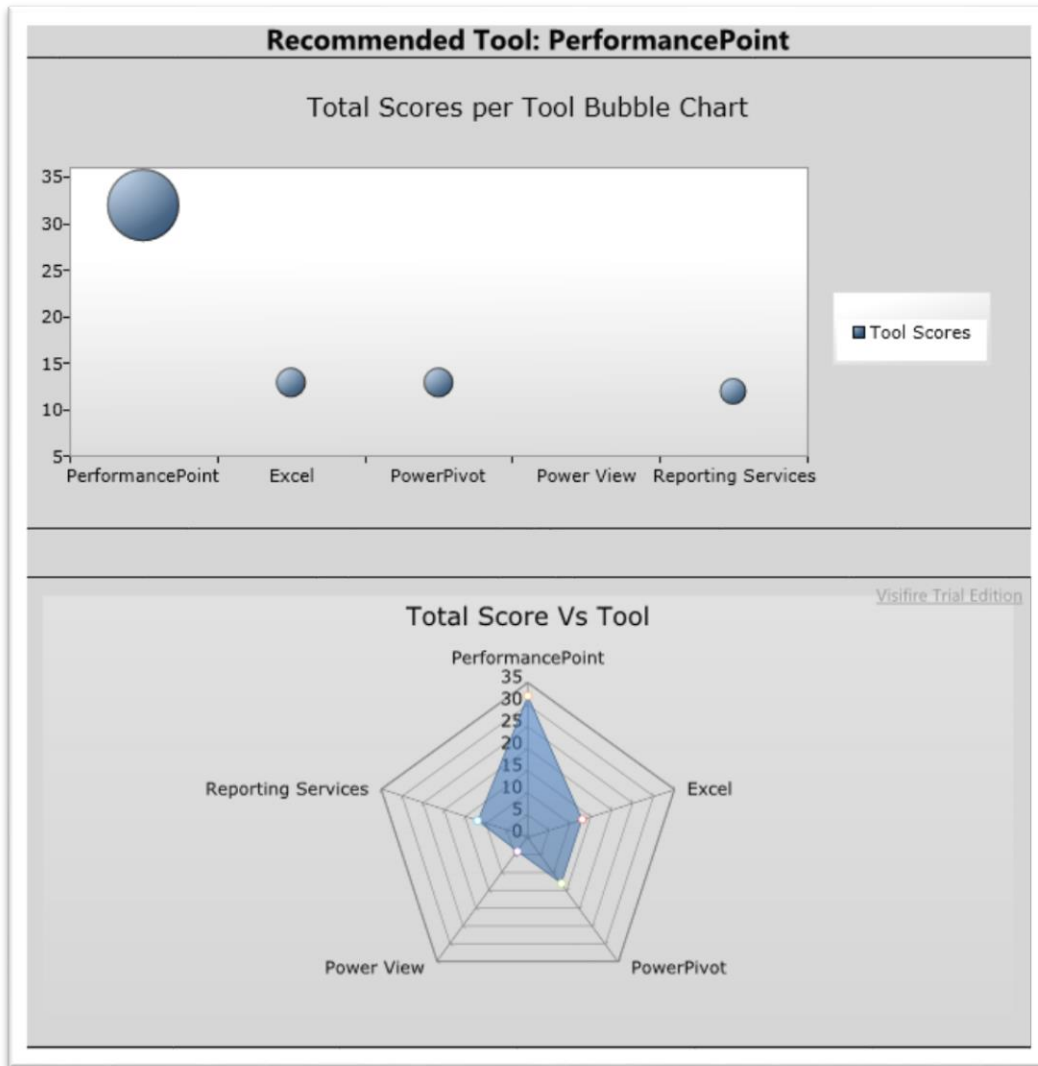


Figure 5.8. Performance Monitoring (Dashboards) Tool Selection

The application recommends **PerformancePoint** as the tool to use.

5.1.1.5. Scorecarding

Let's take this scenario where a user is looking for a tool that supports just this BI style.

In this scenario the user would give high ratings to the features underneath the Scorecarding style and very low scores to all other styles.

Here's a sample user rating in this example:

Performance Monitoring (Dashboards)

- 1 ▾ Allows reports that provide an at-a-glance view of business performance
- 1 ▾ Allows reports provide a more holistic view of the business or business function by combining multiple types of content together
- 0 ▾ Allows data in multiple formats to be combined on one page
- 0 ▾ Allows users to perform root-cause analysis for data anomalies
- 1 ▾ Allows highly customizable and formattable dashboards
- 1 ▾ Allows highly interactive dashboards
- 0 ▾ Allows highly formatted printing for dashboards
- 0 ▾ Allows integration with non-corporate data sources for dashboards
- 0 ▾ Allows advanced visualizations for dashboards

Scorecarding

- 4 ▾ Allows identification of KPIs and their monitoring against articulated targets
- 5 ▾ Allows reports that provide an overall score for an organization, department, or individual's performance
- 4 ▾ Allows reports that present business objectives and their related KPIs hierarchically and can be filtered to help determine root c
- 3 ▾ Allows broad deployment and easy consumption and navigation with a browser
- 1 ▾ Allows custom aggregations, weightings, and threshold configurations
- 4 ▾ Allows KPIs that drive navigation of other report styles in the dashboard

Self-Service Reporting and Analysis, Self Service Data Mashups

- 1 ▾ Allows users to work independently of IT

Figure 5.9. Scorecarding Input

With this input the following is the tool recommendation from the application:

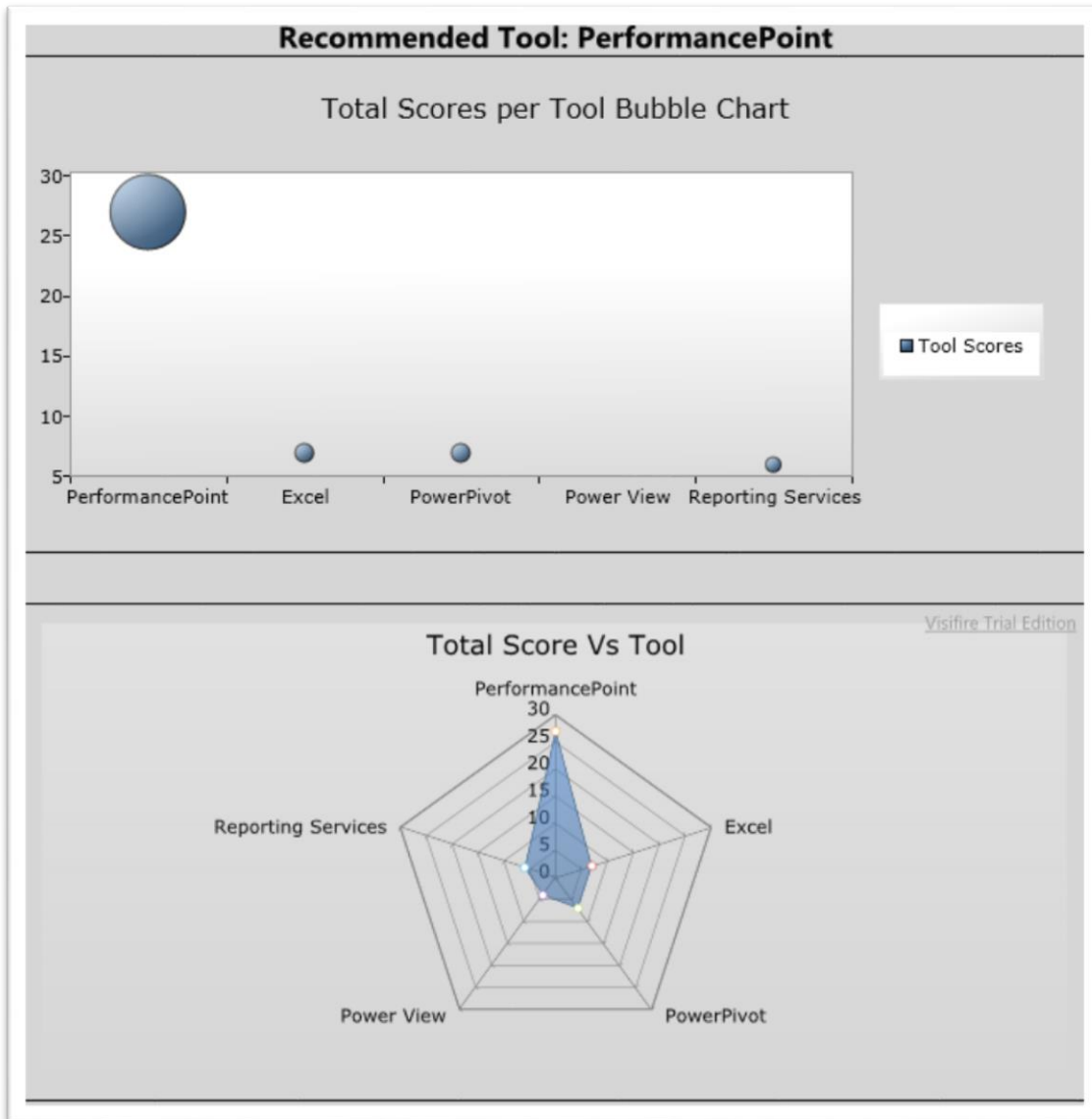


Figure 5.10. Scorecarding Tool Selection

The application recommends **PerformancePoint** as the tool to use.

5.1.2. User provides ratings randomly for the different features without a particular BI style in mind

If a user does not have a specific style in mind and provides ratings randomly for the different features that s/he has in mind, the application would suggest the tool to use based on the features selected and the ratings provided.

Here's a sample user rating in this example:

Self-Service Reporting and Analysis	
3 ▾	Ability to be used by executives, managers, information workers, and analysts
5 ▾	Allows quick reports and data visualizations creation
5 ▾	Allows users to include their reports and visualizations in presentations or informally share them with other team members
1 ▾	Allows use of drag-and-drop report design interfaces
3 ▾	Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX)
Self Service Data Mashups	
4 ▾	Allows access to enterprise, department, and external and personal data sources
0 ▾	Allows commonly used reports to be migrated to formal IT support and management
Professional Reporting	
2 ▾	Allows creation of highly formatted reports
4 ▾	Allows reports to be frequently printed
1 ▾	Allows reports with parametrized filtering and sorting
5 ▾	Allows automatic distribution of reports via email
0 ▾	Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML
3 ▾	Allows reports to be embedded in line-of-business applications

Figure 5.11. Random Input

Performance Monitoring (Dashboards)	
2 ▾	Allows reports that provide an at-a-glance view of business performance
3 ▾	Allows reports provide a more holistic view of the business or business function by combining multiple types of
4 ▾	Allows data in multiple formats to be combined on one page
1 ▾	Allows users to perform root-cause analysis for data anomalies
5 ▾	Allows highly customizable and formattable dashboards
0 ▾	Allows highly interactive dashboards
2 ▾	Allows highly formatted printing for dashboards
2 ▾	Allows integration with non-corporate data sources for dashboards
3 ▾	Allows advanced visualizations for dashboards
Scorecarding	
2 ▾	Allows identification of KPIs and their monitoring against articulated targets
1 ▾	Allows reports that provide an overall score for an organization, department, or individual's performance
0 ▾	Allows reports that present business objectives and their related KPIs hierarchically and can be filtered to help
4 ▾	Allows broad deployment and easy consumption and navigation with a browser
1 ▾	Allows custom aggregations, weightings, and threshold configurations
2 ▾	Allows KPIs that drive navigation of other report styles in the dashboard
Self-Service Reporting and Analysis, Self Service Data Mashups	
5 ▾	Allows users to work independently of IT
Professional Reporting, Performance Monitoring (Dashboards), Scorecarding	
0 ▾	Allows information to be distributed on a regular basis

Figure 5.11. Random Input (continued)

Self-Service Reporting and Analysis, Self Service Data Mashups, Professional Reporting, Performance Mon

3 ▾ Allows users to drill down, pivot, filter, and present the data in tables, charts, and other visualizations

Self Service Data Mashups, Professional Reporting, Performance Monitoring (Dashboards), Scorecarding

3 ▾ Allows data to be refreshed automatically

0 ▾ Allows advanced report creation using SQL, MDX, or other query languages

Self-Service Reporting and Analysis, Self Service Data Mashups, Professional Reporting, Performance Mon

2 ▾ Allows analysis of large data sets

Figure 5.11. Random Input (continued)

With this random input the following is the tool recommendation from the application:

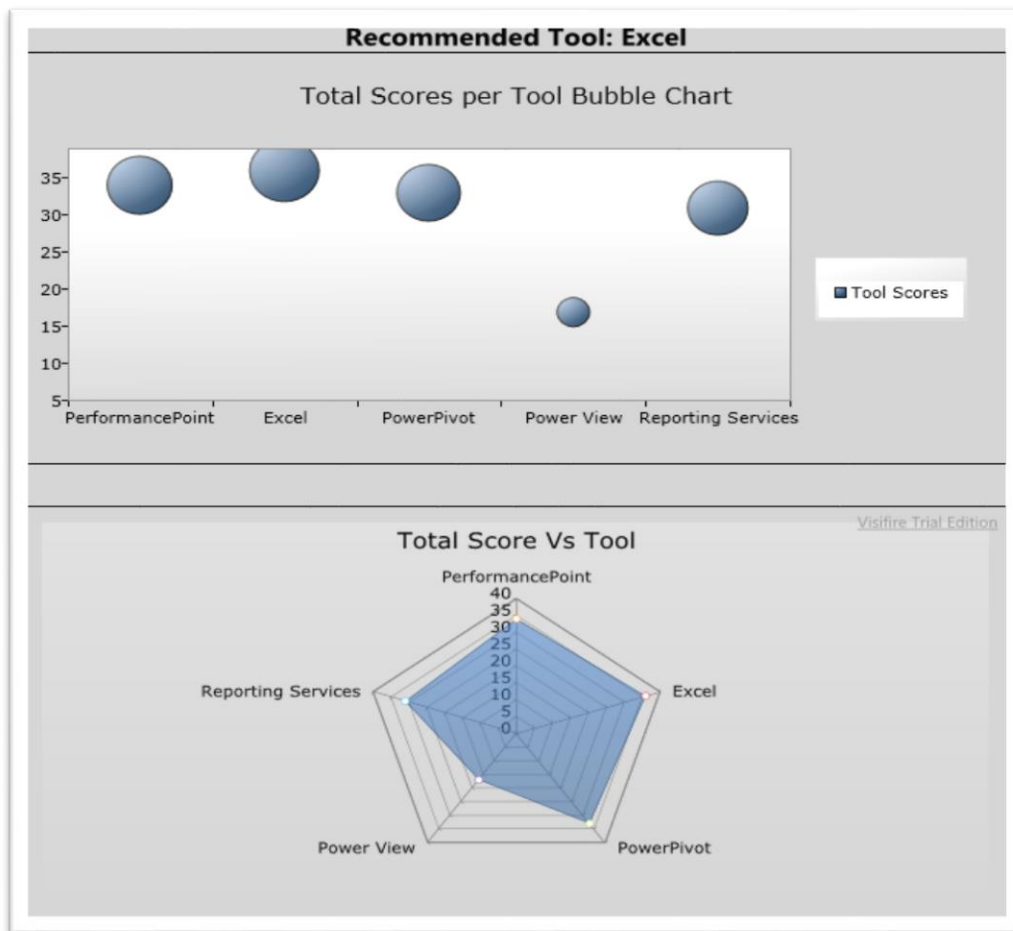


Figure 5.12. Random Tool Selection

The application recommends **Excel** as the tool to use in this case.

5.1.3. User accepts the default ratings assigned by the application to each feature

By default the application gives a rating of 1 to each BI style feature. If a user does not make any changes to the ratings then the application would simply select the tool that provides the most features.

Here's a sample user rating in this example:

The screenshot shows a user rating interface with three sections:

- Self-Service Reporting and Analysis**
 - 1 ▾ Ability to be used by executives, managers, information workers, and analysts
 - 1 ▾ Allows quick reports and data visualizations creation
 - 1 ▾ Allows users to include their reports and visualizations in presentations or informally share them with other team members
 - 1 ▾ Allows use of drag-and-drop report design interfaces
 - 1 ▾ Does not require users to be familiar with query languages such as SQL and Multidimensional Expressions (MDX)
- Self Service Data Mashups**
 - 1 ▾ Allows access to enterprise, department, and external and personal data sources
 - 1 ▾ Allows commonly used reports to be migrated to formal IT support and management
- Professional Reporting**
 - 1 ▾ Allows creation of highly formatted reports
 - 1 ▾ Allows reports to be frequently printed
 - 1 ▾ Allows reports with parametrized filtering and sorting
 - 1 ▾ Allows automatic distribution of reports via email
 - 1 ▾ Allows reports to be delivered in multiple formats such as PDF, Excel, Microsoft Word, and HTML
 - 1 ▾ Allows reports to be embedded in line-of-business applications

Figure 5.13. Default Input

With this input the following is the tool recommendation from the application:

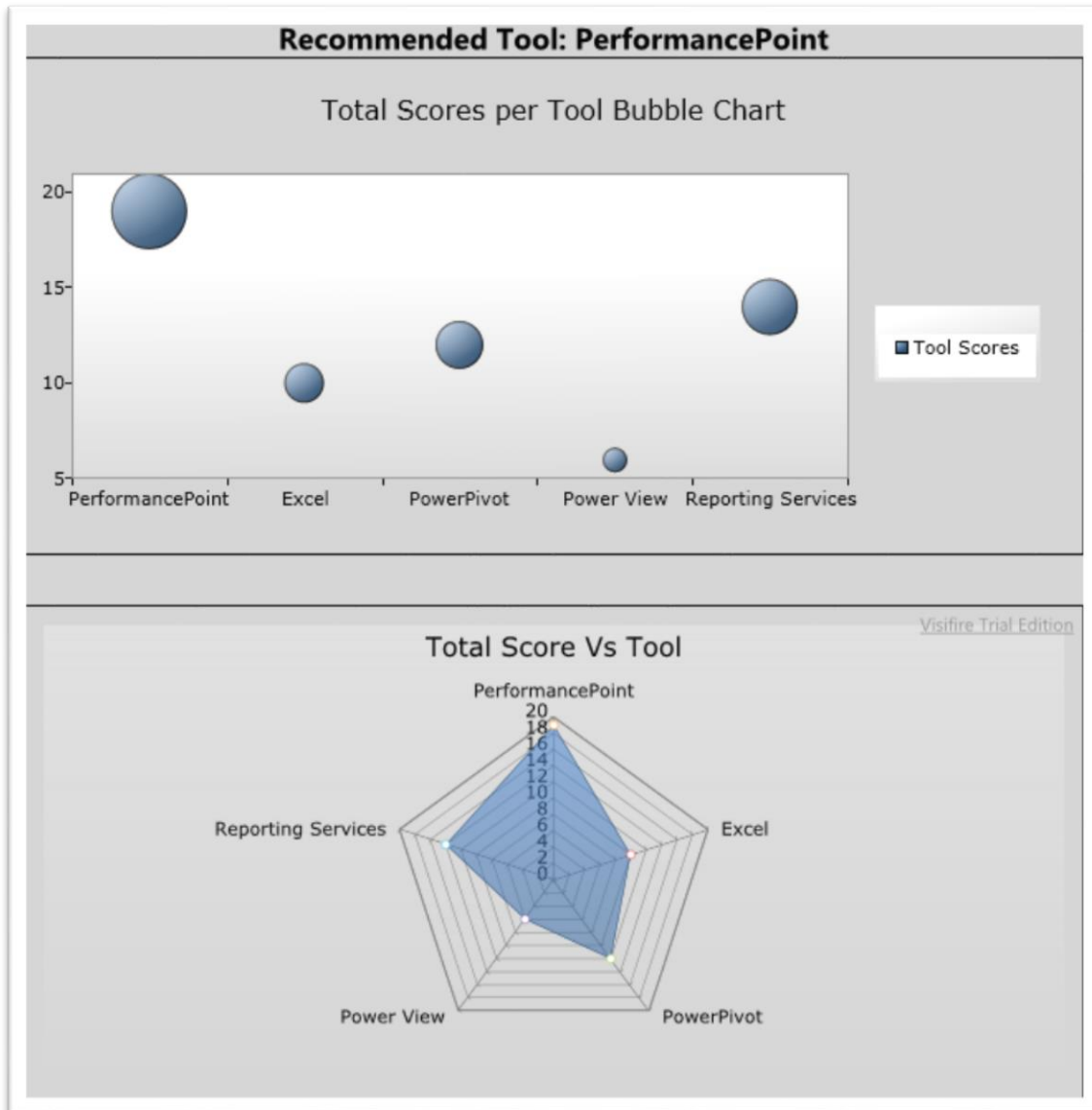


Figure 5.14. Default Tool Selection

The application recommends **PerformancePoint** as the tool to use.

5.2. Evaluation based on the skill set of the users using the tool

The application uses end user skill set as a parameter for suggesting the right tool to use in an organization. Some large-scale organizations house business users, power users and experienced IT developers whereas on the other end of the spectrum we can find small businesses which employ just business and power users or maybe even just business users. The

end user skill set available differs dramatically in the above two organizations. This is a practical reality in the industry and the tool takes this possibility into consideration.

The application shares the minimum end user skill set needed by each tool. Here are the findings:

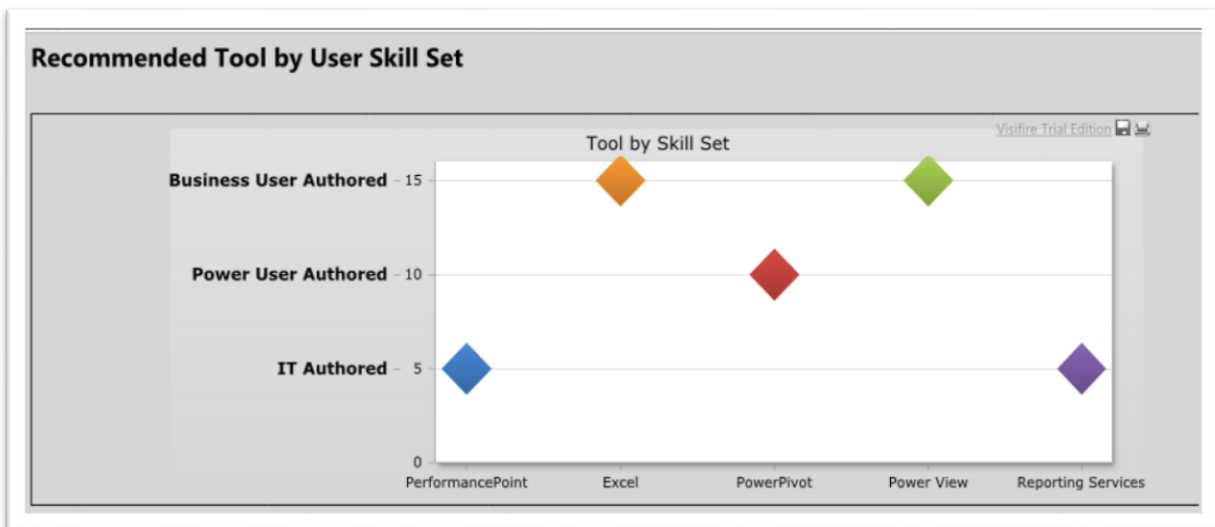


Figure 5.15. Tool Selection based on User Skill Set

- **Excel** and **Power View** can be used by business users, power users and IT users
- **PowerPivot** can only be used by power users and IT users
- **PerformancePoint** and **Reporting Services** can only be used by IT users

These findings can be used in combination with feature ratings provided by the user in the other evaluation criteria to arrive at the best tool to use. Here are three possible scenarios that can take place:

- Organization has business users, power users and IT users
- Organization has just business users and power users
- Organization has only business users

5.2.1. Organization has Business, Power and IT users

If an organization has all the three types of users at its disposal then each of the five BI tools is available for it to use. They can effectively ignore the skill set of the user using the tool. They can make their decision solely based on the first evaluation criteria where they can specify the feature ratings desired. The application will suggest a tool on the basis of that information.

5.2.2. Organization has just Business and Power users

If an organization only has business and power users then it can't use any tool that requires IT intervention. So, **PerformancePoint** and **Reporting Services** are not available to such an organization. In this scenario the users can use the first evaluation criteria and specify the feature ratings that they need. From the total scores computed by the application for **Excel**, **PowerPivot** and **Power View**, they can select the tool which has the highest score.

5.2.3. Organization has just Business users

If an organization only has business users then it can't use any tool that requires IT intervention and Power users. So, **PerformancePoint**, **Reporting Services** and **PowerPivot** are not available to this organization. In this scenario the users can use the first evaluation criteria and specify the feature ratings that they need. From the total scores computed by the application for **Excel** and **Power View**, they can select the tool which has the highest score.

CHAPTER 6. CONCLUSION AND FUTURE WORK

6.1. Conclusion

The Microsoft BI Tool Selector application developed as part of this paper compares five different BI tools. The application lets the user compare the tools on the basis of the feature ratings provided by the user as well as the skill set of the users using the tool. The users can also use both evaluation criteria in conjunction to arrive at the best tool for their needs.

Here is a snapshot of the functionalities provided by the application:

- Recommends the best tool to use based on feature ratings
- Recommends the best tool to use based on user skill set
- Lists the different features provided by the five Business Intelligence tools
- Lists the different features handled in this Business Intelligence tool grouped by the different Business Intelligence styles
- Allows the user to compare multiple tools against each other based on the features provided by them

The application presents different visual charts to help the users in seeing the results. The application is easily installed and available with a quick download. It's easily extendible as well to include more tools, BI styles and features.

Thus the application presents a viable solution to the problem described in section 1.1 Problem Description by guiding a project manager, functional expert, power user or any other IT team member in comparing and selecting the correct Microsoft Business Intelligence Technology tool.

6.2. Future Work

The work presented in this paper is a start towards developing a full-fledged distributable application that can be used across operating systems and platforms to find the right BI tools.

The application currently only supports the **Reporting and analysis** BI technique. Tools that support this technique read data, process and format it into structured reports that are delivered to users. They are used primarily for assessment [24]. The application can eventually be extended to include **Data-Mining** technique and **Knowledge-management** technique. Tools that support the **Data-Mining** technique process data using statistical techniques, search for patterns and relationships, and make predictions based on results. Tools that support the **Knowledge-management** technique store employee knowledge; make it available to whoever needs it. Their source is human knowledge [24].

The application currently only supports the Microsoft BI tools. It can eventually be extended to include tools and features from other vendors in the market.

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