BUSINESS INTELLIGENCE APPLICATION SOLUTION FOR CUTTING EDGE COMMERCE

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Final project report
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List of Acronyms

AHP – Analytical Hierarchy Process

BAM – Business Activity Monitoring

BI - Business Intelligence

BPM – Business Performance Measurement

CEC – Cutting Edge Commerce

CI – Consistency Index

CR – Consistency Ratio

CRM – Customer Relationship Management

DFD – Data Flow Diagram

DW – Data Warehouse

ERP – Enterprise Recourse Planning

IT – Information Technology

JRP – Joint Requirement Planning

MCDM - Multi Criteria Decision Methods

ROI – Return on Investment

SCM – Supply Chain Management

SQL – Structured Query Language

OLAP – Online Analytical Processing

OLTP – Online Transactional Processing

Executive Summary

This project report provides an insight into what business intelligence is, the required processes in selecting and validating the optimal business intelligence (BI) application as well as why it is crucial to the success of Cutting Edge Commerce (CEC). A study was conducted on available literature with regard to the project motivation, advantages of a well-integrated BI application as well as BI application selection methods.

A BI application consists of the design and collection of cohesive operative decision-support applications as well as databases which provide easy and effective access to organisational information. The project report discusses the main approach required to identify, evaluate, select and validate the optimal BI application for CEC. The applied approach consists of tasks such as cause-and-effect analysis, use-cause diagrams as well as the use of an Analytical Hierarchy Process (AHP).

For the comprehensive analysis of the 'as-is' process characteristics of the current BI application, a PIECES framework in combination with a SWOT analysis is conducted. CEC is faced with the decision whether to re-engineer their current in house BI application or to acquire and implement a commercial off the shelf (COTS) BI software package. The decision whether to procure a COTS application is discussed and elaborated on. Numerous BI solutions are available on the market, thus it is necessary for those solutions to be analysed and compared against each other.

The required criteria for the effective evaluation and filtering of possible COTS application vendors is identified through the use literature and requirements analysis. Further literature studies assisted in identifying methods called Multi-Criteria Decision Methods (MCDM) used for the selection of information systems. The proposed method of MCDM was identified as the AHP model which allows for the comprehensive comparison of various criteria simultaneously. This method is used to compare and evaluate the various BI applications identified.

Following the identification of the optimal software application, it was determined that the solution meets all user requirements. In order to measure user satisfaction a survey is conducted to determine the level of end-user satisfaction. The validation of the user survey results is done by using statistical analysis of the survey results.

Tableau is a multi-platform application with multiple implementation options and may be implemented as a web-based, desktop or mobile application. The report is concluded by providing a summary of the prescribed phases, tasks and actives required to successfully implement the BI application as well as a comprehensive training plan to ensure that end-users are able to efficiently use the newly implemented application.

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Chapter 1

1. Introduction

Sperotto defines modern Industrial Engineering as being "concerned with the integration of resources and processes into cohesive strategies" (Sperotto, 1994). Information systems have become one of the most important resources that industrial engineers need to consider when attempting to improve a business or enterprise.

1.1 Background

Cutting Edge Commerce (CEC) was established in 2004 because of the glaring shortfall in business with respect to information visibility and support with regard to business related decisions. CEC is a consultancy firm with first-hand experience with the information required to manage complex functions in public and private enterprises. CEC has developed an innovative range of software as a service (SaaS) consultancy applications that provide context for decision making support. CEC provides services to clients such as: Exxaro; Anglo Platinum; Sasol; MTN; Transnet and many more.

A project's duration may range anywhere from 3 months to 24 months and the basic BI implementation project may continue for 12 months where after, the client will continue to use the toolsets created and implemented by CEC. Project costs are divided between resource and software costs. CEC employs approximately 30 permanent and 40 external employees. Resources average from R 900 per hour to R12 000 per hour. The BI toolset has an average cost of R250 000 per SAP instance per month. CEC also provides a once-off purchasing opportunity which is specific to the SAP toolset, with a cost of R10 million rand and an annual licence fee of 20%.

CEC currently uses WebFOCUS as their software platform with StratWare as the BI application built on top of WebFOCUS. The initial decision to use WebFOCUS was based on the premises that the standard software consists of more than 250 adapters that can connect to various data sources.

The BI application (StratWare) was then built on top of WebFOCUS. CEC developed its own front-end using WebFOCUS code with Cutting Edge Commerce intellectual property (IP) obtained from a range of resources across various business areas, such as: Supply Chain Management; BBBEE Scorecards, System Health Management; Performance Management and Monitoring, Data Profiling and Analysis.

Increased improvement and globalisation have provided plenty of opportunities, choices and competitive pressure in the market. Emphasising the importance of enhancing the organisations' effectiveness and efficiency of supply chain analytics Sahay & Ranjan (2008) highlight the need for using a relevant BI approach.

The current BI platform used by CEC is slowly becoming outdated and is losing traction in the various Gartner quadrants. Although the look and feel is outdated, CEC's IP remains relevant. Their client base is mostly SAP based and therefore very SAP centric. Their preferred applications are Business warehouse (BW) and Business Objects. The user base is leaning towards the newer HTML 5 based applications since these type of applications are more flexible and user appealing.

1.2 Problem Definition and Justification

In order to increase customer satisfaction with regard to the quality of data and costs associated with SAP tools and implementation, CEC must re-invent their current toolsets and underlying database. Using the PIECES framework and SWOT analysis provided in Appendix A, a comprehensive problem analysis was conducted.

WebFOCUS, CECs' current underlying software, has been identified as a cost intensive component of the organisation, resulting in increased costs and reduced annual revenue. Because of these increased costs CEC cannot access small to medium companies, limiting their market accessibility. The complex structure of WebFOCUS has a negative impact on the ease of use of the system, resulting in lacking system maintainability and user satisfaction.

The newly selected BI application must allow CEC to utilise the IP and past experience within the new BI platform. To ensure the future success of CEC a BI Toolset must be selected that has a modern look and feel to attract new clients, reduce time intensive extract, transform and load (ETL) processes, while providing system flexibility and information visibility.

1.2.1 Project Justification

In order to compete with the evolving business climate, organisations must view their data as assets. Mukherjee & Jennings (2014) highligbht the need to improve decision-making and shift the focus to cannier and more efficient use of organisational data to create a sustainable competitive advantage.

Many organisations collect massive amounts of operational data as a result of day to day activities. These large amounts of data is stored in multiple data repositories such as finance, sales and marketing. Understanding and interpretation of this collected data is a key factor in the success of an organisation. Enterprise Resource Planning (ERP) systems is a typical example of the functions that contains data regarding the supply chain and inventory levels.

The line-of-business data stores usually have their own reporting capabilities, with multiple third-party tools that provide complex data analysis (TrustRadius, 2014). A problem is raised due to the fact that the operational data is normally not housed in only one place.

Analytic vendors strive to eliminate the customer process of searching for data and to shift their focus to data analysis (Blumberg, 2003). The process of designing, building and integrating a BI system requires no less than six months, usually resulting in a costly process.

Many firms decide to use COTS applications to maintain a lower cost of ownership, to speed up implementation and to receive a rapid return on investment, with the purpose of maintaining their underlying flexibility, performance and scalability (Rudin & Cressy, 2003).

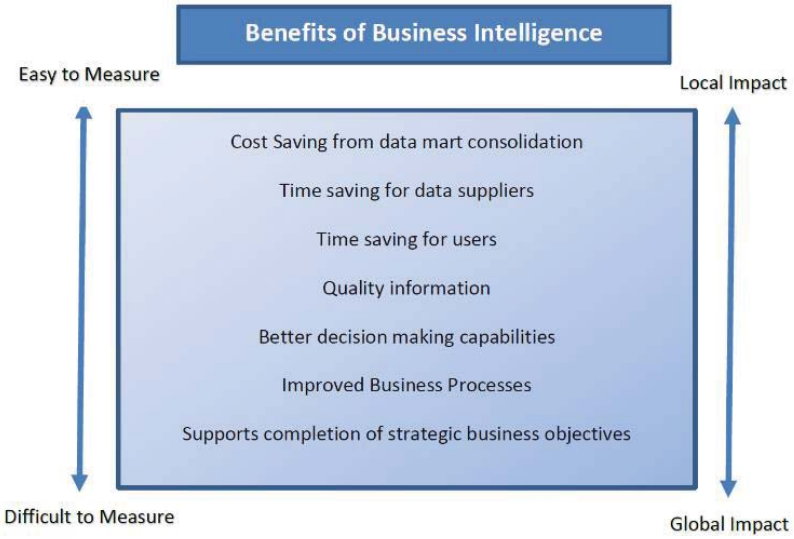


Figure 1: The Benefits of Business Intelligence (Herschel, 2012)

BI applications perform various processes such as data exploration, data relationship identification and trend analysis. Methodologies are used to draw conclusions from the extracted data to drive revenue growth and improve operational efficiency within the organisation (Agostino, 2004). Business intelligence applications can generate the following benefits:

- Quickly generate revenue/expense reports.
- Allows for real time data-flow visibility.
- Ease of distributing sales information to management.
- Better decision making.
- Better quality vendor relationship management.
- Improved profitability.
- Improved customer relationship management.
- Save valuable time by providing online access to data.
- Reducing report generating times.

1.3 Project Objectives

The project aims to improve the current BI application used by CEC, by completing a comprehensive system analysis of CEC's current BI application, to identify and select a BI application that is well known, accepted by clients and will best meet the needs of CEC.

The newly selected BI application must aim to:

- Ensure continued business and increased customer satisfaction from current clients
- To attract new clients.
- To provide a higher level of visibility to clients.
- Reduce the dependency of the clients and to minimise cost, time and resources by implementing software which is compatible with CECs' underlying SAP software.

1.4 Project Deliverables

Deliverables required for project completion:

- Comprehensive system analysis of the as is business processes.
- Business requirement statement including:
  - Functional requirements
  - Non-functional requirements
- A list of commercially available BI applications that meet the business requirements.
- A full evaluation and analysis of COTS BI applications.
- A recommendation of the business intelligence application.
- Validation of the recommended solution and an analysis of user satisfaction.
- An implementation and training plan.

Chapter 2

2. Literature Review

The literature review provides an understanding of the BI application environment, benefits of using a BI application and the information required to procure a commercially off-the-shelf BI application. Section 2.1 to 2.4 provides insight into the background of Business Intelligence and why it is needed. Section 2.5 and section 2.6 provides an overview of how CEC uses BI and StratWare.

The literature in section 2.7 describes the term COTS BI application and identifies the various functionalities of BI applications available. Sections 2.8 and 2.9 provide information required for the selection and evaluation of BI applications. The literature in section 2.10 and 2.11 provide background information to the various fact-finding and problem identification techniques used.

2.1 Business Intelligence Environment

Business intelligence emphasises the analysis of great quantities of data. Business intelligence is a data-driven Decision Support System (DSS) which combines data collecting, storing and information management, while data analysis provides an input to the decision making process.
BI is used to better recognise the capabilities of the organisation, trends, future directions in the market, available technology and the environment in which the organisation must compete. BI analysis ranges from simple reporting to more complex analysis such as slice-and-dice, drill-down analysis and forecasting.

The BI environment includes the information handling, development and backing activities needed to provide relevant and dependable organisational information (Negash, 2004).

BI tools can analyse business scenarios that span short and long time periods, using data captured within the enterprise information systems. BI technology may be used in organisations to organise the information collected in the ERP system and other data repositories such as data warehouses and data marts to perform optimised and effective decision-making (Chou et al., 2005).

BI applications convert data into useful information (Negash, 2004). BI tasks include:

- Forecasting which provides an estimate of future directions based on historical data.
- Provision of information about the impact of changes in the organisational and alternative scenarios by using a what-if analysis.
- Ad-hoc reporting provides data required to answer specific, custom questions.

2.2 Defining Business Intelligence Applications

Business intelligence is a term introduced in 1989 describing a set of ideas and practices designed to improve the quality of decision-making within an organisation by using fact and fact-based systems (Hashmi, 2004).

BI refers a set of different software applications used to collect, store and analyse organisational information and data. Business intelligence is comprised of several related activities such as data transformation, extraction, loading, analysing, querying and reporting (Mulcahy, 2007).

Gartner sheds some light on the next generation business intelligence as seen in Figure 2, this provides an insight into the new composition and approach to BI. From a BI perspective many organisations view BI as the use of data that provides organisations with the ability to best lead, measure and manage performance to become more efficient and gain economic benefit. BI is linked to realising business objectives, Gartner believes that BI capabilities will drive business transformation.

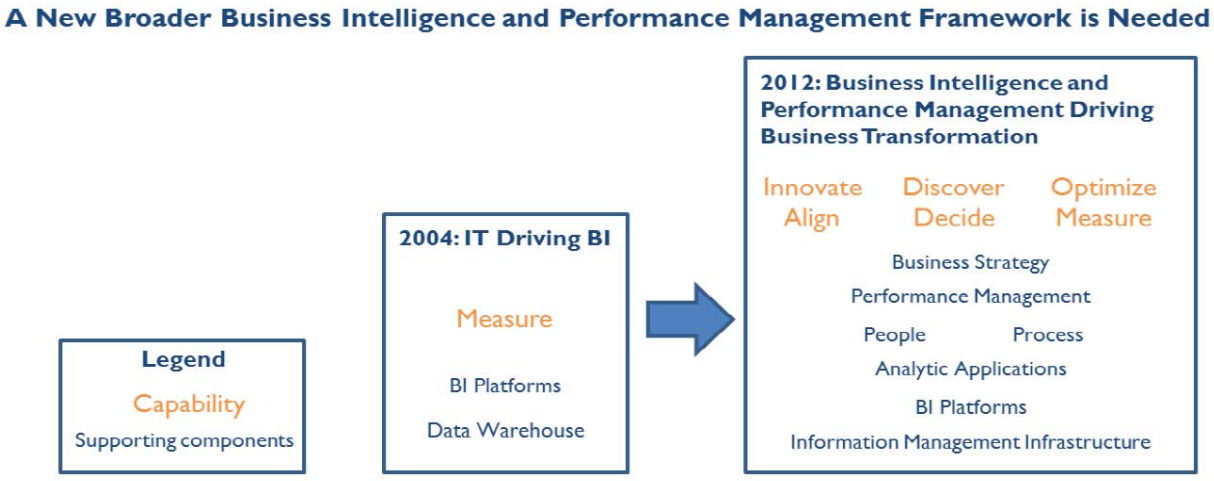


Figure 2: Gartner Symposium (White, 2014)

The BI framework is used to describe, align and integrate the metrics, people, processes, components and capabilities associated with the different layers within a business and places them into an expanded business orientated context. BI applications provide information at the right time, place and format to assist management and decision makers by combining operative data with analytical tools that provide compound and competitive information.

Donor, financial and client information is often kept in separate information silos. BI applications allow for the collection and integration of data from several sources. These applications can collect data from Microsoft applications such as Excel and Access databases, or databases that have an application programming interface.

Most BI applications transfer data into caches, “virtual storage spaces” or segmented data warehouses. Creating separate databases, allowing the data editing for enquiry without affecting the integrity of the data in the original database (Yurgosky, 2012).

2.3 The Purpose of Business Intelligence within the Consultancy Industry

In today's competitive marketplace, a company can benefit from its own distinctive BI processes, ensuring a competitive advantage over its market rivals. BI applications can identify crucial information about a company's customers, vendors and products which will assist executives in making informed decisions (Chou et al., 2005).

BI applications are greatly dependent on the size of the organisation and the sector in which it operates. The SMB Group released the survey, SMB Routes to Market Study, which revealed that SMB's top technological challenge is "getting better insights out of the data they already have" (McCabe, 2010).

In small organisations, spreadsheets and other tools are often not sophisticated enough to complete the required tasks. Management and other decision makers need to comprehend that companies expand, the amount of data increases, new markets and opportunities arise. System growth and change need to be supported and understood by the organisation and key stakeholders.

Business Intelligence can assist an organisation to better understand future occurrences, by analysing the past. Different to traditional reporting tools BI reporting tools provide BI solutions that provide the business with a way to optimise and unify data collection, analysis and reporting. BI applications are built on a unified database, this makes it possible that every employee involved in the process can receive a single, real-time view of all the company data (McCabe, 2010).

By using BI reporting tools, decision makers and analysts will be able to access frequently updated information with more ease and less time, which supports faster and better decision-making. Figure 3 provides a graphical representation of how the BI application is able to provide a visual interface for accessing and circumnavigating through multidimensional data sources stored within the transactional systems.

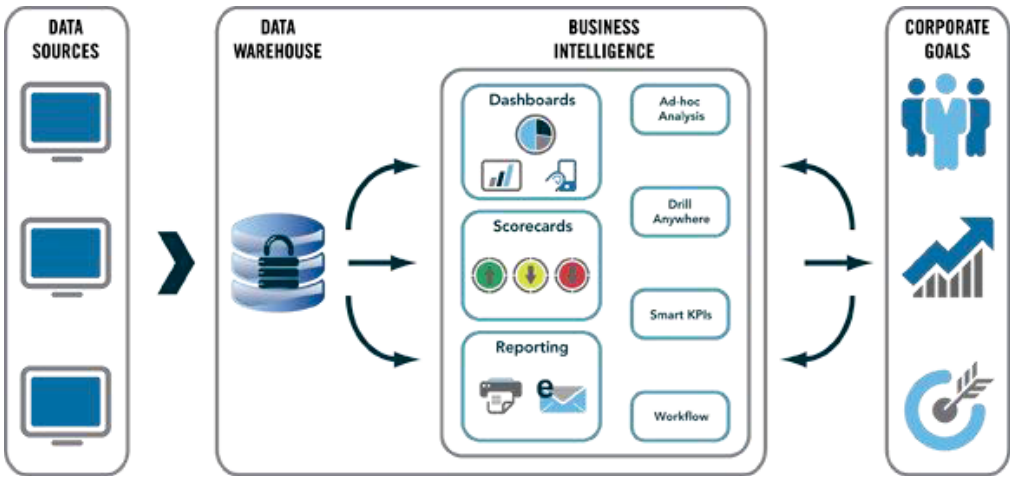


Figure 3: Business Intelligence Framework (Solutions, 2015)

A variety of views from the available data system may be generated using a powerful BI application as identified Figure 3, the user is able to generate reports, visualise data through dashboard and scorecards. Which can deliver valuable, well-structured cleansed and timely information.

2.4 The Need for BI Applications

BI applications can be used to produce many types of business views by enhancing data already available within the organisations information system.

Even if an organisation recognises the value of information contained in Enterprise Resource Planning (ERP) applications, the challenge remains in extracting the information. The ERP system cannot house the decision making function because it was not designed to provide information and reports in real-time (Agostino, 2004).

As a result more human resources are required as part of the data collection and analysis process. The spreadsheet approach typically include the following problems:

- Time consuming and labour intensive: Creating a model which is able to spread over the whole company, distributing and collecting information from various company members in multiple spreadsheets becomes cumbersome.
- Lacking collaboration and feedback capabilities: Attaining accurate opinions becomes difficult because, real-time data sharing and updating is not a functionality in desktop spreadsheets.
- Error prone: In the absence of an audit trail, changes made and errors within the system may be overlocked, resulting in choices made based on incorrect information.
- Insufficient analysis and reporting: Information collection and compounding using spreadsheets is troublesome.

More organisations are starting to shift their current organisational systems such as Excel, to BI systems in order to justify their ROI. BI applications have the ability to gather data which is stored in the ERP system for the execution of various analyses and provide high end reporting capabilities, which help decision-makers to make quick and accurate decisions.

Organisations are beginning to utilise BI applications to spread their ERP systems beyond the back-office level of use to increase customer satisfaction, sales and decision-making (Stedman, 1999).

Although many of the existing systems have the basic reporting and query capabilities, their organisational data is spread over the many information systems. ERP has an isolated reporting capability which is not sufficient for organisations which require a combined view of the business functions. BI applications provide tool sets that can be used throughout the entire organisation, to obtain, analyse and share information contained various data sources.

2.5 Cutting Edge Commerce's Current Business Intelligence Software

Cutting Edge Commerce currently uses a StratWare toolset which contains a complete business intelligence platform which is rapidly deployable within a period of 4 weeks (Commerce, 2014). This allows for the immediate return on investment without the need for prolonged development cycles, costly external consultants and key staff secondment.

CEC takes advantage of IP from a range of industry experts, in order to provide wide variety of pre-populated BI toolsets and services within functional areas such as:

- Master Data Management
- Procure to Pay
- Inventory Management
- Outbound Logistics
- Finance and Compliance
- Human Resources
- BBBEE Score-carding
- Performance Management

2.5.1 Information Gathering and Presentation

Information is most commonly presented on an editorial basis, through the use of dashboards designed for senior management which allows them to drill down into absolute detail to focus on business functionaries and individual transactions.

The StratWare toolset allows for performance monitoring functions which function on corrective actions and a granular basis, providing a simple yet elegant "Consulting in a Box" solution (Commerce, 2014).

CEC is able to analyse every business cycle and provide their clients with complete visibility on their:

- Spend and Materials Management
- Integrity of underlying data (transactional, configuration and master data)
- Efficacy of related business processes
- Compliance defects
- Cost saving opportunities
- Improvement strategies
- Tracking of performance

2.5.2 CEC Client Offerings

Cutting Edge Commerce id able to provide their clients with expert advisory services in addition to easy-to-use, high-end analytical toolsets which are able to (Commerce, 2014):

- Eradicate and/or reduce business costs
- Improve cash management
- Identify compliance defects and enhance compliance
- Improve service delivery
- Optimise stock investment
- Rehabilitate and improve master data
- Optimise business processes
- Identify cost saving opportunities
- Drive improvement strategies
- Monitor and track performance

2.6 Core Functions and Architecture of the StratWare Toolset

A quality BI application typically consists of specific data models which include all of the necessary data modelling and transformation capabilities required to manage customer level customizations, BI tool meta-data and pre-built reporting content (Commerce, 2014).

The StratWare toolset is a pre-built analytic system which provides a more cost effective, faster to implement, easier to maintain, and more feature rich toolset than the design and implementation of a custom built analytic application. StratWare takes advantage of BI analytics expertise, in order to provide BI frameworks for BI implementation.

The frameworks mentioned above consist of pre-built KPI's, reporting tools and dashboards, that speed-up deployment of the framework and reduces costs. The structure and use of StratWare within CEC is depicted in Figure 4, bellow.

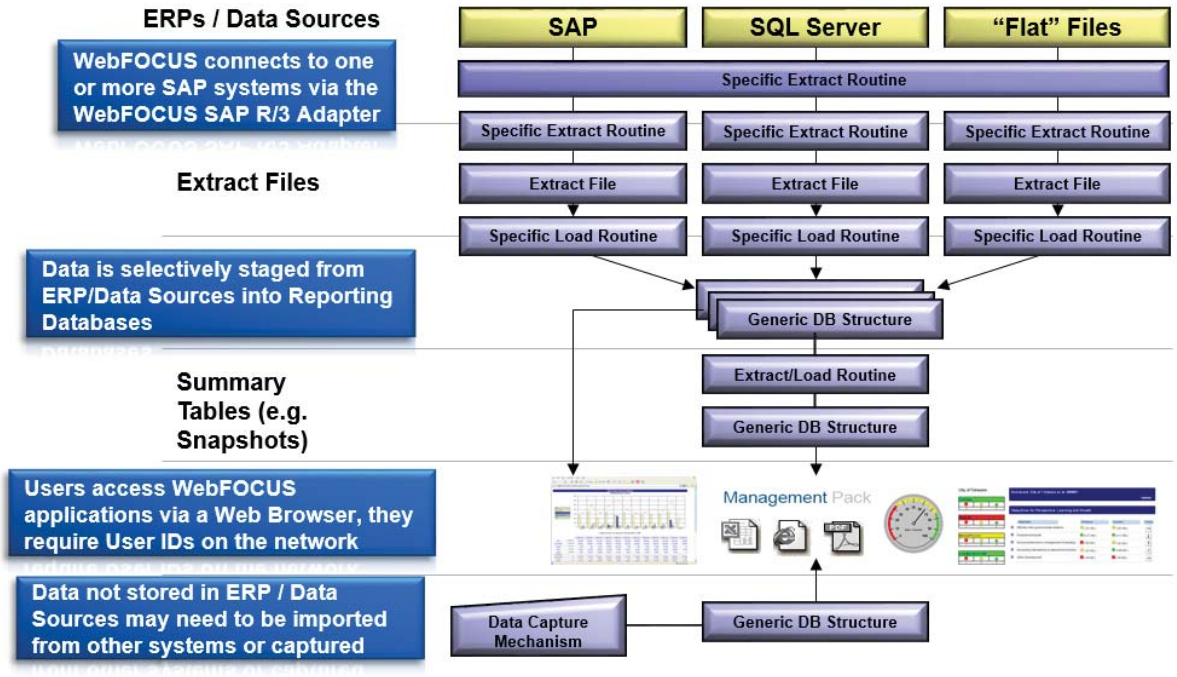


Figure 4: StratWare Toolset Structure and Organisational Interaction (Commerce, 2014)

2.6.1 Cutting Edge Commerce and StratWare Implementation

CEC has several years of StratWare implementation experience. CEC has used this experience to develop a library/database of BI building blocks and pre-existing frameworks which offer functionality such as:

- Pre-built KPI plug-ins and customizable ETL (Extract, Transform, and Load) tools for diverse businesses and data models for various verticals
- Pre-built dashboards and reports across Financial Analytics, Procurement and Spend Analytics, Human Resources Analytics, etc.

Key Benefits
When successfully implemented and used the StratWare toolset will offer the following key benefits to its users:

- Fast time-to-value and lower resource cost
- Enterprise-wide, cross-value-chain pre-built analytics
- Best-practice-based analytics by industry, function, and role
- Address business-specific problems with customized framework implementation.

StratWare framework offerings:
Apart from cost and time benefits, the StratWare framework provides the following elements:

- Information-centric architecture
- Single Version of the Truth
- Role-based security
- Centralized and reusable metadata
- Best-practice-based BI/DW applications
- Ad hoc analyses by end-users

Accelerated BI frameworks:
The accelerated BI framework is set apart by the following characteristics:

- The framework is domain-focused, flexible, and modular and is developed and tailored to client requirements.
- The framework functions independent from the platform where the business information of the customer is stored.
- The accelerated framework has a reputation for developing innovative BI frameworks for most types of industries.

StratWare's pre-built toolset provides the user with immediate access to analyse:

- Critical data that must be measured.
- The data that should be captured and who is responsible for capturing the data.
- Actions that will result from the data captured.

2.7 Commercially Off the Shelf Business Intelligence Applications

In some circumstances it is more practical to buy and information system than it is to build one. Many organisations tend to only build their own information systems when they can gain a direct competitive advantage (Whitten & Bentley, 2005).

As in all make vs. buy decisions, the systems system currently in use has a big impact on the final decision. The term commercial off-the-shelf (COTS) *s*oftware is a term used differentiate between different types or levels of pre-built software. COTS is a software product, supplied by a vendor, to accomplish explicit functionalities as part of the system (Morisio et al., 2000).

Using various types of COTS software will always have advantages and disadvantages associated with the selected COTS software. It is the auditors responsibility to thoroughly evaluate and understand the risks that come with implementing a the specific software (Pat Phelan, 2006).

When new software is needed the selection of the appropriate product is often difficult. Factors such as politics, technology, and economics must be taken into account when selecting a COTS application, which increases the difficulty (Whitten & Bentley, 2005)

The purpose of the procurement and the decision analysis phase are as follows (Whitten & Bentley, 2007a) (J. L. Whitten & Bentley, 2007a):

- Identify products which may possibly meet the requirements of the recommended solution.
- Various vendor proposals should be identified, evaluated and compared.
- The identification and recommendation of the optimal vendor proposal.
- Implement the selected vendor COTS application.

The commercial off-the-shelf software offer some of the following advantages and disadvantages listed in Table 1:

Table 1: Advantages and Disadvantages of COTS Software **(Whitten & Bentley, 2007b)**.

Advantages	Disadvantages
• These systems can be implemented in less time.	• The successful implementation of a COTS relies on the long-run achievements of the vendor.
• The vendor holds the responsibility of system improvements and any errors that might occur.	• The purchased software does not normally have all of the functionalities that in-house software could provide.
• The invest in continuous improvements is possible as vendors spread the development cost between customers that purchase the software	• Resistance to change will almost always be a factor. Some of the users might have to assume new responsibilities.
• Provides a framework for the organisation to work from, as most required functions across organisations in the same sector are very similar.	
• Less expensive than most in-house solutions.	

Business Intelligence consultants are often required to determine whether it makes sense to buy a pre-built analytics solution. As in all make vs. buy decisions, the existing systems and requirements play a key role in the decision (Commerce, 2014). The options below may assist in the decision:

Choose Pre-built if:

- Single major source for all key data.
- Extremely complex source systems. Big ERP.
- Do not have table and data level documentation.
- Key data (sales, customer, product, marketing, orders, inventory) in a single system.
- Have existing integration processes for real time and external coordination
- Looking to jump-start a BI/DW effort.
- Aggressively minimizing IT head count.
- Processes are regulated or standardized.

Choose Custom if:

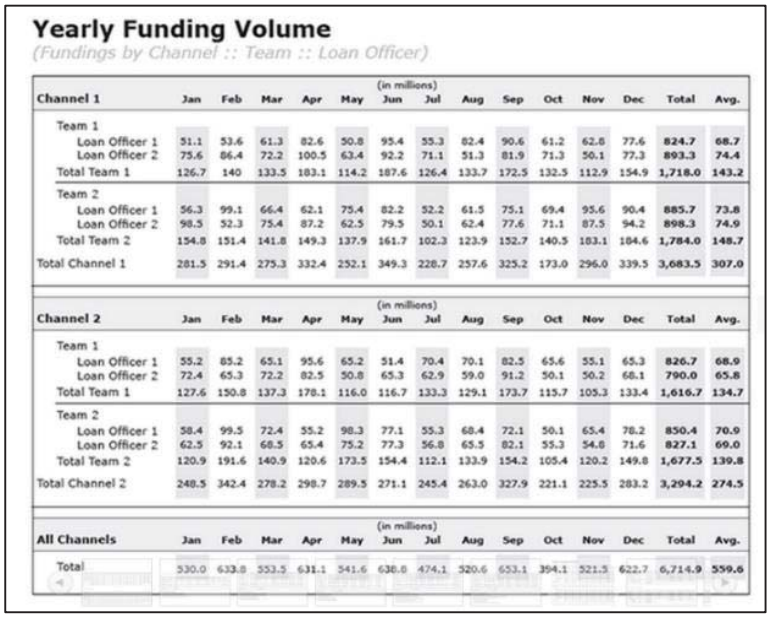
- Multiple sources.
- Production, sales, and or marketing in different systems.
- As a result of major mergers, different units have different business processes.
- Source is a significant customization of packaged software or fully custom system.
- System not always at the package supported version.
- Multiple instances of the same major system with different configuration, version, or customization.
- Not Big ERP
- Highly customized ERP.

2.7.1 Essential Components of a COTS, BI application

A Business Intelligence application is comprised of three essential components and four essential layers. The implementation and use of these components will help to ensure a strong product which can be used effectively as part of the organisation. The three essential components are as follows:

Reporting

An organisation's BI is linked to reports that drill down to a detailed level. These reports allow business users to identify and solve potential problems, Figure 5 provides an example of a generated report that provides the end-user with valuable and detailed information in a timely manner.



Yearly Funding Volume

(Fundings by Channel :: Team :: Loan Officer)

(in millions)

Channel 1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Avg.
Team 1														
Loan Officer 1	51.1	53.6	61.3	82.6	50.8	95.4	55.3	82.4	90.6	61.2	62.8	77.6	824.7	68.7
Loan Officer 2	75.6	86.4	72.2	100.5	63.4	92.2	71.1	51.3	81.9	71.3	50.1	77.3	893.3	74.4
Total Team 1	126.7	140	133.5	183.1	114.2	187.6	126.4	133.7	172.5	132.5	112.9	154.9	1,718.0	143.2
Team 2														
Loan Officer 1	56.3	99.1	66.4	62.1	75.4	82.2	52.2	61.5	75.1	69.4	95.6	90.4	885.7	73.8
Loan Officer 2	98.5	52.3	75.4	87.2	62.5	79.5	50.1	62.4	77.6	71.1	87.5	94.2	898.3	74.9
Total Team 2	154.8	151.4	141.8	149.3	137.9	161.7	102.3	123.9	152.7	140.5	183.1	184.6	1,784.0	148.7
Total Channel 1	281.5	291.4	275.3	332.4	252.1	349.3	228.7	257.6	325.2	173.0	296.0	339.5	3,683.5	307.0

(in millions)

Channel 2	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Avg.
Team 1														
Loan Officer 1	55.2	85.2	65.1	95.6	65.2	51.4	70.4	70.1	82.5	65.6	55.1	65.3	826.7	68.9
Loan Officer 2	72.4	65.3	72.2	82.5	50.8	65.3	62.9	59.0	91.2	50.1	50.2	68.1	790.0	65.8
Total Team 1	127.6	150.8	137.3	178.1	116.0	116.7	133.3	129.1	173.7	115.7	105.3	133.4	1,616.7	134.7
Team 2														
Loan Officer 1	58.4	99.5	72.4	55.2	98.3	77.1	55.3	68.4	72.1	50.1	65.4	78.2	850.4	70.9
Loan Officer 2	62.5	92.1	68.5	65.4	75.2	77.3	56.0	65.5	82.1	55.3	54.8	71.6	827.1	69.0
Total Team 2	120.9	191.6	140.9	120.6	173.5	154.4	112.1	133.9	154.2	105.4	120.2	149.8	1,677.5	139.8
Total Channel 2	248.5	342.4	278.2	298.7	289.5	271.1	245.4	263.0	327.9	221.1	225.5	283.2	3,294.2	274.5

(in millions)

All Channels	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Avg.
Total	530.0	633.8	553.5	631.1	541.6	638.0	474.1	520.6	653.1	394.1	521.5	622.7	6,714.9	559.6

Figure 5: Reporting Example (Solutions, 2015)

Dashboards

As seen in Figure 6, dashboards are data visualisation tools that function as a graphical interface which displays the status of metrics and Key Performance Indicators (KPIs) of an organisation. It allows users to graphically see a top level data summary it also provides the user with the ability to drill down to levels of data to identify exceptions and solve complications (Analitics, 2013).

Scorecards

A Balanced Scorecard is an analysis system which is used to identify the organisation's objectives and business strategy into exact and measurable goals. Figure 7 provides a display of how the scorecard is used to monitor the organisation's performance with regards to achieving their objectives (Analitics, 2013).

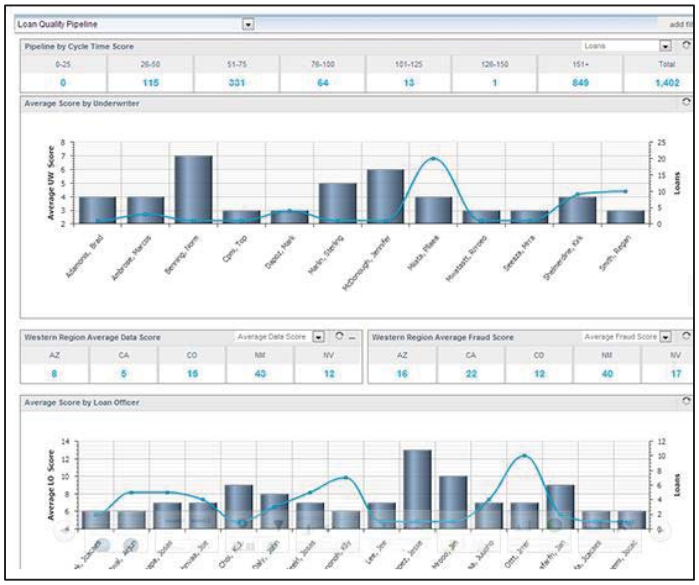


Figure 6: Performance Dashboard Example(Motivity, 2015)

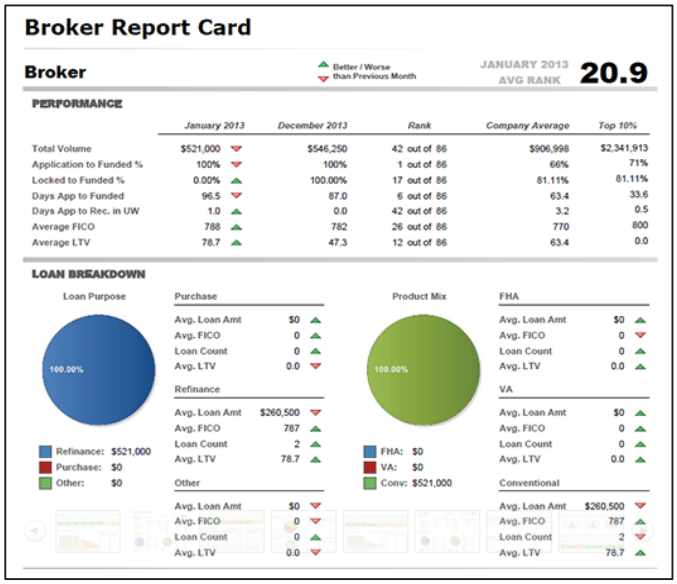


Figure 7: Performance Scorecard Example (Solutions, 2015)

The market place can be better understood by the use of BI which are comprised out of different layers of capabilities. Figure 8, provides a view of the various layers of the BI applications capabilities.

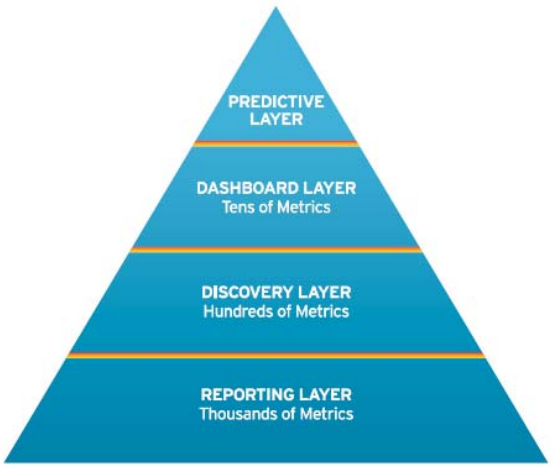


Figure 8: BI Pyramid Depicting the Layers of BI Capabilities (Radius, 2014)

- The reporting layer: This layer provides stationary and interactive report to users within the organisation.
- The discovery layer: This includes all skilled analyst activities to query and explore data, and create visualisations on an ad-hoc basis.
- The dashboard layer: Key operational data such as KPIs' and scorecards can be viewed visually.
- The predictive layer: A highly focussed domain that uses large data sets to identify future events that may happen.

2.7.2 Essential BI Application Features

Targeted, data-driven business decisions are a necessity in today's competitive market. One of the best methods for an organisation to retain its competitive advantage is by leveraging the company's data to achieve greater oversight and offer analytics-based business actions.

When considering the acquisition of a new BI application, features such as mobile accessibility, flexible export formats and financial analysis tools need to be considered in the selection process (Business-Software.com, 2015).

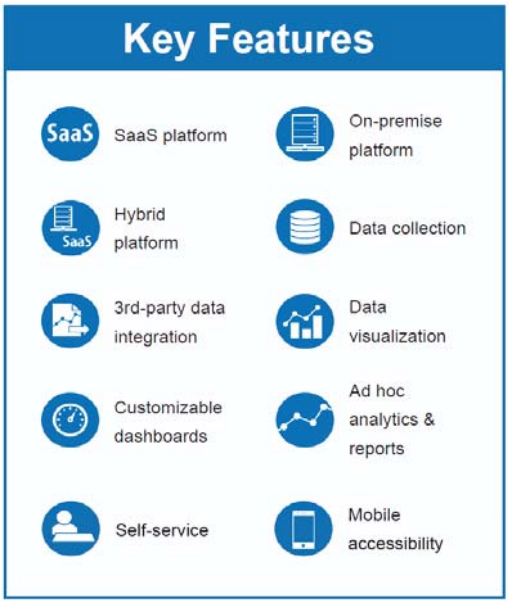


Figure 9: Key Features for Business Intelligence Software (Business-Software.com, 2015).

The key feature descriptions displayed in Figure 9, are described as follows:

- SaaS – Software as a Service

Software as a Service (SaaS) is a software delivery model. The application is hosted within the model by a vendor or service provider. SaaS is becoming a widely used delivery model (Rouse, 2010).

- Hybrid Platform

A hybrid platform is created by integrating "the cloud" and SaaS, this allows for the network to bridge the gap between the organisations existing enterprise such as databases, warehouses, applications, and legacy systems as well as SaaS, Business to Business (B2B), Business to Customer (B2C) and big data (MuleSoft, 2015).

- Customisable Dashboards

Customisable dashboards provide instant visibility into the organisations' overall status and analysis of initiatives with scheduled email delivery. KPIs can be tracked easily using reporting (Brightedge, 2013).

- Self-service

The self-service approach enables end-users to create personalised reports and analytical queries while reducing the amount of IT staff needed. Most of the time self-service BI software will be used by staff who are not computer experts, this is why the user interface must be user friendly and easy to use.

- On-Premise Platform

A software delivery mode that is installed and run from an organisations' server and computing structure. The software then uses the organisations' own computing power, requiring only a license or purchased copy of the software from an independent software vendor (Janssen, 2010).

- Data Collection

Data collection is a component of SQL Server that collects different data sets, it runs either constantly or on a predefined defined schedule. The data collected is stored in a relational database known as the management data warehouse (Sarrayanan, 2014).

- Data Visualisation

Today's data visualisation tools go beyond the conventional use of graphs and spreadsheet as presentation tools. These tools assist to display intricate and in detailed big data for better analytics (Bowden, 2014).

- Ad-hoc analysis and reporting

Ad-hoc analysis can answer specific business questions, which usually produces a statistical model, an analytical report or various types of data summaries. Reports are easily created or used to drill down into a static report in order to access information about accounts, transactions or other records (Rouse, 2014).

- Mobile Accessibility

This feature allows an analyst to gain access to BI-related data in terms of organisation metrics, KPIs and dashboards on mobile devices. Instant access to dashboards and reports is possible through a touch enabled browser. Business performance can be monitored and inspected on a mobile devices such as smartphones (Dresner, 2013).

2.7.3 COTS Categories for BI software products

Before the specifications for the required system is determined it is important to identify the type or category of software that is required.

Table 2 bellow provides a summary of the various categories of BI software products, as well as the advantages and disadvantages associated with each category. A best-fit use case is given to provide scenarios best fit for the type of BI software product to be implemented in (TrustRadius, 2014).

Table 2: BI Software Categories and their Advantages and Disadvantages (TrustRadius, 2014)

TYPE OF TOOL	TRADITIONAL FULL-STACK	CLOUD FULL-STACK	DISCOVERY & VISUALIZATION	DASHBOARDS	PREDICTIVE ANALYTICS
Function	Cover most or all layers of the pyramid including the underlying infrastructure, which involves various kinds of data stores, and Extract, Transform and Load (ETL) technologies. Most vendors have added discovery and visualization capabilities, but not all include predictive capability. The focus of these tools is the provision of detailed, often operational reports, based on thousands of metrics, to users across the organization. These reports describe "what happened."		Discovery and visualization tools are designed for ad-hoc analysis of multiple data sources and answer the question, "why did it happen?"	Dashboard tools keep your eye on KPIs and scorecards to answer the question, "what's happening now?"	Predictive tools at the top of the pyramid are used by highly skilled data scientists to answer the question, "what is most likely to happen next?"
Technology	On-premise business warehouse/ ETL (emerging cloud and in-memory visualization models)	Multi-tenant SaaS deployments of full-stack solutions	In-memory, direct connect, some ETL	Presentation layer sitting on top of full-stack solutions	Becoming an integral part of the big data world; new tools being built on R open-source platform
Advantages	Consistent, single source of the truth; enterprise alignment	Relatively inexpensive, fully featured	Quick to build, low cost, powerful strategic insight	At-a-glance comprehension of key metrics. Alerts to exceptions	Accurate forecasting allows for better strategic planning
Disadvantages	Often expensive, very difficult to deploy, and non-intuitive user interface	Some companies not comfortable storing data in cloud.	Not suitable for cross-company reporting infrastructure	Easy to ignore red flags. Training required on appropriate responses	Requires advanced data science skill set
Best For	Enterprise reporting infrastructure deployments with IT governance and oversight	Fast deployments without upfront investments in hardware and infrastructure	Exploration of data sets and building ad-hoc visualizations to share with others	Display of operational metrics like KPIs, scorecards	Forecasting future probabilities based on deep data analysis
Example Products	IBM Cognos, SAP Business Objects, Microsoft BI, MicroStrategy Analytics, SAS Business Intelligence, Teradata	Birst, GoodData	QlikView, Tableau, Tibco Spotfire, Entrinsik Informer	iDashboards, Yellowfin	Revolution Analytics R., SPSS, SAS

1. Full-Stack BI Software

A start to end solution is provided with regards to data challenges experienced by the organisation. The full-stack BI software category contains three different product types. The subcategories include:

- Full-Stack On-Premise BI Solutions

Organisational data and external is taken from a variety of sources within an organisation. This data is then placed into a common data store for further analysis and reporting (TrustRadius, 2014).

- Open Source Full-Stack BI Solutions

These products are derived from open source projects, but many of them are commercial software based on that open source stack.

- Cloud Full-Stack BI Solutions

These are products designed as cloud based products from the start, most of these offer true SaaS multi-tenant software rather than single-tenant cloud deployments on an individual customer basis.

2. Cloud Full-Stack BI Software

Cloud based full-stack BI software include components such as data stores, ETL and semantic layers and a range of front-end presentation tools. It is easier to implement and does not require as much IT support as traditional full-stack BI products.

3. Discovery & Visualization Software

Data discovery and visualization tools are designed for data analysts and more technical business users. They are mostly used for performing ad-hoc analysis of multiple data sources. They provide data analysts with a way to sift through large volumes of data to expose patterns and outliers within the data.

4. Dashboard Software

Dashboards provide easily understandable graphical demonstrations of data. Dashboards allow for the monitoring various key metrics to ensure that everything is going to plan.

5. Predictive Analytics

BI is usually considered as descriptive information and investigates what has happened in the past to comprehend business drivers, while predictive analysis is focussed on finding the hidden patterns in data using mathematical models to predict future outcomes.

2.7.4 Identification of COTS BI Applications

Selecting a BI platform in an increasingly evolving market is not an easy task and usually results in a long and tedious selection process to select the right BI and vendor. In order to assist organisations with the selection of a BI application, a study was done by Ovum (2014), a leading research and consulting organisation.

A survey was done by Ovum, where after they published the Ovum Decision Matrix report to help enterprises select the most appropriate BI solution (Mukherjee, 2014).

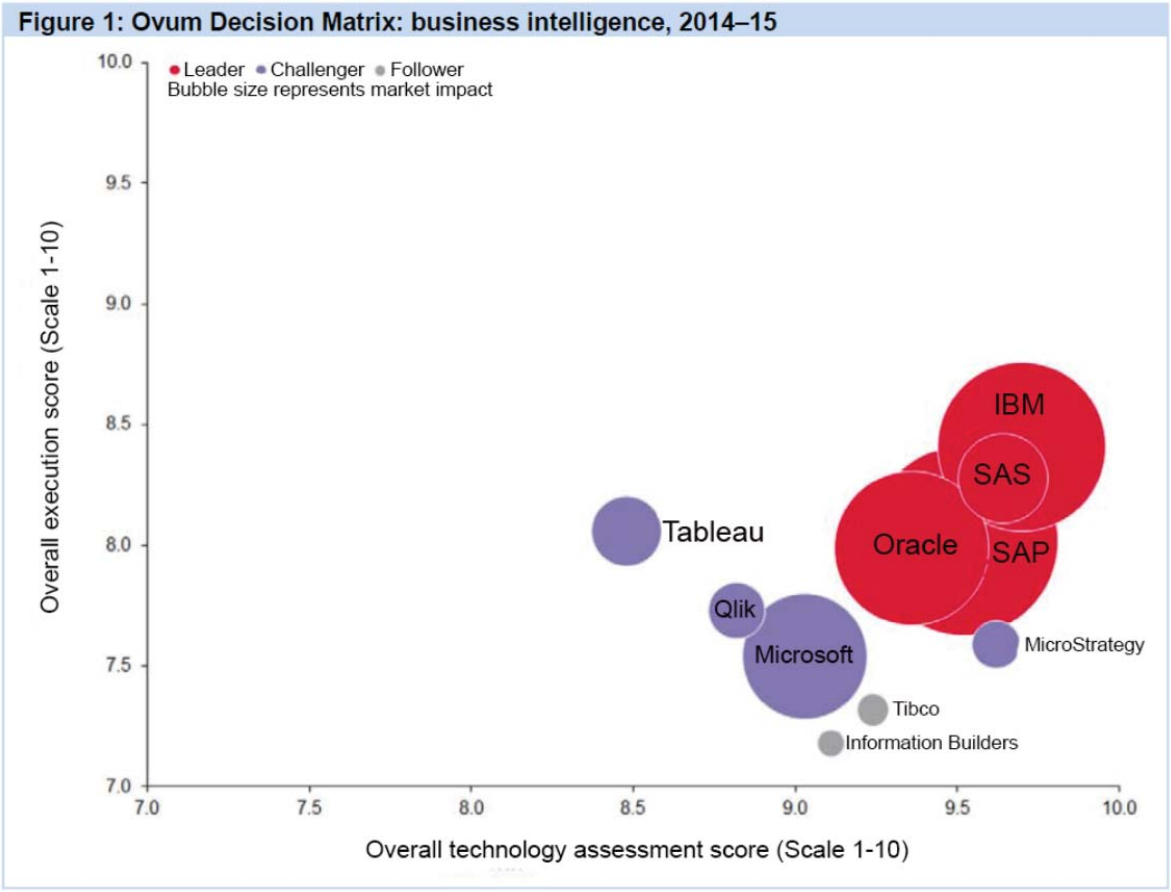


Figure 10: Business Intelligence Decision Matrix (Mukherjee & Jennings, 2014).

The Ovum report, Ovum Decision Matrix (2014), for selecting a BI solution suggests that only certain vendors should be included in the vendor list before the analysis of various BI applications is initiated. The criteria is identified as follows:

Inclusion criteria

The inclusion criteria for the BI Decision Matrix are as follows:

- A BI solution should be given that allows for all modules to be well integrated.
- The application provider must have plenty of active experience.
- The vendor should show substantial presence in the BI market.
- The solution must be available at the current time and date.

Ovum analysts have developed a series of criteria which can be used to identify leading vendors in the market place. The criteria is divided into the following three categories:

1. Technology or system assessment

The criteria for functionalities that differentiate solutions form one another identified for BI are as follows:

- Self-service automation and visual discovery
- Reporting and monitoring
- Mobility
- Query and analysis
- Advanced analytics and data mining
- Data sourcing and integration
- Administration and system management
- Customization and development
- Packaged BI applications

2. Execution

A review of the capability if the solution in terms of the following:

- Maturity
- Interoperability
- Innovation
- Deployment
- Enterprise fit
- Scalability

3. Market impact

Global impact is divided into five categories.

- Revenue growth
- Size-band coverage
- Vertical penetration
- Geographical penetration

Figure 11 below, provides a short summary of the commercial off the shelf applications available for BI. The applications are divided into market leaders, challengers and followers.

Market leaders	Market challengers	Market followers
IBM	Microsoft	Information Builders
Oracle	MicroStrategy	Tibco
SAP	Qlik	
SAS	Tableau	

Figure 11: BI Applications Identified (Mukherjee & Jennings, 2014).

Table 3, provides the top 20 most popular BI applications identified by Capterra. Capterra is a BI software identification website used by businesses to identify and select the best BI application for their needs. Capterra groups the different BI applications by the customer base, user base and social media popularity (Capterra, 2015).

Table 3: Top 20 Most Popular BI Applications (Capterra, 2015).

Business intelligence software	Customers	Users	Twitter	Facebook	LinkedIn
SAP	37 153	4 990 767	138 481	272 691	505 115
Oracle	24 769	3 327 223	299 884	496 556	1 273 829
Qlik	33 000	4 000 000	20 999	22 740	30 296
IBM	23 000	3 089 593	22 350	5 992	2 089 906
Tableau	21 230	3 000 000	43 970	49 732	52 068
SAS	15 923	2 851 829	14 724	61 429	172 056
Microsoft	13 000	2 138 939	169 436	260 527	2 009 208
Information Builders	5 200	2 396 292	9 317	12 782	8 143
Targit	10 000	376 000	4 585	584	1 995
Yellowfin	4 000	1 500 000	2 587	46	736
MicroStraregy	4 000	2 000 000	27 568	14 627	44 441
TIBCO	4 000	537 321	12 993	7 097	4 715
Arcplan	3 200	429 856	413	243	548
InetSoft	3 000	402 990	179	363	528
Board	3 000	300 000	630	451	632
Panorama	2 000	214 928	4 243	1 464	1 553
Pentaho	1 500	200 000	11 193	4 547	7 038
Logi Analytics	1 500	200 000	4 552	534	7 744
Altery	700	200 000	5 620	360	8 636
Domo	600	80 598	30 400	7 060	44 867

2.8 COTS Business Intelligence Application Selection methods

When performing a “buy” analysis as part of the software acquisition strategy, most organisations primarily consider the system requirements and cost. By using a formal method, it is possible to mix different types of criteria into a cohesive decision.

2.8.1 Misconceptions Made when Selecting a COTS BI Application

A BI solution requires a large investment. To ensure that the best use is made of the selected toolset an organisation must think horizontally across the business rather than in individual departments.

Misconceptions about data, technology, training and implementation is common during the selection of COTS software as seen in Table 4 (Dresner, 2015).

Table 4: Misconceptions Made during the Selection of COTS BI Software.

Technology and tools	Data
• Using the BI toolset to bridge the gap for not understanding the business. • Not using BI to solve problems. • Generalising the various types of solutions or tools	• Classifying the lack of data quality as a technical issue. • Assuming that the quality of data is not a problem. • Using bad underlying data just because the BI tool can produce good looking charts. • Making the assumption that not all the data is not relevant.
Training	**Implementation**
• Insufficient funding for the training needed. • Misjudging the amount of training needed.	• Applying BI applications without use cases. • Being unwilling to disrupt the processes in place to gain the BI success.

2.9 Suitable BI Application Selection Process

In order to determine the BI application selection framework, a proposed methodology is described (Wei, Chien, & Wang, 2005):

1. Collect information concerning the BI vendors and applications.
2. Find the BI system features.
3. Construct the fundamental-objective pyramid and means-objective framework.
4. Mine the attributes for the evaluation of the BI application using the structure of objectives.
5. Eliminate vendors that do not meet the required specifications.
6. Evaluate the BI application by using a MCDM.
7. Validate the proposed BI application collected from the MCDM.
8. Make a conclusion and discuss results.

2.9.1 Multi-criteria Decision Making Model Selection

Various multi-criteria decision making (MCDM) support systems are available, each represented by a unique mathematical model (American Association, 2011). Each model implemented has its own set of strengths and weaknesses which must be considered when selecting the appropriate MCDM.

Decision making models such as scoring, multi-criteria decision analysis, mathematical optimization, and ranking have all been applied to BI and other information system selection in the past.

The scoring model can be viewed as an instinctive method, the downfall is that this model lacks the required complexity to reliably assist in the decision making process (Lucas, 1976). In 1983 the ranking approach was proposed to compare computing projects, also limited in the similarly to the scoring model.

The mathematical optimisation models such as goal programming, non-linear programming and 0–1 programming have also been applied to the optimisation of resources for information. Where nonlinear programming models were proposed to optimise resource allocation which allowed for the interaction of factors, but was still limited (Santhanam, 1996).

0–1 Goal programming models were used to select an IS project considering multiple criteria including advantages, hardware and other costs, risk factors, and training time constraints. However, these models are weakened by the fact that only a limited amount of real-world attributes can be modelled (Badri, 2001).

The Analytical Hierarchy Process (AHP) method, was introduced by Saaty (1980). By determining the relative weights of each attribute and applying those weights to the goal programming model a comprehensive MCDM was formed for the selection of information systems (Schniederjans, 1991).

AHP is one of the most common MCDMs to date. The AHP method is the selected decision support model for the identification of the most applicable BI application. It has been applied to various industries and is seen as one of the most popular mathematical models used for decision making. The process flow used for the AHP model can be found in Appendix B.

2.9.2 BI Application Evaluation Criteria

Following the vendor inclusion and exclusion process the AHP may be used to determine the appropriate BI application. In order to apply the AHP to find the optimal BI application a set of criteria must first be identified. Wei et al (2005), provide criteria which may be used as to evaluate the various BI applications. Figure 12, bellow illustrates criteria and sub-criteria.

Attribute details

	Attributes	Evaluation items	Means
System software factors	Total costs	1. Price 2. Maintenance costs 3. Consultant expenses 4. Infrastructure costs	1. Limited project budget 2. Limited annual maintenance budget 3. Limited infrastructure budget
	Implementation time		1. 6–9 months 2. Project management ability
	Functionality	1. Module completion 2. Function fitness 3. Security	1. Availability of necessary modules 2. Parameter setting 3. High function-fitness 4. Multi-currency, multi-language, and multi-site 5. Permission management 6. Database protection
	User friendliness	1. Ease of operation 2. Ease of learning	1. Graphic interface 2. Step-by-step command 3. Provision of a guidebook 4. Online learning 5. Online help
	Flexibility	1. Upgrade ability 2. Ease of integration 3. Ease of in-house development	1. Common programming language 2. Platform independence 3. Ease of integration with other IS
	Reliability	1. Stability 2. Recovery ability	1. Automatic data recovery 2. Automatic data backup

Figure 12: Criteria for System Software Factors (Wei et al., 2005).

2.9.3 Validation of the Selected BI Application

As the investment in information technology (IT) continues to rise the significances of failure become more severe. Many of researchers have suggested that user satisfaction is perceived as one of the key factors in the success of information systems (IS) (Mahmood, Burn, Gemoets, & Jacquez, 2000).

User satisfaction models have been examined, leading to the identification of the following key factors:

- Class of information extracted from the information system.
- IS user interface features.
- Quality of support provided by staff, manuals or vendors.
- User participation in the planning and development information system implementation.
- IS user attitudes.

2.9.4 End-User Surveys

End-user satisfaction in terms of an information system is defined as the overall experience an end-user has when using the information system. Previously focus has primarily been placed on measuring the satisfaction of the computing or use aspect of the system, or even the satisfaction with activities other than system use such as, training, participation or involvement in development (Chin & Lee, 2000).

Chin and Lee (2000), recommend that the term satisfaction or the synonym thereof must either be applied in a Likert-scale or a semantic differential scale format. When using a semantic differential scale, it is advised that close attention is applied when selecting additional adjective pairs that reflect the satisfaction construct.

Doll and Torkzadehs' (1991), 12-item Likert scale as seen in Figure 13, only measures the term satisfaction once. The measures that remain are either perceptual measures of the system for example, "Is the system easy to use?", or a gap measure of needs. It is believed that perceptual measures of the system and gap measures of desires represent only a percentage of the antecedent factors but are not equivalent to satisfaction.

A system that exceeds expectations, but not the desired needs, may still lead to the end-user feeling dissatisfied with the IS. Chin and Lee (2000), proposed an end-user satisfaction model which states that the overall feeling of satisfaction a user experiences is from both direct and multiplicative combinations of expectation-based and desire-based satisfaction.

Content

C1. Does the system provide the precise information you need? [F]
C2. Does the information content meet your needs? [F]
C3. Does the system provide reports that seem to be just about exactly what you need? [F]
C4. Does the system provide sufficient information? [C]

Accuracy

A1. Is the system accurate? [C]
A2. Are you satisfied with the accuracy of the system? [J]

Format

F1. Do you think the output is presented in a useful format? [C]
F2. Is the information clear? [C]

Ease of Use

E1. Is the system user friendly? [C]
E2. Is the system easy to use? [C]

Timeliness

T1. Do you get the information you need in time? [F]
T2. Does the system provide up-to-date information? [C]

Figure 13: End-User Satisfaction Computing Measures (Doll & Torkzadeh, 1991).

Chin and Lee setup a range of questions using Doll and Torkzadehs' five constructs given in Figure 13, in setting the baseline measures whilst adding additional questions which are general enough to allow researchers to measure other areas related to end-user satisfaction.

Table 5, provides the end-user satisfaction survey constructed by Chin and Lee (2000). The questions taken from Doll and Torkzadehs' 12-item user satisfaction survey are marked with a * at the end of each question in Table 5 below.

Table 5: Chin and Lee End-User Satisfaction Survey (Chin & Lee, 2000).

Content of the System	• Does the system provide the precise information you need?* • Does the information content meet your needs?* • Does the system provide reports that seem to be just about exactly what you need?* • Does the system provide sufficient information?* • Does the output from the system meet your needs? • Does the information provided by the system fit your needs? • Does the system give you the right amount of information for your needs?
Accuracy	• Is the system accurate?* • Are you satisfied with the accuracy of the system?* • Is the system error free? • Does the system provide correct information? • Does the system provide accurate information? • Does the system provide reliable information? • Is the information presented by the system dependable?
Format	• Do you think the output is presented in a useful format?* • Is the information clear?* • Are you satisfied with the layout of the output? • Is the format of the output satisfactory? • Are you satisfied with how the information is presented to you? • Are you satisfied with the way in which the information is presented?
Ease of Use	• Is the system user friendly?* • Is the system easy to use?* • Is it easy to get the system to do what you want it to do? • Is your interaction with the system clear and understandable? • Is the system easy to interact with? • Is it easy to operate the system?
Timeliness	• Do you get the information you need in time?* • Does the system provide up-to-date information?* • Does the system provide you with the information in a timely manner? • Does the system provide information that is too old to be useful? • Do you get information from the system that is too late for your needs?
Satisfaction with System Speed	Definition: The extent to which an individual is satisfied with the operational speed of the system? • Are you satisfied with how quickly the system operates? • Does the system operate at a satisfactory pace? • Are you satisfied with how quickly the system runs? • Is the speed of the system satisfactory?

Both usefulness and learnability are determinants of end-user satisfaction when considering information systems as well as the perceived ease of use, system capability and user guidance. In order to gather information to determine whether the end-users of an IS are satisfied with a software application surveys and questionnaires are commonly used. Survey questions can be adopted from literature and academics. An end-user survey is concerned with the respondent's satisfaction in using the IS.

The use of a five-point Likert-type scale is a common occurrence, where 1= very dissatisfied and 5= very satisfied. In order to measure the six interface usability characteristics as well as perceive usefulness and ease of use identified by Calisir (2004) a seven point Likert-type scale is used where 1= strongly disagree to 7= strongly agree.

The six usability characteristics identified by Calisir (2004) are as follows:

- System capability
- Compatibility
- Flexibility
- User guidance
- Learnability
- Minimal memory load

Five point Likert-scale (Calisir & Calisir, 2004):
1= Very dissatisfied
2= Somewhat disagree
3= Neutral
4= Satisfied
5= Very satisfied

Seven point Likert-scale:
1= Very dissatisfied
2= Somewhat disagree
3= Disagree
4= Neutral
5= Agree
6= Somewhat agree
7= Strongly agree

2.10 Sampling and Fact Finding Techniques

Sampling and fact finding is seen as the formal process of using meetings, research, sampling and interviews to gather information about system problems, requirements and preferences (Whitten & Bentley, 2007a) .

Whitten (2007b), identifies the following fact finding methods:

1. Sampling of existing documentation, forms and databases
2. Site visits and research
3. Work environment observation
4. Questioners and surveys
5. Interviews
6. Prototyping
7. Joint requirement planning (JRP)

2.11 Problem Investigation techniques

Problem investigation techniques are most commonly used to gain a better understanding of the opportunities, directives and problems of the element being studied. The following are just some of the problem identification techniques available:

2.11.1 SWOT Analysis

SWOT analysis entails the identification of strengths, weaknesses opportunities and threats. The SWOT analysis is a tool widely recognised for its use in a strategic audit, what makes this tool rather powerful is that can assist a business in uncovering the opportunities that the business may exploit.

Through the identification and understanding of the businesses weaknesses they can be better managed, whilst allowing for the elimination of threats (Piercy & Giles, 1989).

2.11.2 PIECES Framework

PIECES is a framework best used to classify problems (Whitten & Bentley, 2007c). Each letter in the word PIECES is used to represent a specific category where problems may arise. These categories may be identified as follows:

- P the need to improve performance
- I the need to improve information
- E the need to improve economics
- C the need to improve control
- E the need to improve efficiency
- S the need to improve service

2.11.3 Cause and Effect Diagram

To truly understand the problem analysis a cause and effect or “fishbone diagram” was used to categorise the possible causes of the problem. The main effect or problem is placed in the “head” of the fishbone diagram.

The possible causes of the problem are connected to the main bone of the diagram, the bones are categorises and the possible causes listed under each category (Whitten & Bentley, 2007d).

Chapter 3

3. Project Approach

The project was initiated by a literature review of BI applications to obtain background information regarding BI application features, components and various BI vendors.

The literature review assists in identifying the environment in which CEC's current BI application is functioning, the need for enhanced BI applications is determined as well as the benefits associated with the implementation of these applications. The option whether to build-or-buy a BI application is discussed as well as the method for selecting commercially off-the-shelf (COTS) applications.

The problem identification and analysis is done by using joint requirement planning (JRP), to construct a PIECES framework as well as a SWOT analysis of CEC. In order to identify the problem domain and better understand the environment of the BI application a context diagram is constructed. The context diagram is used to investigate how the system interacts with the environment around it, whilst identifying the various inputs and outputs of the system.

A cause and effect diagram is used to collect information concerning the business problems, opportunities and the improvement objectives. An analysis of the "As-Is" business processes of CECs' is performed by identifying and graphically depicting the various process flows within each phase of a project undertaken by CEC.

Through the use of interviews and JRP, the features required for the proposed BI application may be identified as part of the problem investigating phase. The system requirements are identified in order to construct an outline of the functional and non-functional requirements of the CECs' business intelligence needs.

During the Decision analysis phase various candidate solutions are identified analysed and compared in order to provide the needed information for making a BI application, solution recommendation. Sampling and research fact-finding techniques are used to identify the candidate BI solutions. Candidates are eliminated by evaluating each candidate against a minimum set of criteria. After determining the decision making criteria, the selected Multi-Criteria Decision Method (MCDM) namely the AHP method is used to compare the candidate system solutions, enabling an informed BI application solution recommendation for CEC.

In order to determine if the selected BI application solution will satisfy the requirements of CEC, an evaluation of the selected COTS will be conducted. Key stakeholders and BI application users within CEC will be provided with feedback forms to evaluate the recommended COTS application solution. To validate the result attained for the user satisfaction surveys statistical analysis will be used to determine whether the selected solution is valid.

Following the approval of the recommended solution the implementation and training phase will be executed. A conversion plan will be prepared, training specifications and system delivery plans developed to successfully implement the selected Business Intelligence application at CEC.

3.1 Project Approach and Techniques

The approach taken to successfully identify and implement the identified solution is presented graphically in Figure 14:

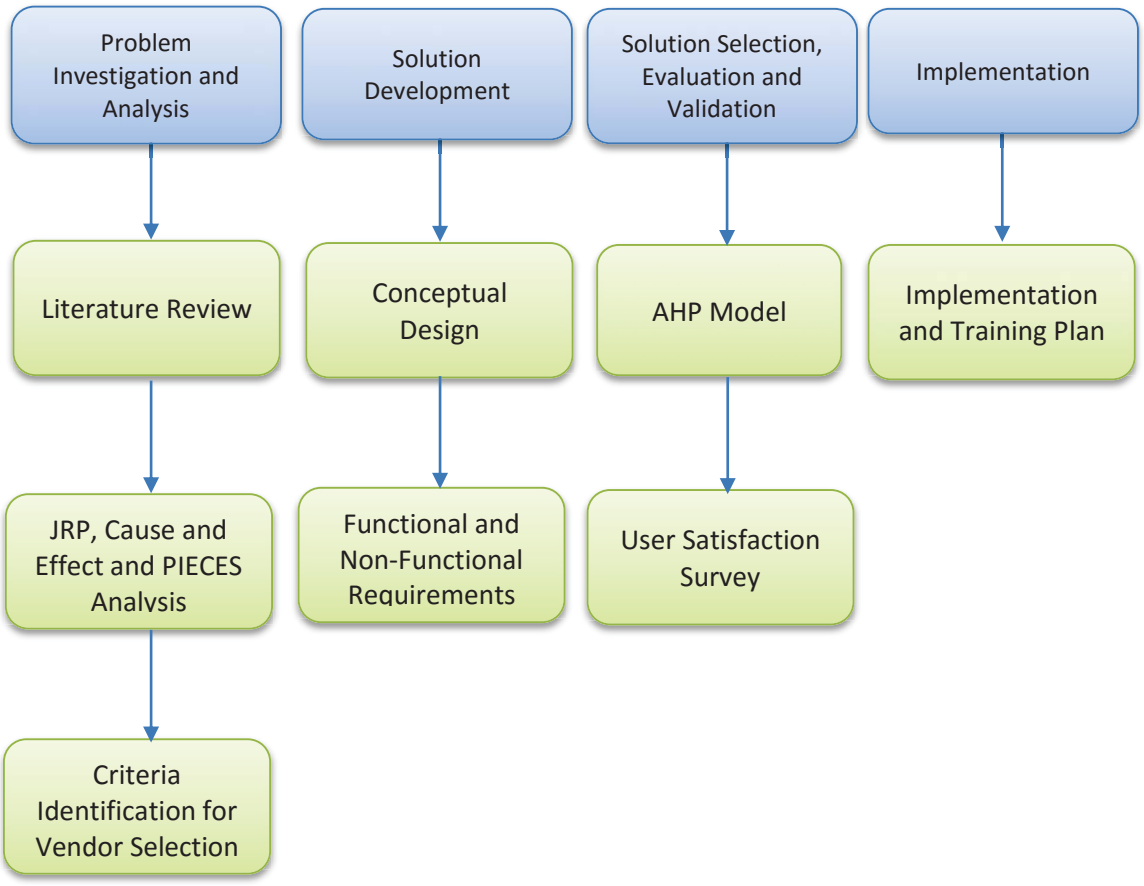


Figure 14: Project Approach and Techniques

Chapter 4

4. Problem Investigation

True problem investigation is a difficult skill to master. The problem investigation phase provides a thorough understanding of the problem, opportunities and directives within an organisation. In order to identify and understand the organisational pitfalls a comprehensive study is required.

The goal of the problem investigation phase is to study and understand the problem domain well enough to analyse organisational problems. Some mythologies require a detailed understanding of the organisations' as-is processes which are documented by means of data flow diagrams as well as cause and effect diagrams. The PIECES framework is an essential tool used to analyse the building blocks of problems, opportunities and causes (Whitten & Bentley, 2007d).

The problem analysis phase will consist of the following tasks:

1. Understand and analyse the problem domain.
2. Analyse the problem and opportunities.
3. Analyse the organisational processes.
4. Establish organisational requirements.

Organisational information was gathered using the joint requirement planning (JRP) technique, where a meeting was scheduled with key stakeholders. The information gathered includes process flows, "as-is" software specifications and general information concerning the environment in which CEC operates.

4.1 The Problem Domain

In order to identify the problem domain and better understand the environment of the BI application a context diagram is constructed. The context diagram is used to investigate how the system interacts with the environment around it, whilst identifying the various inputs and outputs of the system.

The context diagram can be seen in Figure 15, identifying the key stakeholders as the following:

- Project sponsor/ client
- Project team member
- Project leader/ manager
- Functional analyst
- Developer

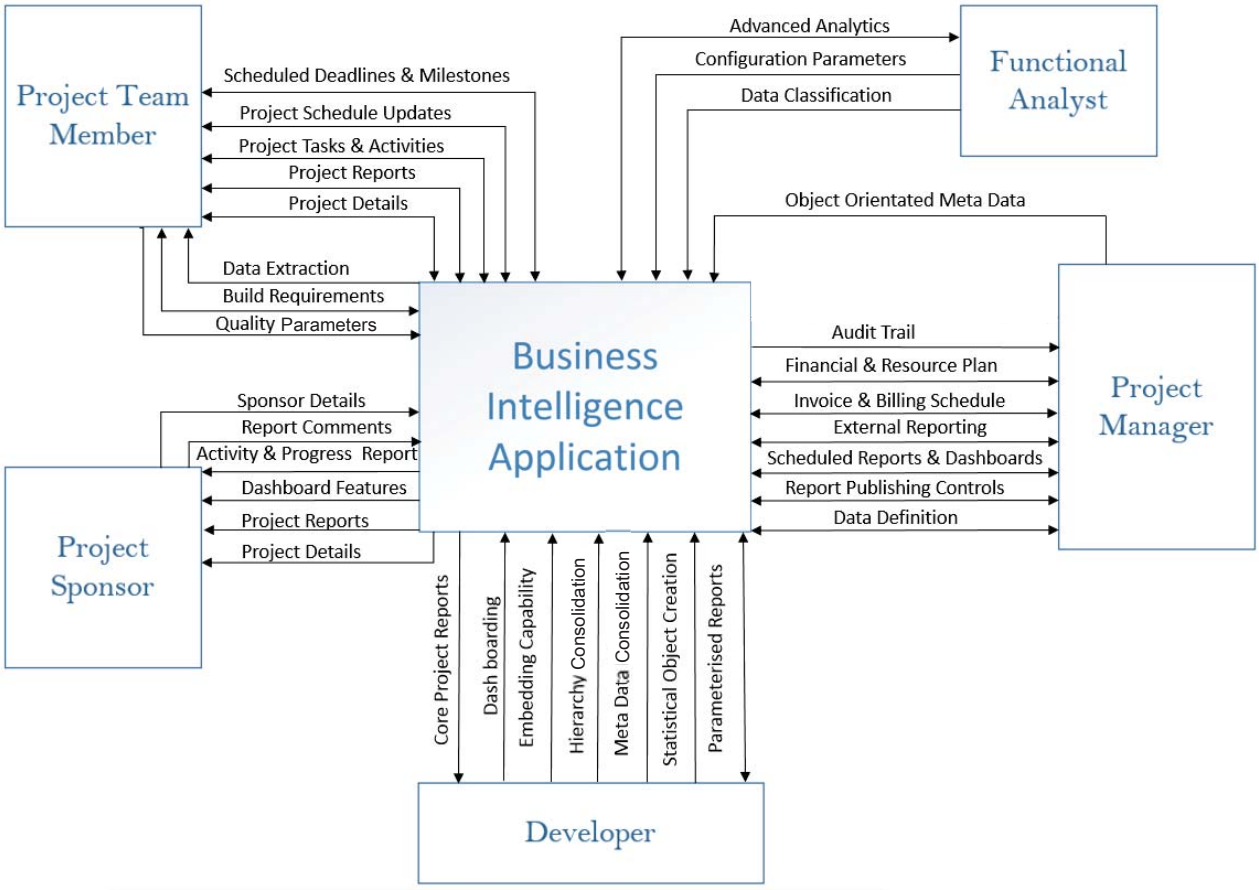


Figure 15: Context Diagram

4.2 Problem Identification and Analysis

The analysis involved must keep focus on the process, not only the people who preform them. Once again, fact-finding and JRP techniques are used to identify crucial information required for problem identification and analysis. The main “as-is” software pitfalls and opportunities have been identified using the PIECES framework and SWOT analysis, the results of these analysis are provided in Appendix A.

4.2.1 Cause and Effect Diagram

To truly understand the problem analysis a cause and effect or “fishbone diagram” was used to categorise the possible causes of the problem. Figure 16 illustrates the identified cause and effect diagram of Cutting Edge Commerce.

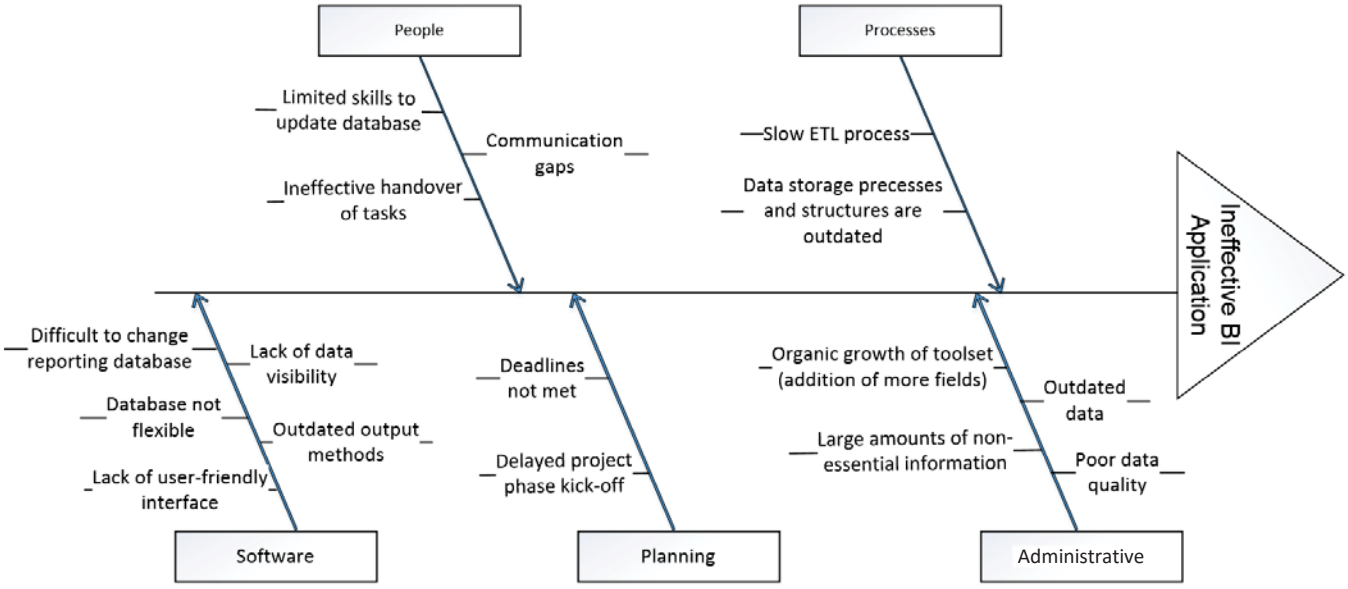


Figure 16: Cause and Effect Diagram

4.2.2 Identified Problems and Opportunities

The completed cause and effect diagram, SWOT analysis and PIECES framework, found in Appendix A, have been combined in order to compile a summary of the problems and opportunities identified during the analysis of Cutting Edge Commerce.
Identified Problems:

- The underlying WebFOCUS software is too cost intensive, reducing the annual revenue of CEC and substantially increasing the required budget.
- CEC cannot access small to medium companies as the high cost rates are not suitable for smaller organisations.
- Due to the complex software currently used, long development cycles are required to enhance toolsets.
- Lack of user maintainability resulting in additional resources to maintain customer satisfaction.
- User have a lack of data and information visibility.
- Time intensive ETL processes for required reports, resulting in time consuming report generation.
- Data storage and data structures are outdated, negatively impacting CECs' competitive advantage due to long extraction times and slow report generation.
- The current database is not flexible and difficult to edit according to user specification.
- Data used as an input or generated is redundant due to the lack of delta extracts and loads.
- The complex database causes a lack in developer impact on speed of change.
- CEC is SAP centric which does not allow for quick accessibility of other systems.
- The current software lack a user-friendly interface.

Opportunities Identified:

- Shift software to real-time, in-memory processing.
- Shift to faster more efficient data platforms.
- Increase the ease of use, modification and maintainability of software.
- To increase the visibility of data and information throughout the organisation.
- Attract a larger market with more relevant and updated software.

4.2.3 The Organisational Processes

Projects within CEC generally consist of five phases. Each phase will differ slightly depending on the specific characteristics of the project at hand. Following the JRP sessions the main process flows of each phase was successfully identified as the following:

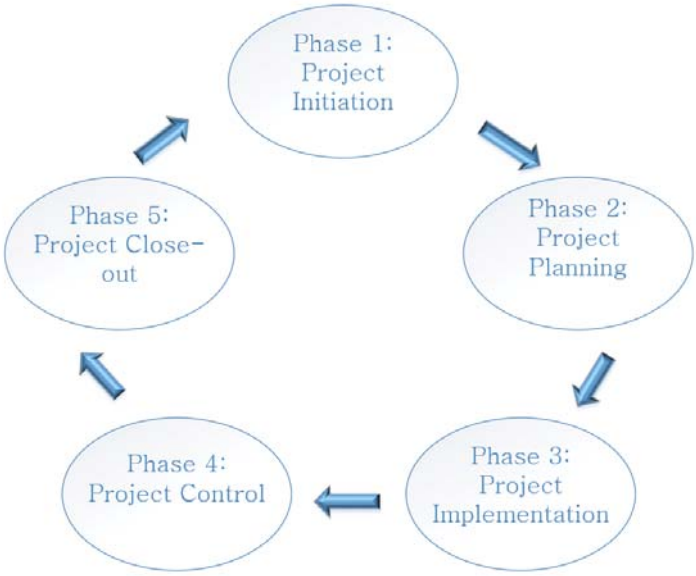


Figure 17: CEC Process Flows

4.2.4 CEC Process Flows

In order to demonstrate the main process flows contained within each phase of a project undertaken by CEC, comprehensive flow diagrams have been constructed. The main purpose of the process flows of CEC is merely to further the understanding of the background, environment and activities in which CEC finds itself. The process flows are provided in Appendix C.

- Project initiation phase
- Project planning phase
- Project implementation phase
- Project control phase
- Project close-out phase
- Report generation

Chapter 5

5. Conceptual Design

In this section the main capabilities of the current system are identified to ensure that the selected solution has the required functionality and capabilities that go above and beyond those of the current system.

5.1 CEC Software Characteristics

The StratWare modules consist of a multitude of predefined toolsets with pre-populated content. Each of these in turn is comprised of a range of parameterised reports that address several functional requirements simultaneously. A literature review was done on how CEC uses the StratWare toolset. The main software characteristics identified are as follows:

- Pre-built StratWare toolsets incorporate best practices across a range of commercial facets.
- Web based application requiring no installation at individual user level.
- User specific parameter selections.
- Standard and simplified look-and-feel of the toolsets.
- Detailed drill-down capability.
- Multiple output display options.
- Identify data quality defects against data governance rules and target clear action for rehabilitation.
- Perpetual monitoring of data to enforce data discipline.
- A single source of information.

5.2 Organisational Functional and Non-functional Requirements

The information gathered from the various problem investigation methods as well as the JRP serves as a useful framework for the identification of functional and non-functional requirements. These requirements need to fulfil in the basic needs of all stakeholders as well as other system users.

5.2.1 Functional Requirements

The functional capabilities and requirements needed for the successful execution of a BI application implementation project may be divided into various categories such as connectivity, analysis functionality, dashboard creation, visualisations etc.

Table 6, depicts some of the most essential functional requirements identified by the project manager of CEC.

Table 6: User Defined Functional Requirements

Hybrid platform	Allows for the network to bridge the gap between the organisations existing enterprise such as databases, warehouses, applications, and legacy systems.
Customisable Dashboards	Allows users to create and change the dashboard content easily. Dashboards provide instant visibility into organisational overall health.
Self-service	Enables end-users to create personalised reports and analytical queries reducing the amount of IT staff needed.
Data Collection	Data collection, collects different sets of data, it can either run constantly or on a user-defined schedule.
Data Visualisation	Allows for the intricate and detailed display of big data for better analytics.
Ad-hoc Analysis and Reporting	Designed to answer user specific business questions which produces a statistical model, an analytical report.
Mobile Accessibility	Access BI data such as KPIs, business metrics, and dashboards on mobile devices.
Alerts and Notifications	Notification that appear within the application, sending emails with a link to the discussion sent to the recipient.
Sorting and Ranking	Data sorting in terms of columns, rows or both or custom rules.
Data Filtering	Data filtration and querying is done by specific members within the grid.
Report Generation	The ability to build complex reports by the business users.
Drill through	Quick and easy drill down between dashboards with all relevant parameters.
Data import/export	Export data to PDF or csv files, export data to Excel, including charts.
Audit Trail	Detection of users who effect the system and create performance issues.
Version Control	The capability to control and manage the different versions of the model, report or cube.
Web Based, Real-time Data	Allows for data to be accessed in real time, for more accurate analysis.

5.2.2 Non-functional Requirements

Non-functional requirements consist of those elements which are not physically seen when using the software but experienced. Table 7, below depicts some of the desired non-functional requirements.

Table 7: Non-functional Requirements

Ease of Maintenance	Easy to locate and correct an error within the software.
Reliable software	Functions performed are done accurately and with precision.
Ease of Use	The software and outputs are easy to use and understand.
Security	Setting security permissions for data permission and single sign on via direct authentication.
Learnability	Training manuals provided to assist the training provided for the use of the system.

5.2.3 Project Sponsor Requirements

The project sponsor will not be able to change any data within the BI application, only dashboards will be available to the project sponsor.

- Send or schedule a static PDF.
- Publish project information to PowerPoint.
- Tabular interface: The ability to have multiple dashboards and windows open.
- Report commenting feature.
- Dashboard and table view of data.
- View project status and progress reports.

5.3 Decision to Use COTS BI Application

Within the consulting industry there are many types of business intelligence applications that may be used to satisfy business needs. Typically organisations like CEC will utilise either COTS, web-based or in-house BI applications. A period of at least 6 months is required to design a custom BI system, build it, and integrate the model, this process is also very costly, with an estimated price of $2-3 million.

Therefore, many organisations select pre-built BI applications to minimise the cost of owning the software and shorten the deployment process (Rudin & Cressy, 2003). Therefore, before any further capital expenditure takes place a thorough evaluation of the available COTS BI applications is done to determine whether these applications will be able to satisfy and exceed the business requirements.

Chapter 6

6. Solution Selection

Section 6.1, will discuss how the BI application alternatives are selected and evaluated against a primary criteria. The applications that do not meet the basic requirements are eliminated. Following this elimination a new set of criteria is identified in section 6.2 to further evaluate each alternative through the use of AHP.

6.1 Identification of COTS Business Intelligence Applications

In today's technologically advanced environment it is easy to identify a vast amount of business intelligence applications which are commercially available, therefore identifying the correct BI applications to evaluate and compare is a crucial element in selecting the final BI application.

Through the use of multiple web pages and reports such as Software Insider, Capterra, Ovum matrix: Selecting a BI solution and many more information concerning the basic functionality and characteristics of each BI application could be identified. A list of the ten most commonly used and highly rates BI applications has been compiled in Table 8.

In order to eliminate some of the BI applications selected an elimination criteria has been identified based on the opportunities and problems identified during the problem identification phase.

The elimination criteria has been identified as follows:

- Cost: The total cost of the application must be no more than R 5 million or must not require more than R 100 000 per year per person for licencing fees.
- Training and Support: The BI solution must provide some form of training as well as offer a quality support system.
- Mobile accessibility: Access BI data such as KPI's, business metrics and dashboards on mobile devices.
- Business size: BI application must be suitable for small to medium businesses.

Table 8: BI Elimination Table (Software-Advice, 2015)

BI Application	Price	Training and Support	Mobile Accessibility Platforms	Business Size
1. Oracle	R 76 038/ User licence/ year	**Training:** • Online training • In person training **Support:** • Email facilities • Online chat • Phone representatives	• Android • iOS	• Small • Medium
2. Qlik View	R 17 698.5/ User licence/ year	**Training:** • In person training **Support:** • Online chat • Phone representatives	• Android • iOS	• Small • Medium
3. Tableau	R 6555/ User licence/ year	**Training:** • Training documentation • Webinars • Live online training • In person training **Support:** • Online support • Business hours • Email facilities	• Android • iOS • Mobile Website • Windows Phone	• Small • Medium • Large
4. SAP	Not available	**Training:** • Training Tutorials **Support:** • Email facilities • Online chat • Phone representatives • FAQ	• Android • iOS	• Medium • Large
5. IBM	Not available	**Training:** • Training tutorials • In person training **Support:** • 24/7 Live representatives • Email facilities • FAQ	• None	• Large
6. SAS	R 117 990/ User licence/ year	**Training:** • Training documentation • Webinars • In person training **Support:** • Online support • Phone representatives • Email facilities	• Android • iOS	• Small • Medium • Large

BI Application	Price	Training and Support	Mobile Accessibility Platforms	Business Size
7. MicroStrategy	Not available	**Training:** • In person training • Training tutorials **Support:** • FAQ • Online chat • Phone representatives • Email facilities • 24/7 Live representatives • Business hours	• None	• Small • Medium • Large
8. Information Builders/ Webfocus	Not available	**Training:** • Training tutorials **Support:** • Email facilities • Phone representatives	• Mobile Website	• Medium • Large
9. Sisense	R 124 545/ User licence/ year	**Training:** • Training tutorials **Support:** • Email facilities • Phone representatives	• Android • iOS • Mobile Website • Windows Phone	• Small • Medium • Large
10. Birst	Not available	**Training:** • In person training • Training tutorials **Support:** • Email facilities • Phone representatives • FAQ	• Mobile Website	• Medium • Large

For the calculation of the price of each BI application the following exchange rate was used:

- US dollar = 13.11 (2015/08/27)

Each BI application was evaluated against the preliminary criteria. Oracle, Qlik View and Tableau were the three top contending BI applications identified during the elimination process. A basic summary of each of the three BI applications identified is given in Table 9, below.

The identified BI applications will be evaluated against a more rigorous criteria through the use of the analytical hierarchy process in the following section the criteria for this process will be discussed further.

Table 9: Summary of the Top 3 Identified BI Applications

BI Application Information	Identified BI Applications		
	Qlik View	Oracle	Tableau
Platform	• Online • On Premise • Mobile	• Online • On Premise • Mobile	• Online • Mobile
Operating system	• Windows • Mac • Linux	• Windows • Mac • Linux	• Windows • Mac • Linux
Reporting Features • *Ad Hoc Reporting* • *Automatic Scheduled Reporting* • *Customisable Dashboard* • *Customisable Features* • *Dashboard* • *Financial Forecast/ Budget* • *Graphic Benchmark Tools* • *Multiple Languages* • *Performance Measurement*	• Ad Hoc Reporting • Customizable Dashboard • Customizable Features • Dashboard	• Ad Hoc Reporting • Customizable Dashboard • Dashboard • Financial Forecast/Budget • Performance Measurements	• Ad Hoc Reporting • Automatic Scheduled Reporting • Customizable Dashboard • Dashboard • Financial Forecast/Budget • Graphic Benchmark Tools • Multiple Languages
Analysis features • *Ad Hoc Analysis* • *Issue Indicators* • *OLAP* • *Predictive Analytics* • *Profit Analysis* • *Trend Indicators*	• Ad Hoc Analysis • OLAP • Predictive Analytics	• Ad Hoc Analysis • Issue Indicators • OLAP • Predictive Analytics	• Ad Hoc Analysis • OLAP • Predictive Analytics • Trend Indicators
Self-service	Yes	Yes	Yes
Mobile accessibility Platform	• Android • iOS	• Android • iOS	• Android • iOS • Mobile Website • Windows Phone
Cost	Single named user - $1350, Enterprise server license $35,000 per server	$5,800 to $20,000 per license, minimum 25 licenses	$ 500 per user/year $ 999 per user/year desktop application

6.2 Business Intelligence Evaluation and Selection Criteria

With consideration of available literature on the selection and evaluation of BI applications, three categories could be identified. These categories include technical criteria, software quality and software procurement. The categories were chosen as each category represents important aspects and characteristics which must be taken into consideration when selecting a BI application. Each main criterion consists of various sub-criteria, which will be discussed below.

6.2.1 Software Quality

There are various criteria which may be used to evaluate and determine the software quality. The overall quality may be measured using the following sub-criteria:

- **Functionality**
  This includes the overall functionality of the software such as the ability to provide the user with access to accurate and timely reports, to customise dashboards as well as do a profit analysis. Table 10, provides a list of the most common functional features found in BI applications.

Table 10: BI Application Functional Features (Capterra, 2015).

Reporting Features	Analysis Features
• Ad Hoc Reporting • Automatic Scheduled Reporting • Customisable Dashboard • Customisable Features • Dashboard • Financial Forecast/ Budget • Graphic Benchmark Tools • Multiple Languages • Performance Measurement	• Ad Hoc Analysis • Issue Indicators • OLAP • Predictive Analytics • Profit Analysis • Trend Indicators

- **Ease of use**
  The quality of a software application may be measured by how easy it is to use. If a feature of the application or even the entire application is complicated and difficult the tool will most likely be used incorrectly or not at all.

- **Reliability**
  The reliability of the software may be defined as the probability that the software will operate problem free in terms of glitches and total failure of the system. Another aspect is the reliability and accuracy of the information provided by the system.

- **Mobile Accessibility**
  The ability of the software to be accessed on multiple mobile devices may have an influence on the perceived quality of the system.

6.2.2 Software Functionality

The functionality of software may be defined as the capabilities of the system, tasks and process completed by the software. An increase in functionality will allow the user to perform a wider variety of analysis and reporting.

The functional features of a BI application as listed in Table 10, may be used as a criteria, because of the fact that each function varies in importance and availability. The functional features that set BI applications apart may be used as criteria to identify the functional capabilities and advances of a software product. The six main functional capabilities were identified and selected by evaluating Table 9. The criteria was selected based on the functionalities that set each BI application apart from the other, whilst removing the functionalities that are recurring in each application. The criteria identified is listed below:

- Financial Forecast
- Graphic Benchmark Tools
- Ad Hoc Analysis
- Issue Indicator
- Trend Indicator
- OLAP

6.2.3 Software Procurement

When purchasing new software it must be taken into consideration that the cost of the software will not be the only cost included. In addition to cost of ownership, additional costs include:

- **Software Cost**
  Software costs include the cost of licencing fees which are usually paid annually per user.
- **Training and Support**
  To ensure that all employees using the new software are able to use the tool correctly and efficiently, training will be required. This may be an expensive venture if training documents, tutorials and in person training is not provided as part of the software package. The support provided to the end-user is also very important. In the event that an error does occur the end-user must be able to receive support either online or via the phone to resolve the issue.
- **Operating System**
  The available operating systems include Windows, Linux and Mac. Additional costs are incurred when the purchased software is limited to functioning on only one or two of these operating systems. If an end-user does not have access to the operating system required for the software, new hardware must be purchased to accommodate the software.
- **Deployment**
  Software can be store in two ways, either on-premise or in the cloud. If the organisation does not have access to the required on-premise capabilities, new hardware must be purchased.

Thus the main and sub-criteria identified for the AHP can be summarised as seen in Table 11

Table 11: Evaluation Criteria for AHP

Main Criteria	Sub-criteria
Software Quality	• Functionality • Ease of use • Mobile accessibility • Reliability
Software Functionality	• Financial forecast • Graphic benchmark tool • Ad hoc analysis • Issue indicators • Trend indicator • OLAP
Software Procurement	• Software cost • Training and support • Operating system • Deployment

6.3 Evaluation of BI Application Alternatives

Following the analysis of literature concerning various MCDM, the analytical hierarchy process was selected for the evaluation and comparison of the three BI application identified in section 6.1.

A hierarchal information tree is given in Figure 18. The hierarchy is used to break down the decision making problem into the main criteria, sub-criteria and the alternative BI applications identified in section 6.1.

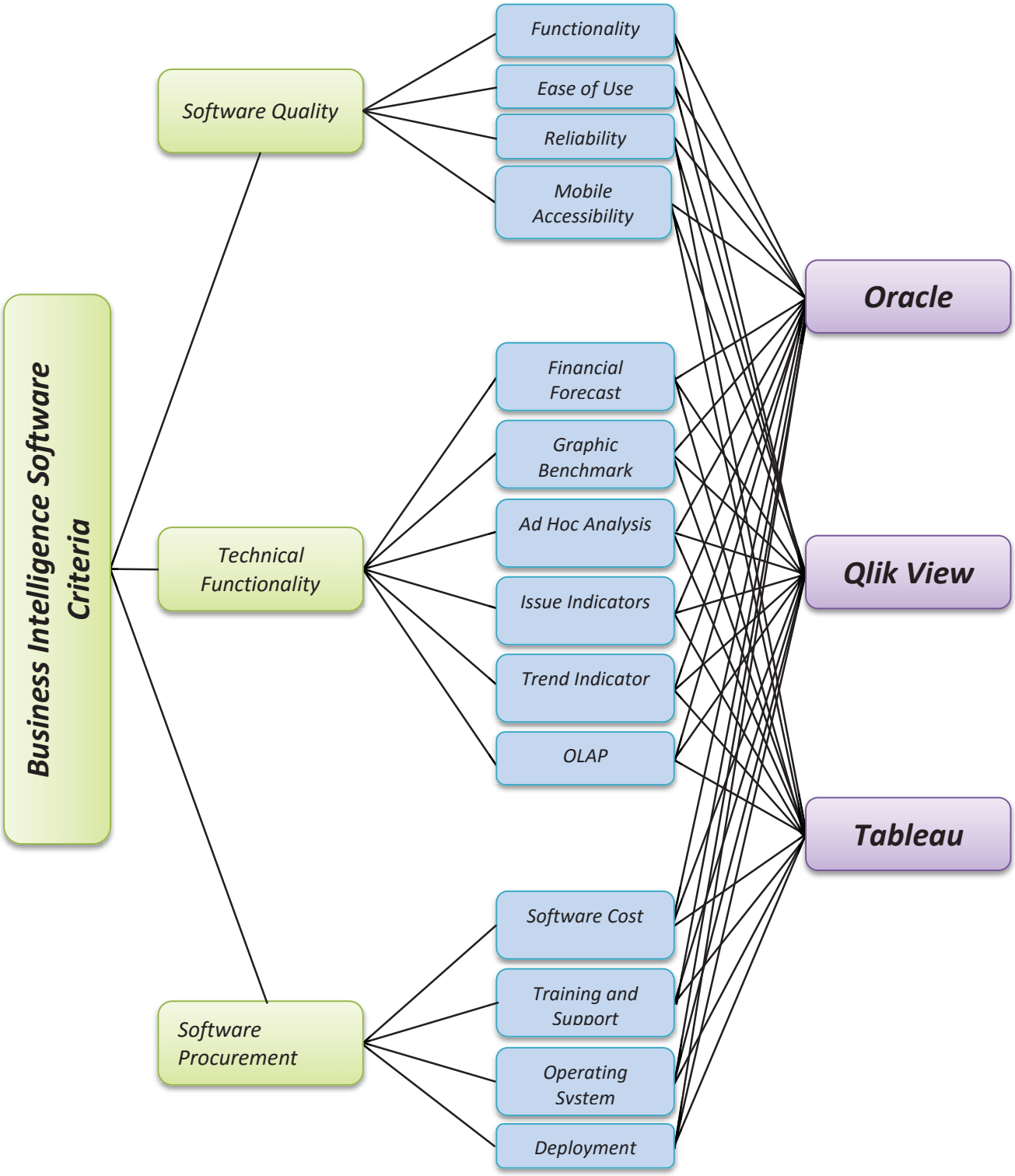


Figure 18: AHP Hierarchical Information Tree

Following the completion of the hierarchical information tree in Figure 18, it is required that a pairwise and comparison matrix for each criteria and sub-criteria must be created. In order to complete the pairwise matrix a scoring scale created by Saaty (2008), is used. This scale is given in Table 12.

Table 12: Saaty Scoring Scale (Saaty, 2008)

Intensity of importance	Description
1	Equally important
3	Moderately more important
5	Strongly more important
7	Very strongly more important
9	Absolutely more important
2,4,6,8	Intermediate values

The pairwise matrix is used to identify and score which criteria is more important than the other. The Intermediate matrix is then developed by dividing each cell in the pairwise matrix by the total calculated for each column of the criterion in the pairwise matrix.

The average is then calculated in the intermediate matrix, which indicated the relative importance of each criteria.

6.3.1 Evaluation of Main Criteria

The pairwise comparison and intermediate matrix developed for the main criteria is provided below The relative importance of each criteria is also provided ranging from most important to less important.

Table 13: *Pairwise* Comparison of the Main Criteria

Pairwise Comparison	Software Quality	Technical Functionality	Software Procurement
Software Quality	**1,00**	0,33	1,00
Technical Functionality	3,00	**1,00**	2,00
Software Procurement	1,00	0,50	**1,00**
Total	5,00	1,83	4,00

Table 14: Intermediate Matrix of the Main Criteria

Intermediate Matrix	Software Quality	Technical Functionality	Software Procurement	Total score	Average
Software Quality	0,20	0,18	0,25	0,63	0,24
Technical Functionality	0,20	0,55	0,50	1,25	0,48
Software Procurement	0,20	0,27	0,25	0,72	0,28

Table 15: Weighted Importance of each Main Criteria

Technical Functionality	**0,48**
Software Procurement	0,28
Software Quality	0,24

6.3.2 Evaluation of Sub-Criteria

The pairwise comparison and intermediate matrix developed for each sub-criteria is provided below. The relative importance of each criteria is also provided ranging from most important to less important.

1. Software Quality

Table 16: Software Quality Pairwise Comparison

Pairwise Matrix	Functionality	Ease of Use	Mobile Accessibility	Reliability
Functionality	**1,00**	3,00	7,00	3,00
Ease of Use	0,33	**1,00**	7,00	3,00
Mobile Accessibility	0,14	0,14	**1,00**	0,20
Reliability	0,33	0,33	5,00	**1,00**
Total	1,81	4,48	20,00	7,20

Table 17: Software Quality Intermediate Matrix

Intermediate Matrix	Functionality	Ease of Use	Mobile Accessibility	Reliability	Total	Average
Functionality	0,55	0,67	0,35	0,42	1,99	0,50
Ease of Use	0,18	0,22	0,35	0,42	1,17	0,29
Mobile Accessibility	0,08	0,03	0,05	0,03	0,19	0,05
Reliability	0,18	0,07	0,25	0,14	0,65	0,16

Table 18: Software Quality Weighted Criteria

Functionality	**0,50**
Ease of Use	0,29
Reliability	0,16
Mobile Accessibility	0,05

2. Technical functionality

Table 19: Technical Functionality Pairwise Comparison

Pairwise Matrix	Financial Forecast	Graphic Benchmark Tools	Ad Hoc Analysis	Issue Indicators	Trend Indicator	OLAP
Financial Forecast	1,00	0,33	0,20	0,33	0,33	0,33
Graphic Benchmark Tools	3,00	1,00	0,33	0,50	0,50	0,20
Ad Hoc Analysis	5,00	3,00	1,00	5,00	5,00	0,50
Issue Indicators	3,00	2,00	0,20	1,00	0,50	0,33
Trend Indicator	3,00	2,00	0,20	2,00	1,00	0,20
OLAP	3,00	5,00	2,00	3,00	5,00	1,00
Total	18,00	13,33	3,93	11,83	12,33	2,57

Table 20: Technical Functionality Intermediate Matrix

Intermediate Matrix	Financial Forecast	Graphic Benchmark Tools	Ad Hoc Analysis	Issue Indicators	Trend Indicator	OLAP	Total	Average
Financial Forecast	0,03	0,02	0,01	0,02	0,02	0,04	0,15	0,03
Graphic Benchmark Tools	0,10	0,06	0,01	0,02	0,02	0,04	0,25	0,06
Ad Hoc Analysis	0,17	0,28	0,07	0,35	0,41	0,03	1,31	0,31
Issue Indicators	0,10	0,22	0,01	0,07	0,02	0,04	0,47	0,11
Trend Indicator	0,17	0,22	0,01	0,28	0,08	0,03	0,79	0,19
OLAP	0,10	0,17	0,27	0,21	0,41	0,13	1,29	0,30

Table 21: Technical Functionality Weighted Criteria

Financial Forecast	0,31
Graphic Benchmark Tools	0,30
Ad Hoc Analysis	0,19
Issue Indicators	0,11
Trend Indicator	0,06
OLAP	0,03

3. Software Procurement

Table 22: Software Procurement Pairwise Comparison

Pairwise Comparison	Software Cost	Training and Support	Operating System	Deployment
Software Cost	**1,00**	3,00	3,00	0,25
Training and Support	0,33	**1,00**	3,00	0,20
Operating System	0,33	0,33	**1,00**	0,20
Deployment	4,00	5,00	5,00	**1,00**
Total	5,67	9,33	12,00	1,65

Table 23: Software Procurement Intermediate Matrix

Intermediate Matrix	Software Cost	Training and Support	Operating System	Deployment	Total	Average
Software Cost	0,18	0,32	0,25	0,15	0,90	0,22
Training and Support	0,06	0,11	0,25	0,12	0,54	0,13
Operating System	0,08	0,04	0,08	0,12	0,32	0,08
Deployment	0,71	0,54	0,42	0,61	2,26	0,56

Table 24: Software Procurement Weighted Criteria

Deployment	**0,56**
Software Cost	0,22
Training and Support	0,13
Operating System	0,08

6.3.3 Evaluation of BI Application Alternatives

After comparing the various criteria and sub-criteria with each other to determine which is most important, each alternative identified during the BI application elimination process in section 6.1, must now be compared. The alternatives are compared against each other to determine which alternative performs better with regard to a certain sub-criteria.

The tabulated pairwise comparisons and intermediate matrixes of all alternatives and sub-criteria is given in Appendix D. Table 25 below provides an example of the pairwise comparison and intermediate matrix constructed for software quality's first sub-criteria.

Table 25: Functionality Pairwise Comparison and Intermediate Matrix

Functionality	**Oracle**	**Qlik View**	**Tableau**
Oracle	**1,00**	2,00	0,20
Qlik View	0,50	**1,00**	0,25
Tableau	5,00	4,00	**1,00**
Total	6,50	7,00	1,45

	Oracle	**Qlik View**	**Tableau**	**Total**	**Average**
Oracle	0,15	0,29	0,14	0,58	0,19
Qlik View	0,08	0,14	0,17	0,39	0,13
Tableau	0,77	0,57	0,69	2,03	0,68

6.4 Analytical Hierarchy Process Results

Following the completion of all pairwise and intermediate matrixes with both the main and sub-criteria Figure 19, has been constructed. The figure provides a view of the final objective hierarchy with each criteria assigned with a respective weight.

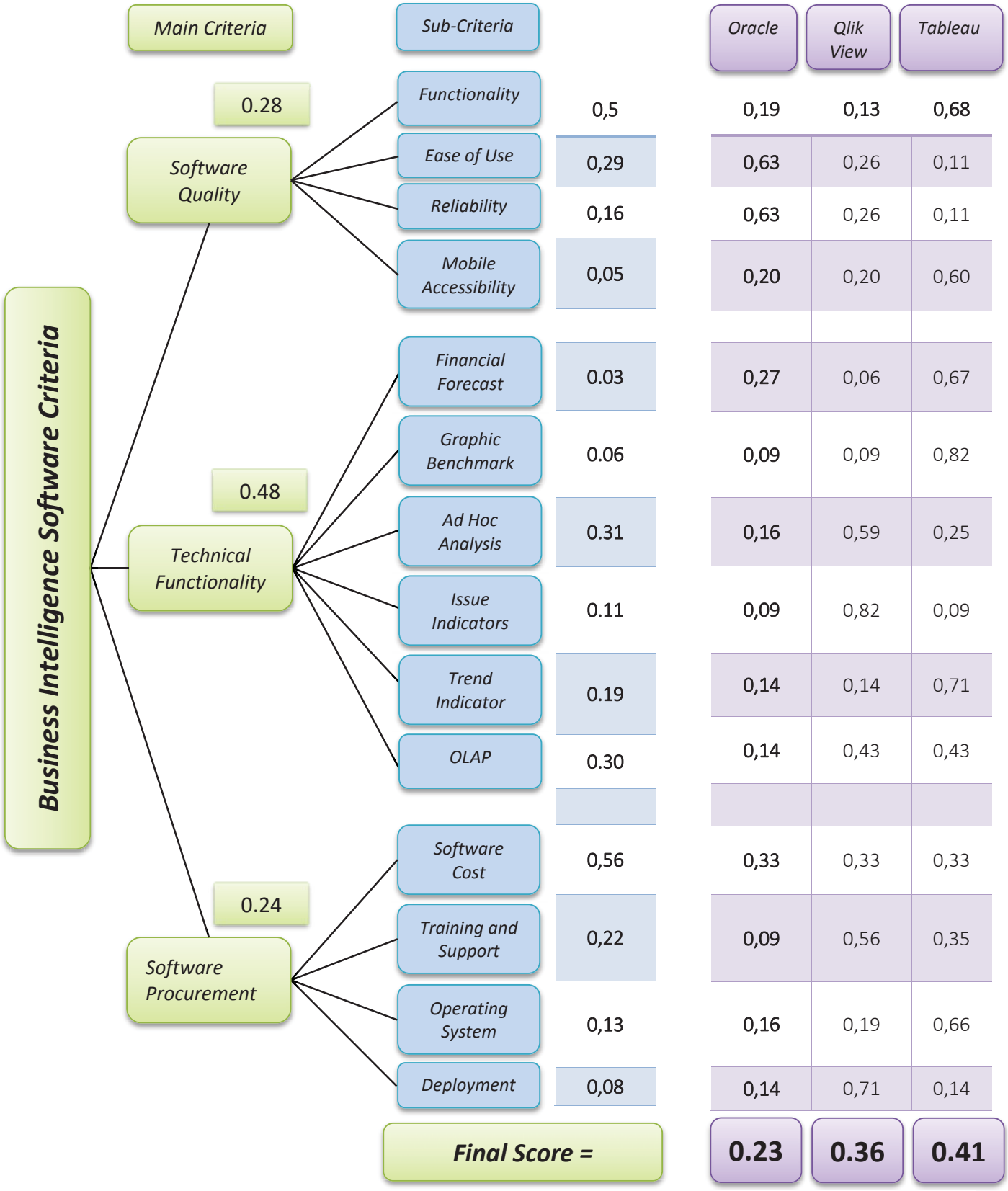


Figure 19: Analytical Hierarchy Process Results

The final score of each alternative is calculated by multiplying the weighted score of each main criteria with its respective sub-criteria, this is done for each sub-criteria. The following step includes multiplying each answer received in the previous calculation with the weight allocated to a specific BI application. All multiplications of the one BI application is then summed to determine the final result.

The final score of each alternative is then calculated. The BI application with the highest score is the best alternative. The final scores are given in Table 26 and may be found in Figure 19.

Table 26: Final AHP Results

Tableau	0.41
Qlik View	0.36
Oracle	0.23

Tableau scored the highest with 41%, while Qlik View scored second highest with a total of 36% and finally Oracle scored the lowest with 23%. The high score obtained by Tableau is because of its low cost, well spread training and support and most predominantly due to the fact that it has a rich variety of functional capabilities.

6.4.1 Consistency Index Test Process

In order to determine the consistency of the pairwise and intermediate matrixes constructed during the AHP model a consistency index calculation was performed to ensure that each matrix constructed is both accurate and valid.

The Consistency Ratio (CR) indicates whether the person constructing the pairwise comparison was consistent. A larger CR score indicates that the pairwise comparison is less consistent, where a lower CR indicates a higher level of consistency while making decisions.

- CR < 0.10, the decision-makers' pairwise matrix is relatively consistent.
- CR > 0.10, the decision-makers' pairwise comparison is not consistent and the analysis should be re-done.

A detailed step by step process for the calculation of the CR is given in Appendix E.

Thus, to ensure that all weights used in the AHP are accurate and of use, the CR of each matrix created must be equal to or less than 0.1. Appendix E, provides all of the CI calculations and tables used to determine the CR of each matrix.

Table 27 provides an example of the tables constructed. All matrixes pass the CI test, as each CR value calculated is less than 0.1. This ensures that the results of the AHP analysis will be valid and accurate.

Table 27: Main Criteria Consistency Index Test

Pairwise Comparison	Software Quality	Technical Functionality	Software Procurement	3rd Root Product	Priority Vector (PV)
Software Quality	**1.00**	0.33	1.00	0.69	0.21
Technical Functionality	3.00	**1.00**	2.00	1.82	0.55
Software Procurement	1.00	0.50	**1.00**	0.79	0.24
Sum	5.00	1.83	4.00	**3.30**	1.00
*Sum*PV*	1.05	1.01	0.96	**3.02**	
Lambda max =	**3.02**				
CI =	**0.01**				
CR =	**0.02**				

Chapter 7

7. Selected Business Intelligence Solution and Validation

Section 7.1 provides a detailed summary of the solution of the selected BI application which was identified through the use of the AHP model. Section 7.2 provides a clear description of the solution validation method as well as the results obtained after performing a statistical analysis of the solution validation results.

7.1 Solution Summary

Through the use of the multi criteria decision making model namely AHP identified in literature an evaluation was done on the top three BI applications identified.

The available BI applications were identified through the use of multiple BI application vendor websites. The top three BI applications were then identified by process of elimination. The elimination criteria used includes cost, training and support, mobile accessibility and business size. This process is fully shown in Table 8, section 6.1. The optimal BI application to be implemented by CEC has been identified as Tableau. A detailed breakdown of Tableau is given in Table 28 below.

Table 28: Summary of the Selected Solution

	
Cost	R 6555/ User licence/ year
Training and Support	**Training:** • Training documentation • Webinars • Live online training • In person training **Support:** • Online support • Business hours • Email facilities
Mobile Accessibility Platforms	• Android • iOS • Mobile Website • Windows Phone
Business Size	• Small • Medium • Large
Platform	• Online • Mobile
Operating System	• Windows • Mac • Linux
Reporting Features	• Ad Hoc Reporting • Automatic Scheduled Reporting • Customizable Dashboard • Dashboard • Financial Forecast/Budget • Graphic Benchmark Tools • Multiple Languages

Analysis Features	• Ad Hoc Analysis • OLAP • Predictive Analytics • Trend Indicators
Self-service	Yes
Hybrid platform	Yes
Data collection	Yes
Data visualization	Yes
Customisable dashboards	Yes
3rd- party data integration	Yes
Need for expert staffing	No
Integration with office apps	Yes

Appendix G provides screenshots of the fundamental Tableau functionalities and dashboards as well as the view provided by the mobile application.

7.2 Solution Validation

This section is used to validate the solution selected in terms of end-user satisfaction. The end-user satisfaction is quantified through the use of statistical analysis of the results obtained from the completed surveys.

7.2.1 User Satisfaction Survey

The satisfaction of the end-user as well as the customer in terms of the quality of the selected BI application is immensely important to ensure a productive work environment. The satisfaction of users and customers can best be determined through the use of an end-user satisfaction survey.

Using the information presented in the literature review, a survey was developed and distributed to the selected BI application users within Cutting Edge Commerce. In order to improve the accuracy of the survey a trial version of the selected BI was provided to all users.

Participants in the survey used the trial version to enter only the crucial information of current projects, allowing them to experience, inspect and evaluate the key functionalities of Tableau. The end-users then rated the selected BI application based on their user experience.

The survey distributed among the participants uses a 5 point Likert scale, which is used to score each category, as seen in Table 29 below. Following the completion of the surveys the data collected was evaluated through data analysis in order to interpret the survey results.

Table 29: End-User Satisfaction Survey

System content	The system provides the precise information needed.	1	2	3	4	5
	The system provides comprehensive reports.	1	2	3	4	5
	The system provides sufficient information.	1	2	3	4	5
Accuracy	The system is error free.	1	2	3	4	5
	The system provides accurate information.	1	2	3	4	5
	The information provided by the system is dependable.	1	2	3	4	5
Format	The output is presented in a useful format.	1	2	3	4	5
	The information is clear and concise.	1	2	3	4	5
	The format of the output is satisfactory.	1	2	3	4	5
Ease of use	The system is easy to use.	1	2	3	4	5
	It is easy to get the system to do what you want it to do.	1	2	3	4	5
	Interacting with the system is clear and easy to learn.	1	2	3	4	5
Timeliness	The system provides up to date information.	1	2	3	4	5
	The system provides information in a timely manner.	1	2	3	4	5
System Speed	The system operates at a satisfactory pace.	1	2	3	4	5
Flexibility	The system is easily modified.	1	2	3	4	5
	Customisable windows are easily moved and edited.	1	2	3	4	5

7.3 User Satisfaction Results and Analysis

The user satisfaction survey was completed by a total of 14 participants. The results of the completed surveys are provided in Table 63, Appendix H. An analysis of the collected survey results was done and is summarised in Table 30. This table provides information with regard to the level of satisfaction of each survey question.

The completed surveys were then used to determine the overall user satisfaction as well as the user satisfaction with regard to each survey category.

The survey results were categorised into 7 main groups to indicate the user satisfaction with regard to each main element in the survey as seen in Figure 20 below. Figure 20 also indicates the overall user satisfaction score which has been determined by calculating the average of the 7 user satisfaction categories identified.

Table 30: End-User Satisfaction Survey Results Analysis

	Survey Question	n	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied	Total
1	The system provides the precise information needed.	14	29%	36%	36%	0%	0%	100%
2	The system provides comprehensive reports.	14	43%	43%	14%	0%	0%	100%
3	The system provides sufficient information.	14	29%	57%	14%	0%	0%	100%
4	The system is error free.	14	14%	57%	29%	0%	0%	100%
5	The system provides accurate information.	14	29%	36%	36%	0%	0%	100%
6	The information provided by the system is dependable.	14	14%	79%	7%	0%	0%	100%
7	The output is presented in a useful format.	14	21%	71%	7%	0%	0%	100%
8	The information is clear and concise.	14	21%	71%	7%	0%	0%	100%
9	The format of the output is satisfactory.	14	7%	71%	21%	0%	0%	100%
10	The system is easy to use.	14	0%	57%	43%	0%	0%	100%
11	It is easy to get the system to do what you want it to do.	14	7%	64%	29%	0%	0%	100%
12	Interacting with the system is clear and easy to learn.	14	0%	71%	29%	0%	0%	100%
13	The system provides up to date information.	14	29%	43%	29%	0%	0%	100%
14	The system provides information in a timely manner.	14	29%	43%	29%	0%	0%	100%
15	The system operates at a satisfactory pace.	14	7%	50%	43%	0%	0%	100%
16	The system is easily modified.	14	14%	71%	14%	0%	0%	100%
17	Customisable windows are easily moved and edited.	14	29%	43%	29%	0%	0%	100%
Overall User Satisfaction Score		14	19%	57%	24%	0%	0%	100%

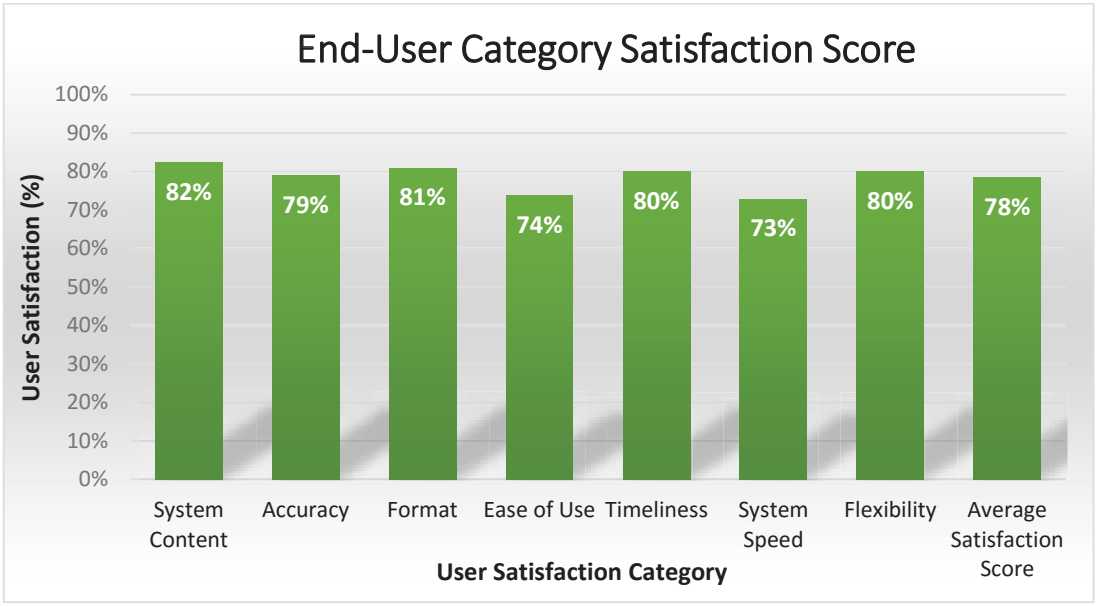


Figure 20: End-User Category Specific Satisfaction Score

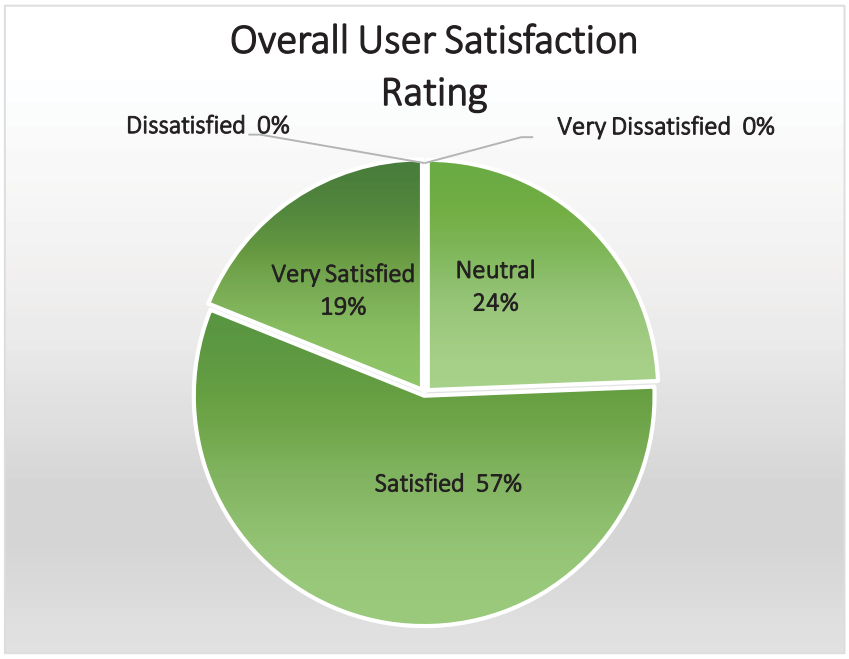


Figure 21: Overall User Satisfaction Rating

A summary of the overall perceived performance and user satisfaction of Tableau is provided in Figure 21. The overall user satisfaction ratings determined that 57% of the participants rated their user experience as satisfactory while 19 % of the participants rated their experience as very satisfactory. Following the data analysis it could be concluded that 78% of all participants found that the user experience was satisfactory indicating that Tableau is a valid solution for CEC to implement.

Chapter 8

8. Training and Implementation Plan

Section 8.1 provides the prescribed guidelines to be used when implementing the Tableau BI application while section 8.2 provides a training plan that will ensure that all end-users have proficient knowledge of how to effectively use the new software.

8.1 Implementation Plan

Tableau is a multi-platform application with multiple implementation options. Tableau may be implemented as a web-based, desktop or mobile application. For CEC the recommended implementation option is the web-based application. The web-based Tableau application is hosted external to CEC which means that the only infrastructure required to run Tableau is either a desktop or laptop as well as a stable internet connection.

Table 31 below provides a summary of all phases, tasks and activities that are required to successfully implement the Tableau application. Each activity is assigned to a time period, indicating when the activity should be completed. For example, the stakeholder consultation and discussion must take place during the first month of the project implementation while approval from the CEC board members must be attained during the third month of the project implementation plan.

Table 31: Project Implementation Plan

Phase	Tasks	Activity	Projected period (month)
Project definition	Stakeholder consultation and discussion.	- Meet with key stakeholders for a consultation session. - Identify primary project scope, outputs and objectives.	1
System requirements	Technical requirement definition. Software requirements definition.	- Ensure the reliability of CEC's internet access as well as hardware (desktop/laptop) availability. - Determine the need for the new BI application by communicating with the software users and project managers.	1 1-2
Approval	Attain board member approval.	- Identify the costs associated, potential risks and benefits of implementing Tableau. - Prepare a business case to justify implementing the new software and present the proposal to the key stakeholders.	3

Design	Identify project team	- Identify and assign the required personnel to the project team.	3
	Create project implementation plan	- Construct a detailed project plan which indicates all required tasks, dates, outputs and people responsible for certain project implementation roles.	2-3-4
	Discuss project plan with managers	- Communicate the implementation plan with managers as well as the expected benefits.	4
Execution	Manager briefing	- Confirm the project plan, status and benefits.	4,6,8
	Employee/user briefing	- Confirm the project plan, status and benefits.	5,9
	Software acquisition, installation and testing	- Purchase user licences and install new BI application.	7-10
	Developer training	- Provide developers with sufficient training to integrate and program new software.	6-8
	End-user training	- Provide both beginner and advanced online training modules to users. - Provide users with classroom training if needed. - Assess the user skills and software knowledge base.	7-10
Project evaluation	Evaluation of project implementation	- Determine end-user satisfaction and training needs. - Compare expected implementation and training timeline to the actual timeline.	12 13
	Evaluate application performance	- Measure software performance - Compare expected results to actual performance.	14
	Provide feedback to managers and users	- Prepare a feedback report providing managers and key stakeholders with findings.	
Maintain software	Software evaluation	- Evaluate software performance and prepare a software upgrading plan.	

8.1.1 Business plan

The business plan provides a summary of the objectives, expected outputs, potential risks and benefits identified during each phase of the implementation plan.

Business goal:
The business goal is to implement the Tableau software within CEC allowing them to utilise their IP and past experience within the new BI platform. The implemented application must provide a modern look and feel to attract new clients, reduce time intensive data extractions, transform and load (ETL) processes, while providing system flexibility and information visibility.

Objective
- Streamline the process of report publishing.
- Improve BI analyst productivity.
- Improve data understanding and interpretation.
- Reduce the time required for report creation.
- Reduce BI support costs.
- Allow employees to directly connect and interact with organisational data.

Outputs
- Sufficiently trained staff, with the ability to effectively and efficiently use the implemented software.
- Acquire the Tableau online software and mobile application.
- Tableau integration with current underlying BI application.

Potential Risks
- Employees might resist change.
- Insufficient time provided for training and skills development can lead to decreased productivity and an increase in reporting errors.
- Lack of developers and skilled employees to implement new software, requiring expensive classroom training.
- Integrating Tableau with CECs legacy system may require additional time and lead to additional challenges.

Expected Benefits
- Access a larger customer base including both small and medium businesses.
- Store and access large amounts of historical data.
- Increased system flexibility and scalability through the implementation of rational database management.
- Decreased operating and maintenance costs.
- Increased database speed through the use of Tableau's in-memory data engine.
- Tableau is able to integrate with existing IT infrastructures allowing for fast deployment and low total cost of ownership.
- Improved collaboration capabilities and data sharing through the use of the web deployment functionality.
- Access to interactive visualisations and dashboards improving data and information visibility.

Expected Costs
- Licence fee - R 6555 per user/ year
- No online training costs involved
- Free on-demand training
- Classroom training – R 19 241, 91 per person per module for a 2 day training session.

Expected finish date – Thirteen months from the start date of the project.

8.2 End-user Training Plan

The amount and level of training that end-users and developers require to operate and maintain the newly implemented software will be dependent on factors such as the current skill level and experience of users, the type of tasks executed as well as the functional characteristics of Tableau.

8.2.1 Training Objective

The user training plan will focus on the end-user and developer as Cutting Edge Commerce will require their development team to have proficient knowledge of Tableau and its functionalities to ensure that they are able to successfully integrate Tableau with their underlying StratWare application.

8.2.2 Personnel Requiring Training

- Project managers
- Project team members (end-users)
- Developers
- CEC client users

8.2.3 Training Methods

The training methods made available to users are classified into three categories namely, on-demand training, live online training and classroom training. Tableau is a relatively new BI application which means that the classroom training provided by this application is not yet available in South Africa.

- On-demand training

Tableau on-demand training does not require any additional cost and is internet-based. The training sessions are freely available when needed and allow the user to master the BI application at their own pace.

- Live online training

Tableau provides users with the ability to partake in real-time online learning and training sessions. These sessions are led by an instructor and scheduled according to a specific topic, time and date.

- Classroom training

The Tableau classroom training is a training option offered to specific regions across the world. These sessions are instructor-led and may be completed at the organisations site or virtual classroom. This training method is designed to improve the learning experience through hands-on training. The instructor leads the user through intensive courses and modules to ensure that the user can use the Tableau application in the optimal and most efficient way.

8.2.4 Selected Training Method

On-demand training was selected as the preferred training method as it is readily available to all trainees. The on-demand training material and video sessions are free of charge eliminating training costs.

8.2.5 Expected Training Benefits

- Expertly skilled end-users and developers.
- Efficient and error free software integration.
- Timely reporting and dashboarding.

8.2.6 Training Modules and Course Content

Tableau provides training opportunities and documentation to ensure that both the users and developers will be able to access and utilise Tableau with ease. Appendix I, Table 32 provides a summary of all modules available to both end-users and developers.

8.2.7 Training Schedule

The training schedule given in Table 32, provides the time period allocated for each module where each time period consists of one week. The trainee type and module name is also provided.

Table 32: Training Schedule

User	Module	Time Period Allocated	Training Method
Project manager, team member and developer	Introduction	1	On-demand training with live online training if required.
	Tableau interface	1	
	Distributing and publishing	1-2	
	Connecting to data	3	
	Visual analysis	3-4	
	Dashboards	3-4	
	Data mapping	3-4	
	Calculations	5	
	Tableau online	1	
	Chart creation	4	
Developer	API	1-2	

8.2.8 Estimated Training Cost

- No costs involved for online training
- Free on-demand training
- Classroom training – R 19 241, 91 per person per module for a 2 day training session.

8.2.9 Training Evaluation and Tracking

A user training evaluation matrix for competency development, in Figure 22, is used to evaluate and track the progress of each system user. The competency of each user must be evaluated every week for the duration of the allocated time periods.

After the minimum training period has been completed users must be able to use Tableau without supervision and meet the minimum competency requirements. The training matrix will provide CEC with the information required to establish whether the end-users and developers are able to use Tableau at a satisfactory level of competency.

User Training Evaluation Matrix for Competency Development

User Name:	Week 1	Week 2	Week 3	Week 4	Week 5	User Signature
Introduction	X					
Tableau interface	X					
Distributing and publishing	X	X				
Connecting to data			X			
Visual analysis			X	X		
Dashboards			X	X		
Data mapping			X	X		
Calculations					X	
Tableau online	X					
Chart creation				X		
API	X	X				

Time Period	1	2	3	4	5
Evaluator Name					

Final evaluation result:

☐ Trained but requires supervision

☐ Meets minimum competency requirement

☐ Exceeds minimum competency requirement

☐ Sufficiently trained and capable of working without supervision

Recommendation:

Figure 22: User Evaluation Matrix for Competency Development

The user training evaluation matrix for competency development was adapted from the user competency training matrix provided by the World Wide Industrial and Systems Engineers (2010).

Chapter 9

9. Conclusion

The purpose of the project report was to investigate the BI environment of CEC and to identify the functional and non-functional requirements of the required BI application. The decision to purchase a commercial of the shelf application was made, as COTS applications are often more comprehensive, minimise the cost of ownership and requires a shorter implementation period.

The analytical hierarchy process, a multi criteria decision making model was identified to accurately determine the optimal business intelligence solution. The BI application identified will allow CEC to utilise their IP and past experience within the new BI platform. The implemented application provides a modern look and feel to attract new clients, reduce time intensive data extraction, transform and load (ETL) processes, while providing system flexibility and information visibility. The new BI application will aim to reduce the operating cost of Cutting Edge Commerce and improve their efficiency.

Tableau, a commercial of the shelf BI application was identified as the optimal BI solution for CEC. The AHP model was used to identify the best solution through the use of the main criteria identified as software quality, functionality and procurement.

The candidate solutions identified were Tableau, Qlik View and Oracle. Tableau had the highest overall score at 41%, while Qlik View scored second highest with a total of 36% and finally Oracle scored the lowest with 23%. The high score obtained by Tableau is because of its low cost, well spread training and support and most predominantly due to the fact that it has a rich variety of functional capabilities.

A user satisfaction survey was used to identify whether the selected BI solution satisfies all user needs. To ensure that the results obtained by the survey feedback forms were acceptable, statistical analysis was used to determine whether an acceptable user satisfaction level had been achieved. Ethical clearance has been acquired for the survey provided to participants to ensure that the survey questions are within ethical bounds.

Following the statistical analysis of the data received from the end-user satisfaction survey, it was determined that 78% of all participants found their user experience satisfactory, indicating that Tableau is a valid solution for CEC to implement.

Finally an implementation and training plan was developed, to ensure that the selected BI application is successfully installed and integrated with CEC's underlying software and that the end-users have the required competency level to efficiently use Tableau.

Appendix A: Problem Investigation Tools

PIECES Problem Investigation

Table 33: PIECES Problem Investigation

PIECES PROBLEM SOLVING FRAMEWORK FOR THE CURRENT BUSINESS INTELLIGENCE SOFTWARE		
	PROBLEMS	**OPPORTUNITEES**
PERFORMANCE Problems, Opportunities, and Directives		
A. Throughput-- the amount of work performed over some period of time.	A. ETLs slow - takes too long to extract and load data for reporting toolsets	A. Needs to change to real time in memory processing
B. Response time-- the average delay between a transaction or request and a response to that transaction or request and a response to that transaction or request.	B. Due to the organic growth of the toolsets (adding more fields) info it has become slow to run the outputs.	B.
INFORMATION (and Data) Problems, Opportunities, and Directives		
A. Outputs		
1. Lack of any information	1	1. Due to CEC creators feedback the toolsets contain up to 90% of the basic requirements for business.
2. Lack of necessary information	2. Too much non-essential information that slows the system	2
3. Lack of relevant information	3. difficult to easily change reporting DB's - non relevant data stays in DB's	3
4. Too much information -- "information overload"	4. Too many report selections and potential outputs - the frequent users are fine, new users struggle.	4
5. Information that is not in a useful format	5. CEC display and output methods are outdated	5
6. Information that is not accurate	6	6. Well tested - long track record - high level of confidence
7. Information that is difficult to produce	7. Standard lay-outs difficult to change if different view is required	7
8. Information is not timely to its subsequent use	8. Due to long extract and load time. New datasets cannot be created daily	8
B. Inputs		
1. Data is not captured in time to be useful	1. garbage in, garbage out	1. CEC toolsets perfectly positioned to assist with data quality and clean-up
2. Data is captured redundantly -- same data captured more than once	2. garbage in, garbage out	2. CEC toolsets perfectly positioned to assist with data quality and clean-up
C. Stored data		
1. Data is stored redundantly in multiple files and/or databases	1. CEC data storage and structures are outdated	1 Need to move to newer platforms
3. Data is not secure to accident or vandalism	3.	3 hosted in secure environment
4. Data is not well organized	4. CEC data storage and structures are outdated	4
5. Data is not flexible -- not easy to meet new information needs from stored data.	5. Proprietary database - limited skills to update/change	5
6. Data is not accessible	6. Proprietary database - limited skills to update/change	6

ECONOMICS Problems, Opportunities, and Directives		
A. Costs are too high	A. Cost not suitable for small to medium companies	A.
CONTROL (and Security) Problems, Opportunities, and Directives		
A. Too little security or control		
1. Input data is not adequately edited	1	1. CEC BI only reads data - no impact on source
2. Ethics are breached on data or information -- refers to data or information getting to unauthorized people.	2	2. Access controlled based on company profiles
3. Redundantly stored data is inconsistent in different files or databases	3. Issue as the current DB structure is not flexible	3
4. Data privacy regulations or guidelines are being (or can be) violated.	4. Issue as POPI act regulations are not imbedded	4
6. Decision - making errors are occurring	6	6.CEC toolsets enhances decision making
B. Too much control or security		
1. Bureaucratic red tape slows the system	1. No	1. No
2. Controls inconvenience customers or employees	2. No	2. No
3. Excessive controls cause processing delays	3. No	3. No
EFFICIENCY Problems, Opportunities, and Directives		
A. People, machines, or computers waste time		
1. Data is redundantly input or copied	1. CEC lacks delta extracts and loads	1
2. Data is redundantly processed	2. CEC lacks delta extracts and loads	2
3. Information is redundantly generated	3. CEC lacks delta extracts and loads	3
SERVICE Problems, Opportunities, and Directives		
A. The system produces inaccurate results	A. No	A. No
B. The system produces inconsistent results	B. No	B. No
C. The system produces unreliable results	C. No	C. No
D. The system is not easy to learn	D. Due to complexity of initial selection screens it does take some effort	D.
E. The system is not easy to use	E. Lacks user-friendly interface	E.
F. The system is inflexible to new or exceptional situations	F. Complex Database, lack of developers impact on speed of change	G.
G. The system is inflexible to change	G. Complex Database, lack of developers impact on speed of change	H.
H. The system is incompatible with other systems	H. CEC is SAP centric which leads to the lack of the capability to quickly access others systems.	I.
I. The system is not coordinated with other systems	I. CEC is SAP centric which leads to the lack of the capability to quickly access others systems.	J.

SWOT Analysis of Cutting Edge Commerce

Table 34: Cutting Edge Commerce SWOT Analysis

SWOT analysis of Cutting Edge Commerce	
Strengths	Weakness
• CEC offers consulting and thought leadership • CEC enables the perpetual monitoring to constantly track business performance and benefits realisation. • Tactical groupings, which facilitate and optimize effective management. • Provide a flexible and user friendly combination of tools across more than 280 platforms • The reporting toolsets facilitate deep drill down capability, providing any desired depth of drill down. • CEC's reports meet the needs of all parties, addressing the needs of both management and staff with no need to modify for specific users. • Various display formats available i.e. Excel, HTML & PDF. • Menu access and navigation controlled by information sensitivity • Pre-populated toolsets offer rapid deployment	• Long development cycles to enhance toolsets due to lack of skilled resources. • Data storage (DB) seen as black box as customer does not have visibility of content. • BI app/Toolsets does not have a modern/current look and feel. • Clients cannot maintain by themselves, always dependant on CEC. • Not SAP certified • Not well known in market space. • Not SAP partner status or preferred vendor. • Cost – WebFOCUS as the underlying software is too expensive. • Long development and enablement cycles on systems other than SAP.
Opportunities	Threats
• Currently there is over 200 SAP clients in SAA who is not happy with their SAP implementation, quality of data and cost associated to SAP tools. StratWare can easily fill the gap if we can modernise our toolsets and underlying database. • There is a large market for other systems such as Oracle, SAP Business 1 etc. which could be targeted if CEC can change their database.	• SAP centrism – most of our current clients are establishing SAP centred networks and infra-structure. SAP SA are giving away SAP owned BI tools to ensure continuity of work/consulting. • Cost – we are pricing ourselves out of the market.

Appendix B: AHP Model Process Flow and Measurement Scale

AHP Model Process Flow

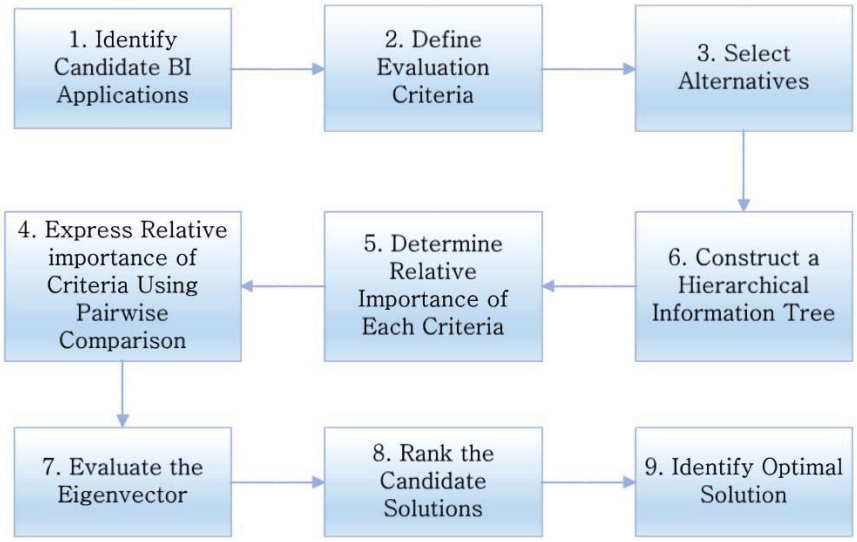


Figure 23: AHP Method for BI Application Selection (Triantaphyllou, 2000)

Measurement Scale for Pairwise Comparison

Table 35: Measurement Scale for the Pairwise Comparison (Saaty, 2008)

Intensity of Importance	*Definition*	*Explanation*
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity *i* has one of the above non-zero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	A reasonable assumption
1.1–1.9	If the activities are very close	May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

Appendix C: Cutting Edge Commerce Project Process Flows

Project Initiation Phase Process Flows

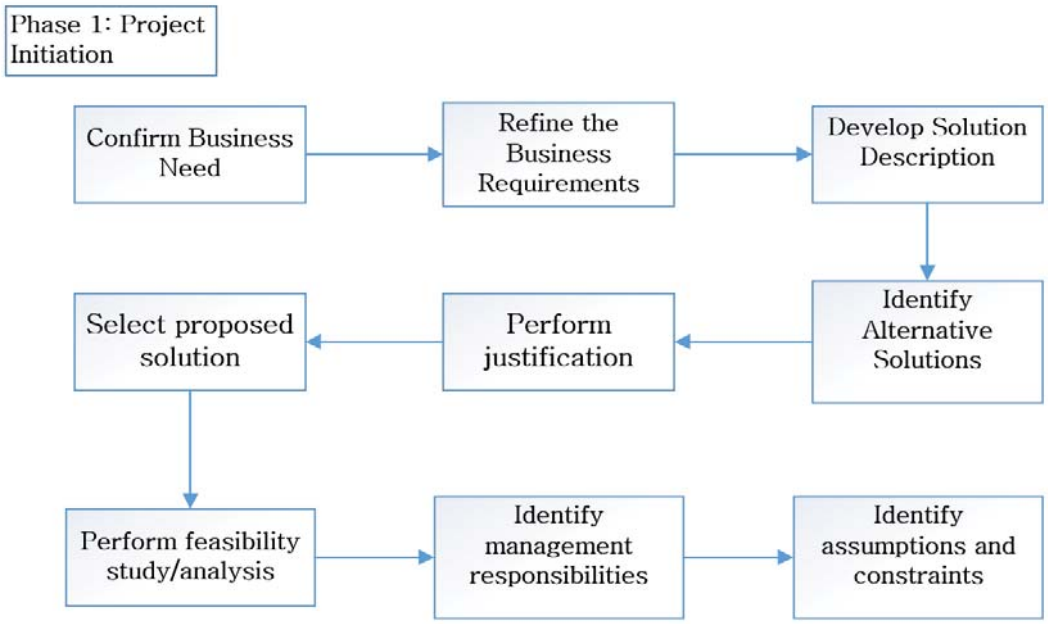


Figure 24: Project Initiation Section 1

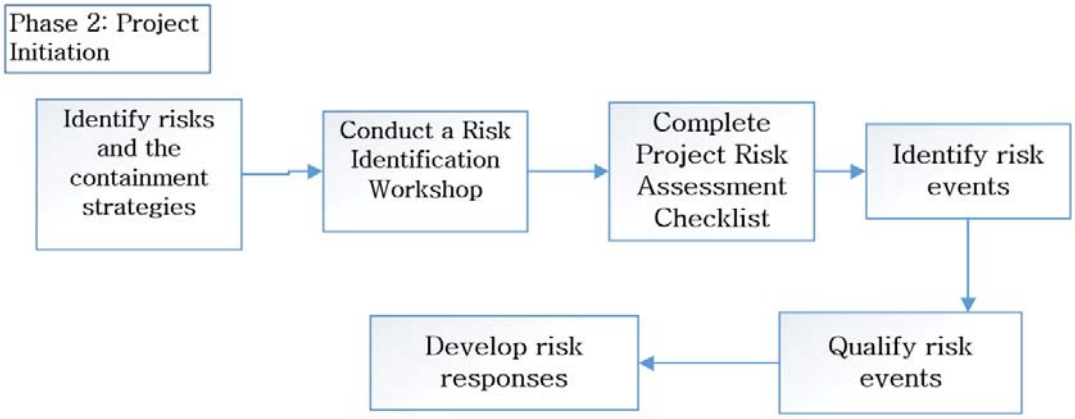


Figure 25: Project Initiation Section 2

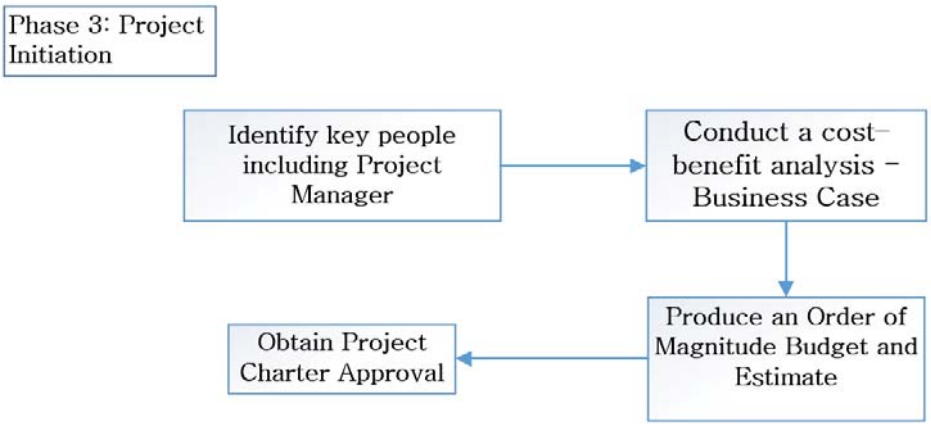


Figure 26: Project Initiation Phase 3

Project Planning Phase Process Flows

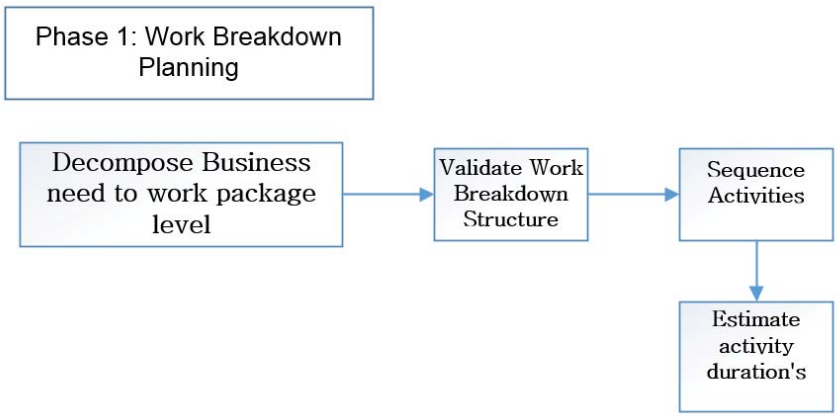


Figure 27: Project Work Breakdown Planning, Phase 1

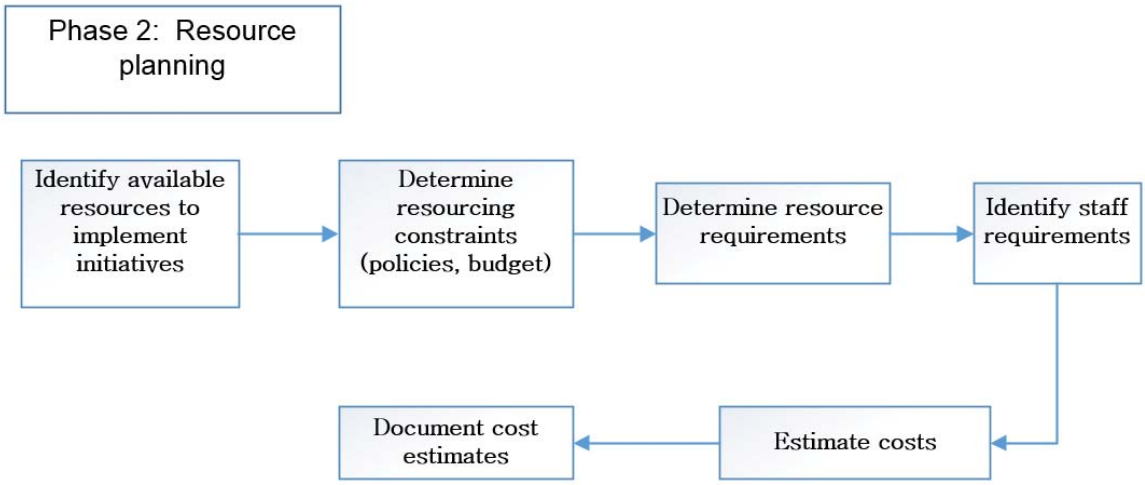


Figure 28: Project Resource Planning, Phase 2

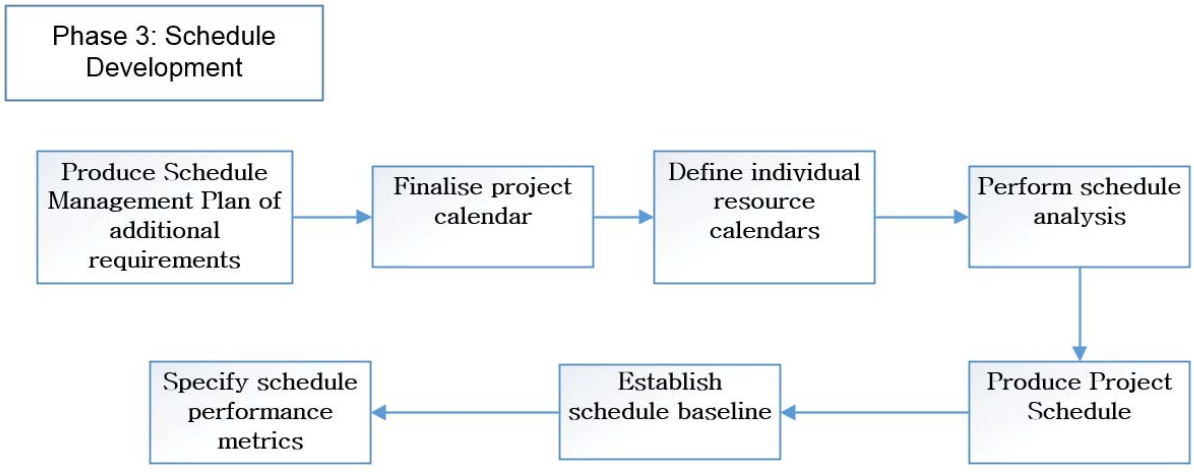


Figure 29: Project Schedule Development, Phase 3

Project Implementation Phase Process Flows

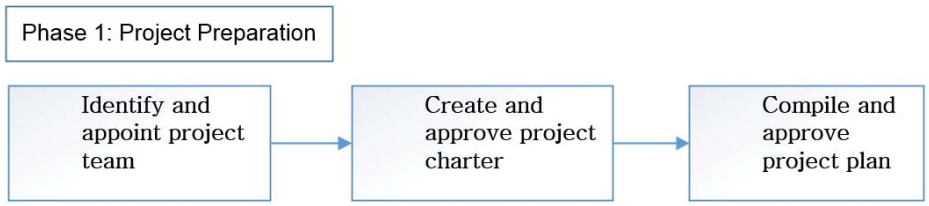


Figure 30: Project Preparation Phase

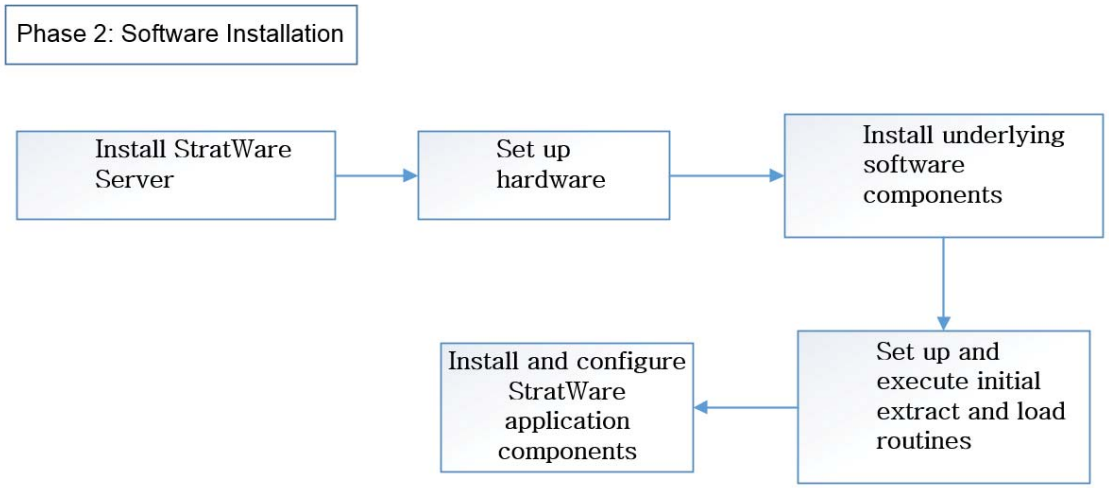


Figure 31: Software Installation Phase

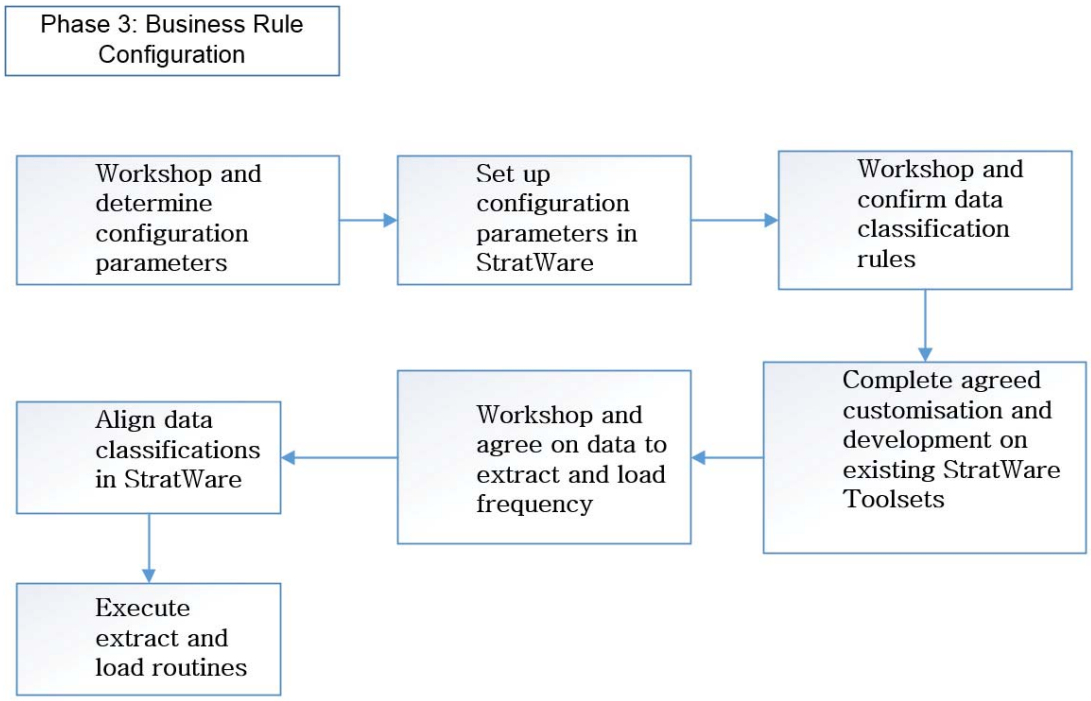


Figure 32: Business Rule Configuration Phase

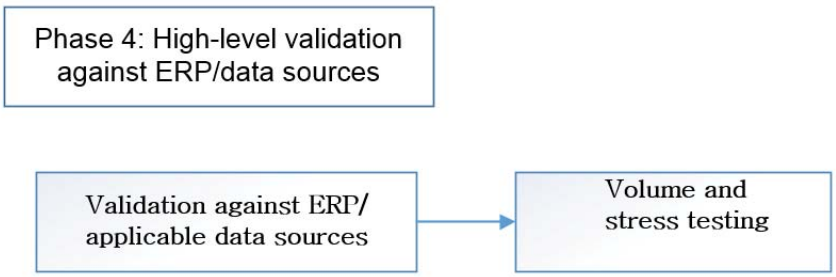


Figure 33: High-level Validation Phase

Project Control Phase Process Flows

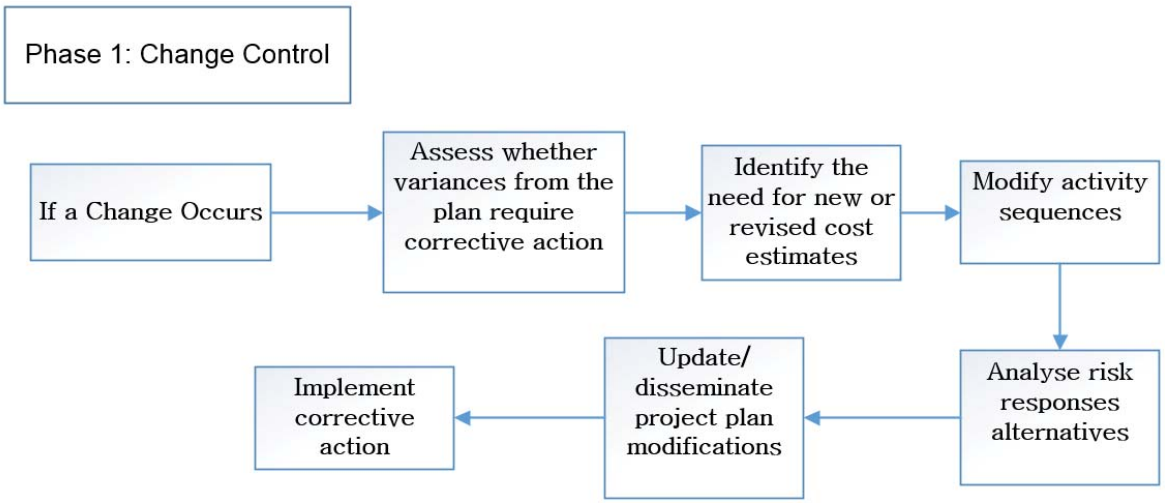


Figure 34: Change Control Phase

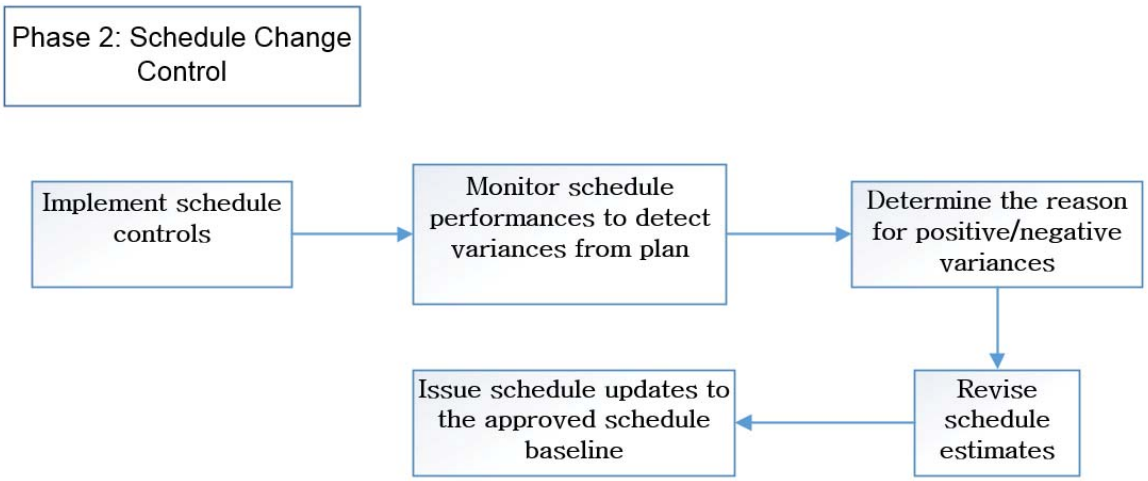


Figure 35: Schedule Change Control Phase

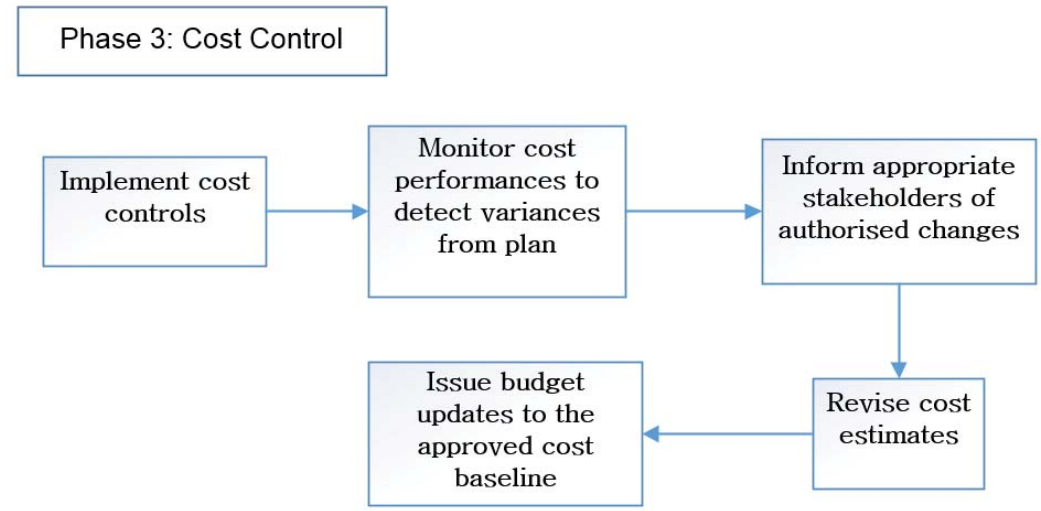


Figure 36: Cost Control Phase

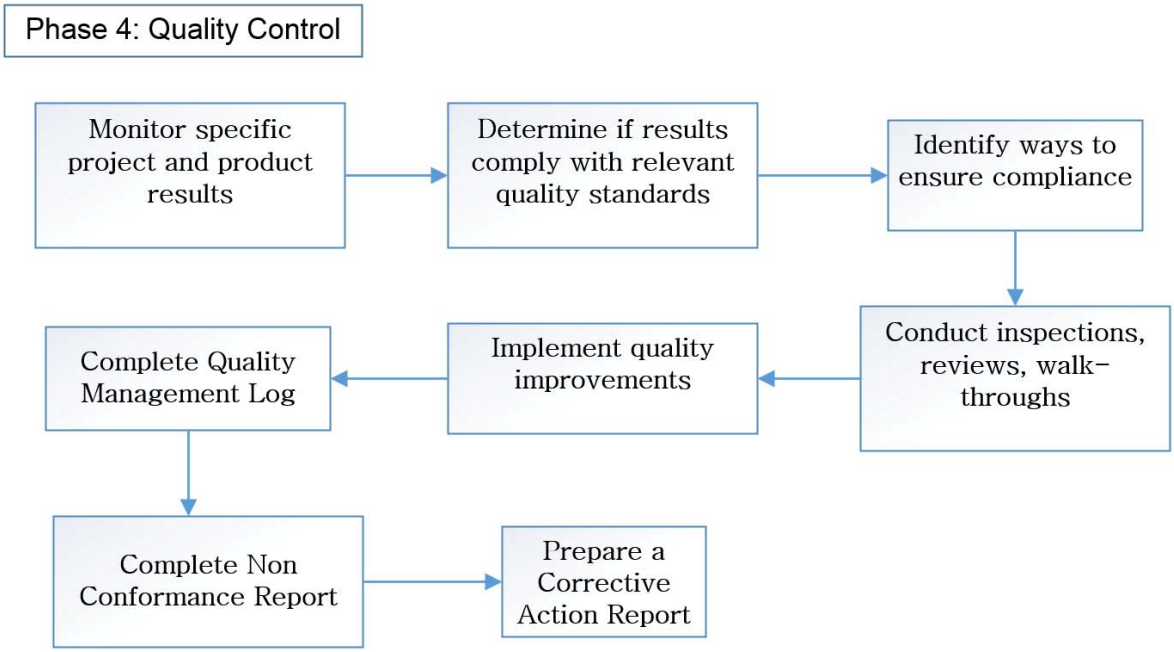


Figure 37: Quality Control Phase

Project Close-Out Phase Process Flows

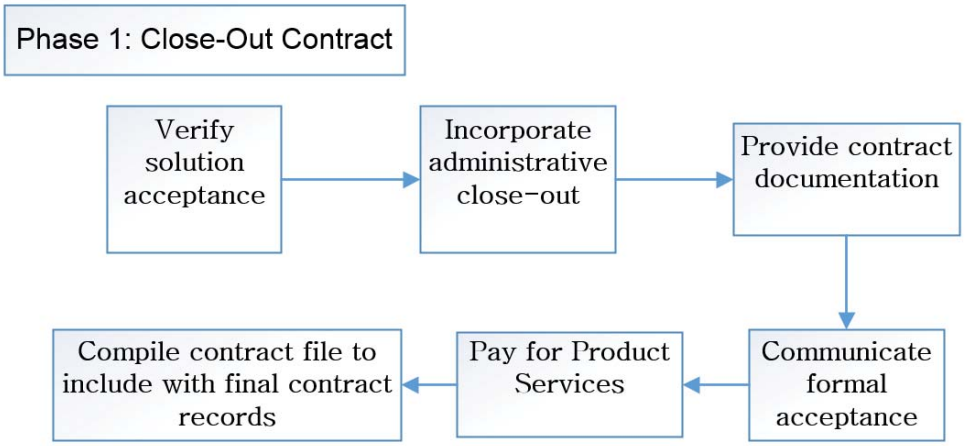


Figure 38: Contract Close-out Phase

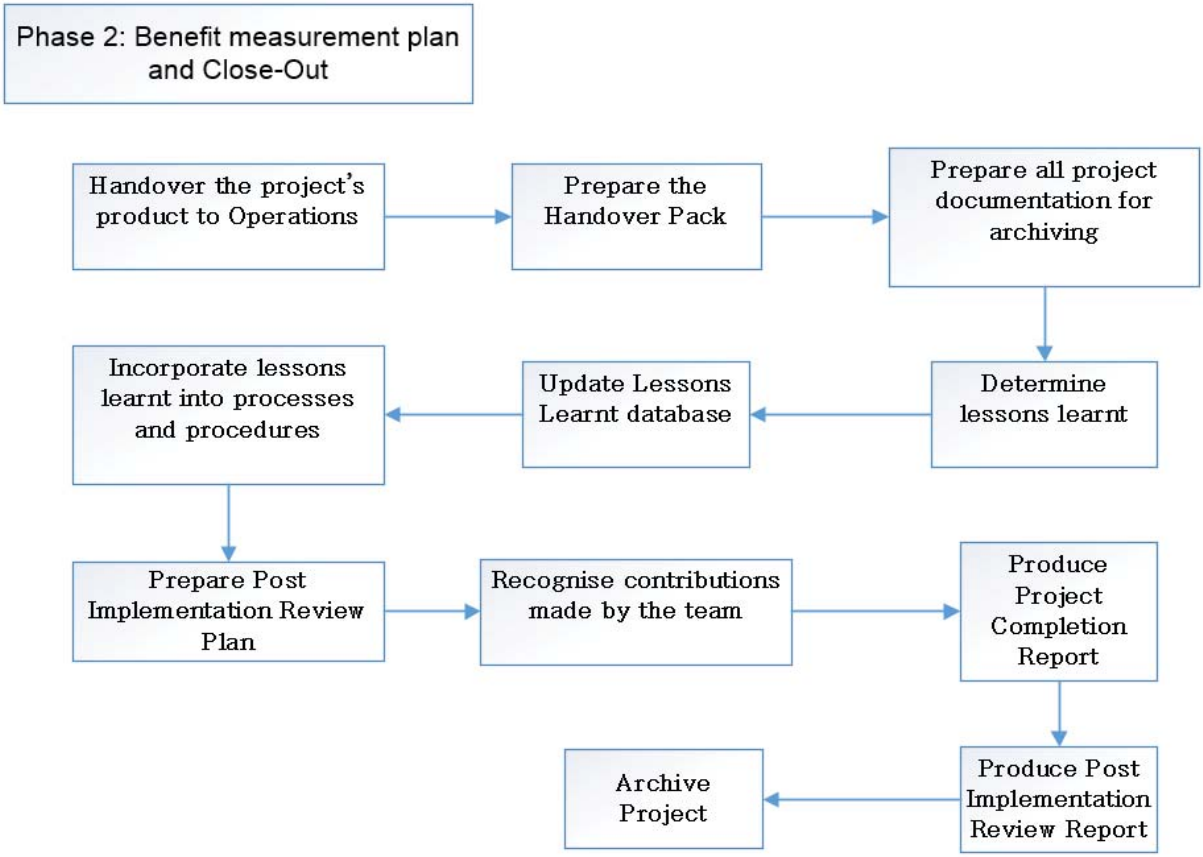


Figure 39: Measurement and Close-out Phase

Project Report Generation Phase Process Flows

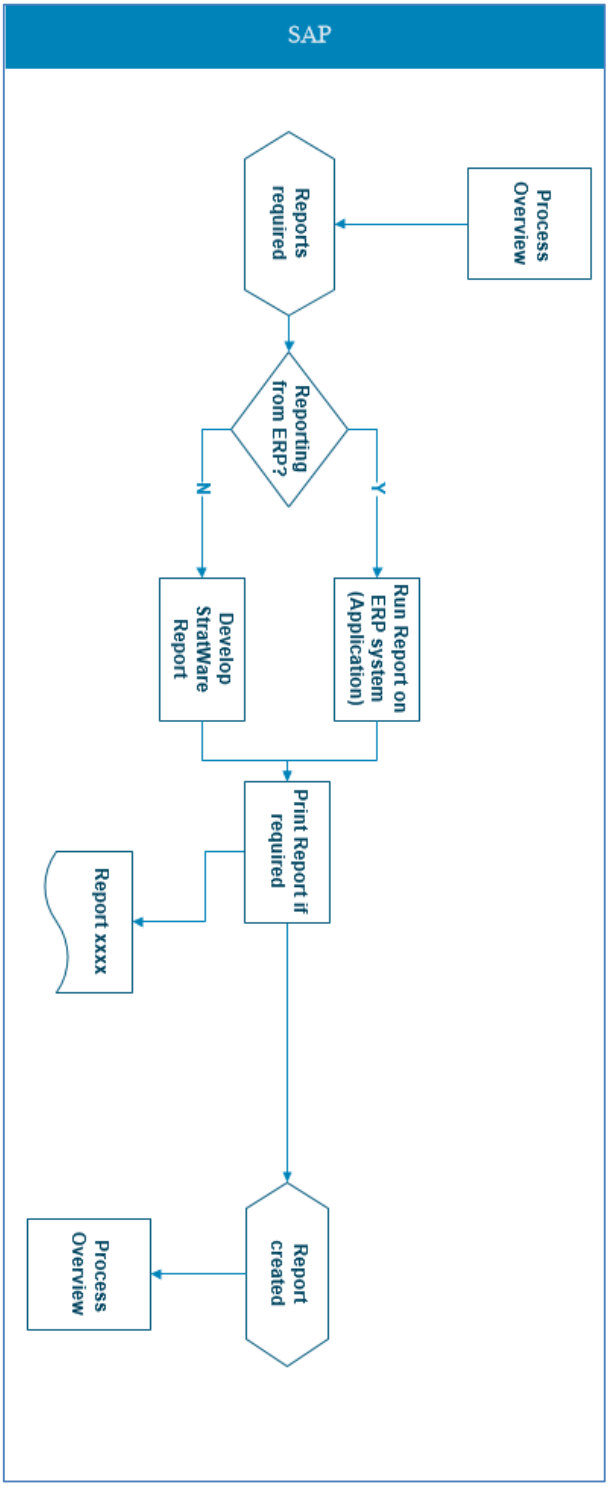


Figure 40: Report Generation Process Flow

Appendix D: Evaluation of Alternatives

Evaluation of Alternatives

The evaluation of alternatives is done using pairwise comparison and intermediate matrixes

1. Software Quality

Table 36: Functionality Pairwise and Intermediate Matrixes

Functionality	Oracle	Qlik View	Tableau
Oracle	**1,00**	2,00	0,20
Qlik View	0,50	**1,00**	0,25
Tableau	5,00	4,00	**1,00**
Total	6,50	7,00	1,45

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,15	0,29	0,14	0,58	0,19
Qlik View	0,08	0,14	0,17	0,39	0,13
Tableau	0,77	0,57	0,69	2,03	0,68

Table 37: Ease of Use Pairwise and Intermediate Matrixes

Ease of Use	Oracle	Qlik View	Tableau
Oracle	**1,00**	3,00	5,00
Qlik View	0,33	**1,00**	3,00
Tableau	0,20	0,33	**1,00**
Total	1,53	4,33	9,00

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,65	0,69	0,56	1,90	0,63
Qlik View	0,22	0,23	0,33	0,78	0,26
Tableau	0,13	0,08	0,11	0,32	0,11

Table 38: Mobile Accessibility Pairwise and Intermediate Matrixes

Mobile Accessibility	Oracle	Qlik View	Tableau
Oracle	**1,00**	1,00	0,33
Qlik View	1,00	**1,00**	0,33
Tableau	3,00	3,00	**1,00**
Total	5,00	5,00	1,67

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,20	0,20	0,20	0,60	0,20
Qlik View	0,20	0,20	0,20	0,60	0,20
Tableau	0,60	0,60	0,60	1,80	0,60

Table 39: Reliability Pairwise and Intermediate Matrixes

Reliability	Oracle	Qlik View	Tableau
Oracle	**1,00**	3,00	5,00
Qlik View	0,33	**1,00**	3,00
Tableau	0,20	0,33	**1,00**
Total	1,53	4,33	9,00

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,65	0,69	0,56	1,90	0,63
Qlik View	0,22	0,23	0,33	0,78	0,26
Tableau	0,13	0,08	0,11	0,32	0,11

2. Technical Functionality

Table 40: Financial Forecast Pairwise and Intermediate Matrixes

Financial Forecast	Oracle	Qlik View	Tableau
Oracle	**1,00**	5,00	0,33
Qlik View	0,20	**1,00**	0,11
Tableau	3,00	9,00	**1,00**
Total	4,20	15,00	1,44

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,24	0,33	0,23	0,80	0,27
Qlik View	0,05	0,07	0,08	0,19	0,06
Tableau	0,71	0,60	0,69	2,01	0,67

Table 41: Graphic Benchmark Tools Pairwise and Intermediate Matrixes

Graphic Benchmark Tools	Oracle	Qlik View	Tableau
Oracle	**1,00**	1,00	0,11
Qlik View	1,00	**1,00**	0,11
Tableau	9,00	9,00	**1,00**
Total	11,00	11,00	1,22

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,09	0,09	0,09	0,27	0,09
Qlik View	0,09	0,09	0,09	0,27	0,09
Tableau	0,82	0,82	0,82	2,45	0,82

Table 42: Ad Hoc Analysis Pairwise and Intermediate Matrixes

Ad Hoc Analysis	Oracle	Qlik View	Tableau
Oracle	**1,00**	0,33	0,50
Qlik View	3,00	**1,00**	3,00
Tableau	2,00	0,33	**1,00**
Total	6,00	1,67	4,50

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,17	0,20	0,11	0,48	0,16
Qlik View	0,50	0,60	0,67	1,77	0,59
Tableau	0,33	0,20	0,22	0,76	0,25

Table 43: Issue Indicator Pairwise and Intermediate Matrixes

Issue Indicators	Oracle	Qlik View	Tableau
Oracle	**1,00**	0,11	1,00
Qlik View	9,00	**1,00**	9,00
Tableau	1,00	0,11	**1,00**
Total	11,00	1,22	11,00

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,09	0,09	0,09	0,27	0,09
Qlik View	0,82	0,82	0,82	2,45	0,82
Tableau	0,09	0,09	0,09	0,27	0,09

Table 44: Trend Indicator Pairwise and Intermediate Matrixes

Trend Indicator	Oracle	Qlik View	Tableau
Oracle	**1,00**	1,00	0,20
Qlik View	1,00	**1,00**	0,20
Tableau	5,00	5,00	**1,00**
Total	7,00	7,00	1,40

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,14	0,14	0,14	0,43	0,14
Qlik View	0,14	0,14	0,14	0,43	0,14
Tableau	0,71	0,71	0,71	2,14	0,71

Table 45: OLAP Pairwise and Intermediate Matrixes

OLAP	Oracle	Qlik View	Tableau
Oracle	**1,00**	0,33	0,33
Qlik View	3,00	**1,00**	1,00
Tableau	3,00	1,00	**1,00**
Total	7,00	2,33	2,33

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,14	0,14	0,14	0,43	0,14
Qlik View	0,43	0,43	0,43	1,29	0,43
Tableau	0,43	0,43	0,43	1,29	0,43

3. Software Procurement

Table 46: Software Cost Pairwise and Intermediate Matrixes

Software Cost	Oracle	Qlik View	Tableau
Oracle	**1,00**	0,20	0,20
Qlik View	5,00	**1,00**	2,00
Tableau	5,00	0,50	**1,00**
Total	11,00	1,70	3,20

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,09	0,12	0,06	0,27	0,09
Qlik View	0,45	0,59	0,63	1,67	0,56
Tableau	0,45	0,29	0,31	1,06	0,35

Table 47: Training and Support Pairwise and Intermediate Matrixes

Training and Support	Oracle	Qlik View	Tableau
Oracle	**1,00**	1,00	0,20
Qlik View	1,00	**1,00**	0,33
Tableau	5,00	3,00	**1,00**
Total	7,00	5,00	1,53

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,14	0,20	0,13	0,47	0,16
Qlik View	0,14	0,20	0,22	0,56	0,19
Tableau	0,71	0,60	0,65	1,97	0,66

Table 48: Operating System Pairwise and Intermediate Matrixes

Operating System	Oracle	Qlik View	Tableau
Oracle	**1,00**	1,00	1,00
Qlik View	1,00	**1,00**	1,00
Tableau	1,00	1,00	**1,00**
Total	3,00	3,00	3,00

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,33	0,33	0,33	1,00	0,33
Qlik View	0,33	0,33	0,33	1,00	0,33
Tableau	0,33	0,33	0,33	1,00	0,33

Table 49: Deployment Pairwise and Intermediate Matrixes

Deployment	Oracle	Qlik View	Tableau
Oracle	**1,00**	0,20	1,00
Qlik View	5,00	**1,00**	5,00
Tableau	1,00	0,20	**1,00**
Total	7,00	1,40	7,00

	Oracle	Qlik View	Tableau	Total	Average
Oracle	0,14	0,14	0,14	0,43	0,14
Qlik View	0,71	0,71	0,71	2,14	0,71
Tableau	0,14	0,14	0,14	0,43	0,14

Appendix E: Consistency Index Process

Consistency Index Test

The following section shows all calculations and steps required to calculate the consistency index as well as the consistency ration of the pairwise matrixes used during the AHP.

Step:

1. Create a single pairwise comparison matrix for each criterion.

Table 50: Consistency Index Test

Pairwise Comparison	Software Quality	Technical Functionality	Software Procurement	3rd Root Product	Priority Vector (PV)
Software Quality	**1.00**	0.33	1.00	0.69	0.21
Technical Functionality	3.00	**1.00**	2.00	1.82	0.55
Software Procurement	1.00	0.50	**1.00**	0.79	0.24
Sum	5.00	1.83	4.00	**3.30**	1.00
*Sum*PV*	1.05	1.01	0.96	**3.02**	
Lambda max =	**3.02**				
CI =	**0.01**				
CR =	**0.02**				

2. Multiply all values in a row with each other and determine the nth root of the element.

   Nth root calculation:

   - Software Quality: $(1 \times 0.33 \times 1)^{\frac{1}{3}} = 0.69$
   - Technical Functionality: $(3 \times 1 \times 2)^{\frac{1}{3}} = 1.82$
   - Software Procurement: $(1 \times 0.50 \times 1)^{\frac{1}{3}} = 0.79$

3. Normalise the nth root of each element with the appropriate weight.

   Calculate the Priority vector (PV):

$$\text{PV} = \frac{\text{3rd root product}}{\text{sum of 3rd root product}} = \frac{0.69}{(0.68+1.82+0.79)}$$

   - Software Quality: $\frac{0.69}{3.30} = 0.21$
   - Technical Functionality: $\frac{1.82}{3.30} = 0.55$
   - Software Procurement: $\frac{0.79}{3.30} = 0.24$

4. Calculate the Consistency Ratio (CR)

   Consistency Ratio = Sum x PV

   - Software Quality: $(1 + 3 + 1) \times (0.21) = 1.05$
   - Technical Functionality: $(0.33 + 1 + 0.5) \times (0.55) = 1.01$
   - Software Procurement: $(1 + 2 + 1) \times (0.24) = 0.96$

5. Calculate Lambda max:

   Lambda max = (1.05 + 1.01 + 0.96) = 3.02

6. Calculate the Consistency Index (CI)

   Where: n = the number of criterion in the matrix

   - $\mathrm{CI} = \frac{(\mathrm{Lambda\ max} - \mathrm{n})}{(\mathrm{n}-1)}$
   - $\mathrm{CI} = \frac{(3.02-3)}{(3-1)} = 0.02$

7. Calculate the Consistency Ratio (CR)

   The consistency ratio is determined by dividing the CI by a Random Index (RI). The RI is a function of the number of criteria used in the matrix. Table 48, below provides the RI corresponding to the number of criteria.

   - $\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}$
   - $\mathrm{CR} = \frac{0{,}01}{0{,}58} = 0{,}02$

Table 51: Random Index

n	*Random Index (RI)*
1	0,00
2	0,00
3	0,58
4	0,90
5	1,12
6	1,24
7	1,32
8	1,41
9	1,45

Appendix F: Consistency Index Test

Consistency Index Test

1. Main Criteria

Table 52: Main Criteria Consistency Index Test

Main Criteria	**Software Quality**	**Technical Functionality**	**Software Procurement**	**3rd Root Product**	**Priority Vector**
Software Quality	1,00	0,33	1,00	0,69	0,21
Technical Functionality	3,00	1,00	2,00	1,82	0,55
Software Procurement	1,00	0,50	1,00	0,79	0,24
Sum	5,00	1,83	4,00	3,30	1,00
Sum*PV	1,05	1,01	0,96	3,02	
Lambda max =	**3,02**				
CI =	**0,01**				
CR =	**0,02**				

2. Software Quality

Table 53: Software Quality Consistency Index Test

Software Quality	**Functionality**	**Ease of Use**	**Mobile Accessibility**	**Reliability**	**4th Root Product**	**Priority Vector**
Functionality	1,00	3,00	7,00	3,00	2,82	0,51
Ease of Use	0,33	1,00	7,00	3,00	1,63	0,29
Mobile Accessibility	0,14	0,14	1,00	0,20	0,25	0,05
Reliability	0,33	0,33	5,00	1,00	0,86	0,16
Sum	1,81	4,48	20,00	7,20	5,56	1,00
Sum*PV	0,92	1,31	0,91	1,12	4,25	
Lambda max =	**4,25**					
CI =	**0,08**					
CR =	**0,09**					

Table 54: Functionality Consistency Index Test

Functionality	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	2,00	0,20	0,74	0,19
Qlik View	0,50	1,00	0,25	0,50	0,13
Tableau	5,00	4,00	1,00	2,71	0,69
Sum	6,50	7,00	1,45	3,95	1,00
Sum*PV	1,21	0,89	1,00	3,09	
Lambda max =	**3,09**				
CI =	**0,05**				
CR =	**0,08**				

Table 55: Ease of Use Consistency Index Test

Ease of Use	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	3,00	5,00	2,47	0,64
Qlik View	0,33	1,00	3,00	1,00	0,26
Tableau	0,20	0,33	1,00	0,41	0,10
Sum	1,53	4,33	9,00	3,87	1,00
Sum*PV	0,98	1,12	0,94	3,04	
Lambda max =	**3,04**				
CI =	**0,02**				
CR =	**0,03**				

Table 56: Mobile Accessibility Consistency Index Test

Mobile Accessibility	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	1,00	0,33	0,69	0,20
Qlik View	1,00	1,00	0,33	0,69	0,20
Tableau	3,00	3,00	1,00	2,08	0,60
Sum	5,00	5,00	1,67	3,47	1,00
Sum*PV	1,00	1,00	1,00	3,00	
Lambda max =	**3,00**				
CI =	**0,00**				
CR =	**0,00**				

Table 57: Reliability Consistency Index Test

Reliability	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	3,00	5,00	2,47	0,64
Qlik View	0,33	1,00	3,00	1,00	0,26
Tableau	0,20	0,33	1,00	0,41	0,10
Sum	1,53	4,33	9,00	3,87	1,00
*Sum*PV*	0,98	1,12	0,94	3,04	
Lambda max =	**3,04**				
CI =	**0,02**				
CR =	**0,03**				

3. Technical Functionality

Table 58: Technical Functionality Consistency Index Test

Pairwise Matrix	Financial Forecast	Graphic Benchmark Tools	Ad Hoc Analysis	Issue Indicators	Trend Indicator	OLAP	6th Root Product	Priority Vector
Financial Forecast	1,00	0,33	0,20	0,33	0,33	0,33	0,37	0,05
Graphic Benchmark Tools	3,00	1,00	0,33	0,50	0,50	0,20	0,61	0,08
Ad Hoc Analysis	5,00	3,00	1,00	5,00	5,00	0,50	2,39	0,31
Issue Indicators	3,00	2,00	0,20	1,00	0,50	0,33	0,76	0,10
Trend Indicator	3,00	2,00	0,20	2,00	1,00	0,20	0,88	0,11
OLAP	3,00	5,00	2,00	3,00	5,00	1,00	2,77	0,36
Sum	18,00	13,33	3,93	11,83	12,33	2,57	7,78	1,00
*Sum*PV*	0,85	1,04	1,21	1,16	1,40	0,91	6,58	
Lambda max =	**6,58**							
CI =	**0,12**							
CR =	**0,08**							

Table 59: Financial Forecast Consistency Index Test

Financial Forecast	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	5,00	0,33	1,19	0,27
Qlik View	0,20	1,00	0,11	0,28	0,06
Tableau	3,00	9,00	1,00	3,00	0,67
Sum	4,20	15,00	1,44	4,47	1,00
*Sum*PV*	1,11	0,94	0,97	3,03	
Lambda max =	**3,03**				
CI =	**0,01**				
CR =	**0,03**				

Table 60: Graphic Benchmark Tools Consistency Index Test

Graphic Benchmark Tools	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	1,00	0,11	0,48	0,09
Qlik View	1,00	1,00	0,11	0,48	0,09
Tableau	9,00	9,00	1,00	4,33	0,82
Sum	11,00	11,00	1,22	5,29	1,00
Sum*PV	1,00	1,00	1,00	3,00	
Lambda max =	3,00				
CI =	0,00				
CR =	0,00				

Table 61: Ad Hoc Analysis Consistency Index Test

Ad Hoc Analysis	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	0,33	0,50	0,55	0,16
Qlik View	3,00	1,00	3,00	2,08	0,59
Tableau	2,00	0,33	1,00	0,87	0,25
Sum	6,00	1,67	4,50	3,50	1,00
Sum*PV	0,94	0,99	1,12	3,05	
Lambda max =	**3,05**				
CI =	**0,03**				
CR =	**0,05**				

Table 62: Issue Indicators Consistency Index Test

Issue Indicators	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	0,11	1,00	0,48	0,09
Qlik View	9,00	1,00	9,00	4,33	0,82
Tableau	1,00	0,11	1,00	0,48	0,09
Sum	11,00	1,22	11,00	5,29	1,00
Sum*PV	1,00	1,00	1,00	3,00	
Lambda max =	**3,00**				
CI =	**0,00**				
CR =	**0,00**				

Table 63: Trend Indicator Consistency Index Test

Trend Indicator	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	1,00	0,20	0,58	0,14
Qlik View	1,00	1,00	0,20	0,58	0,14
Tableau	5,00	5,00	1,00	2,92	0,71
Sum	7,00	7,00	1,40	4,09	1,00
*Sum*PV*	1,00	1,00	1,00	3,00	
Lambda max =	**3,00**				
CI =	**0,00**				
CR =	**0,00**				

Table 64: OLAP Consistency Index Test

OLAP	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	0,33	0,33	0,48	0,14
Qlik View	3,00	1,00	1,00	1,44	0,43
Tableau	3,00	1,00	1,00	1,44	0,43
Sum	7,00	2,33	2,33	3,37	1,00
*Sum*PV*	1,00	1,00	1,00	3,00	
Lambda max =	**3,00**				
CI =	**0,00**				
CR =	**0,00**				

4. Software Procurement

Table 65: Software Procurement Consistency Index Test

Software Procurement	Software Cost	Training and Support	Operating System	Deployment	4th Root Product	Priority Vector
Software Cost	1,00	3,00	3,00	0,25	1,22	0,23
Training and Support	0,33	1,00	3,00	0,20	0,67	0,12
Operating System	0,33	0,33	1,00	0,20	0,39	0,07
Deployment	4,00	5,00	5,00	1,00	3,16	0,58
Sum	5,67	9,33	12,00	1,65	5,44	1,00
*Sum*PV*	1,28	1,15	0,85	0,96	4,23	
Lambda max =	**4,23**					
CI =	**0,08**					
CR =	**0,09**					

Table 66: Software Cost Consistency Index Test

Software Cost	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	0,20	0,20	0,34	0,09
Qlik View	5,00	1,00	2,00	2,15	0,56
Tableau	5,00	0,50	1,00	1,36	0,35
Sum	11,00	1,70	3,20	3,85	1,00
*Sum*PV*	0,98	0,95	1,13	3,05	
Lambda max =	**3,05**				
CI =	**0,03**				
CR =	**0,05**				

Table 67: Training and Support Consistency Index Test

Training and Support	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	1,00	0,20	0,58	0,16
Qlik View	1,00	1,00	0,33	0,69	0,19
Tableau	5,00	3,00	1,00	2,47	0,66
Sum	7,00	5,00	1,53	3,74	1,00
*Sum*PV*	1,09	0,93	1,01	3,03	
Lambda max =	**3,03**				
CI =	**0,01**				
CR =	**0,03**				

Table 68: Operating System Consistency Index Test

Operating System	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	1,00	1,00	1,00	0,33
Qlik View	1,00	1,00	1,00	1,00	0,33
Tableau	1,00	1,00	1,00	1,00	0,33
Sum	3,00	3,00	3,00	3,00	1,00
*Sum*PV*	1,00	1,00	1,00	3,00	
Lambda max =	**3,00**				
CI =	**0,00**				
CR =	**0,00**				

Table 69: Deployment Consistency Index Test

Deployment	Oracle	Qlik View	Tableau	3rd Root Product	Priority Vector
Oracle	1,00	0,20	1,00	0,58	0,14
Qlik View	5,00	1,00	5,00	2,92	0,71
Tableau	1,00	0,20	1,00	0,58	0,14
Sum	7,00	1,40	7,00	4,09	1,00
Sum*PV	1,00	1,00	1,00	3,00	
Lambda max =	3,00				
CI =	0,00				
CR =	0,00				

Appendix G: Tableau Functionality Preview

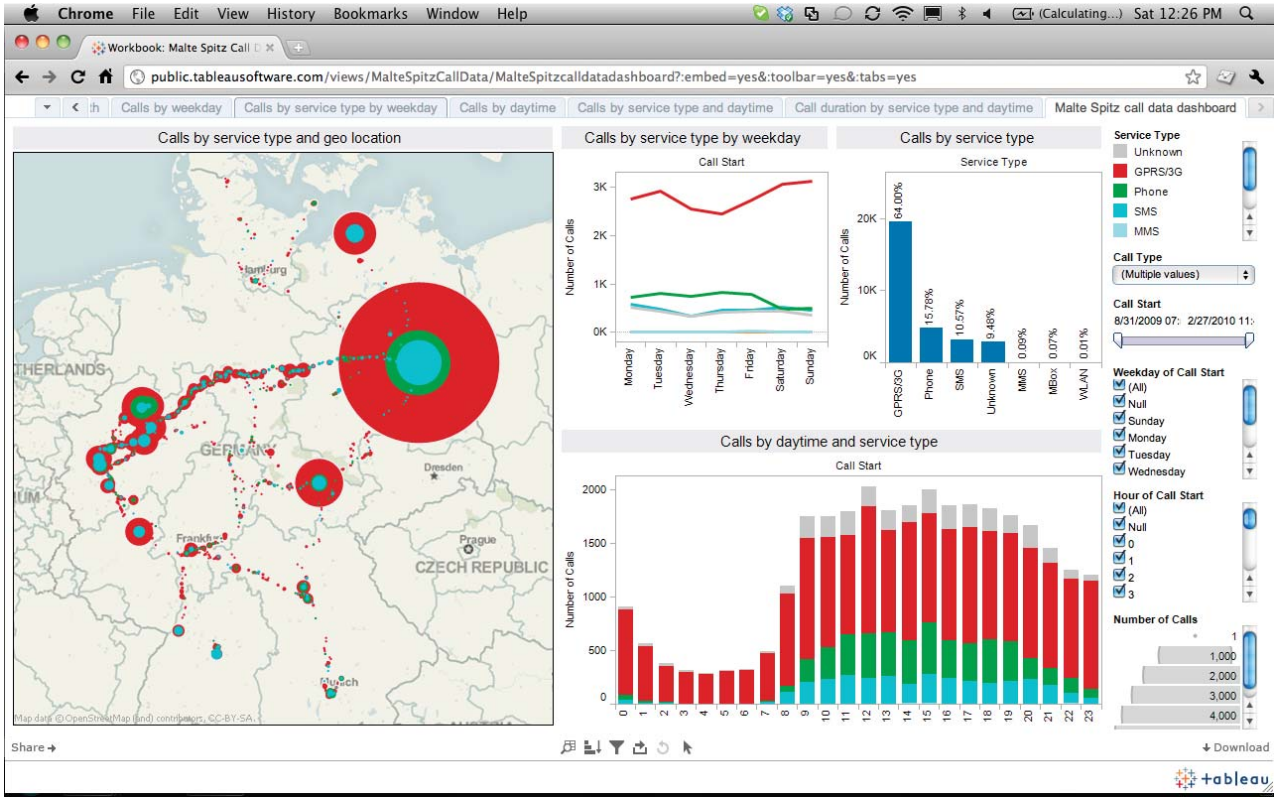


Figure 41: Web-based Tableau Report (Tableau, 2015).

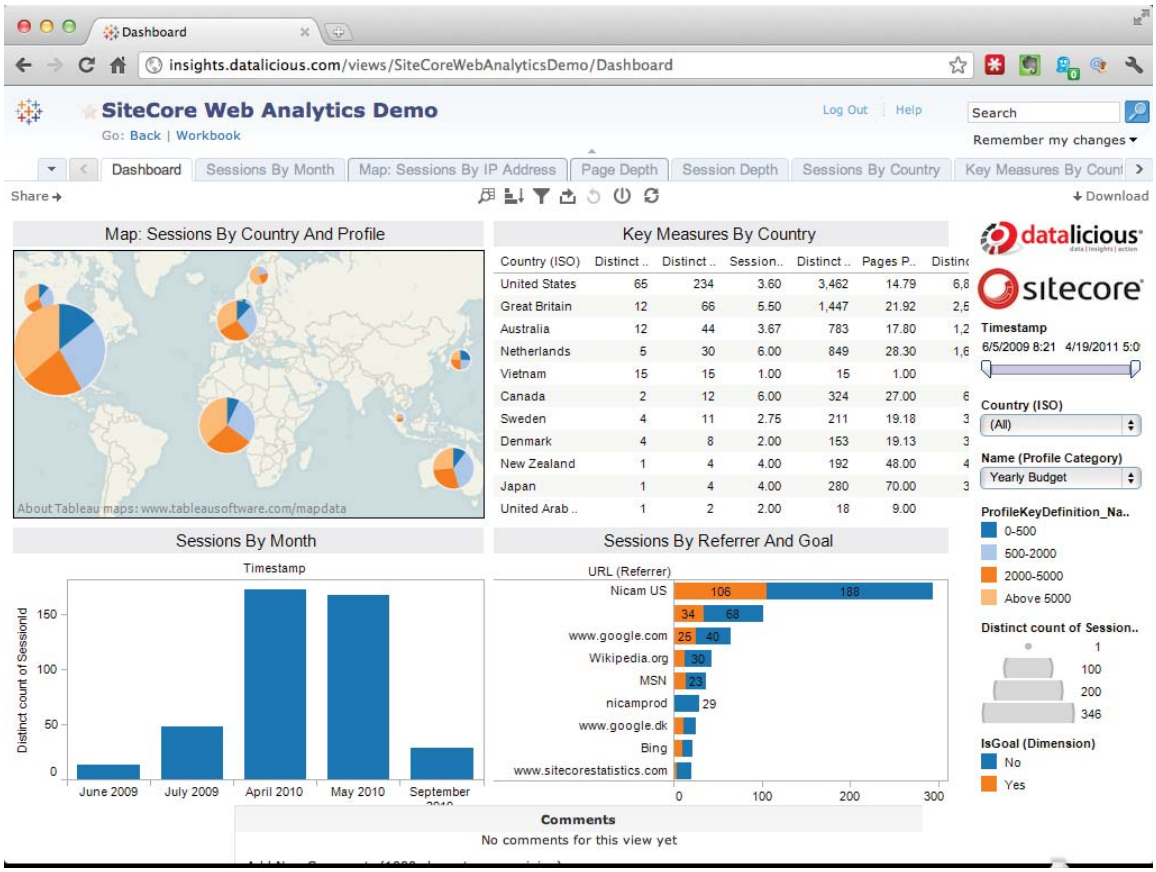


Figure 42: Web-based Tableau Dashboard (Tableau, 2015).

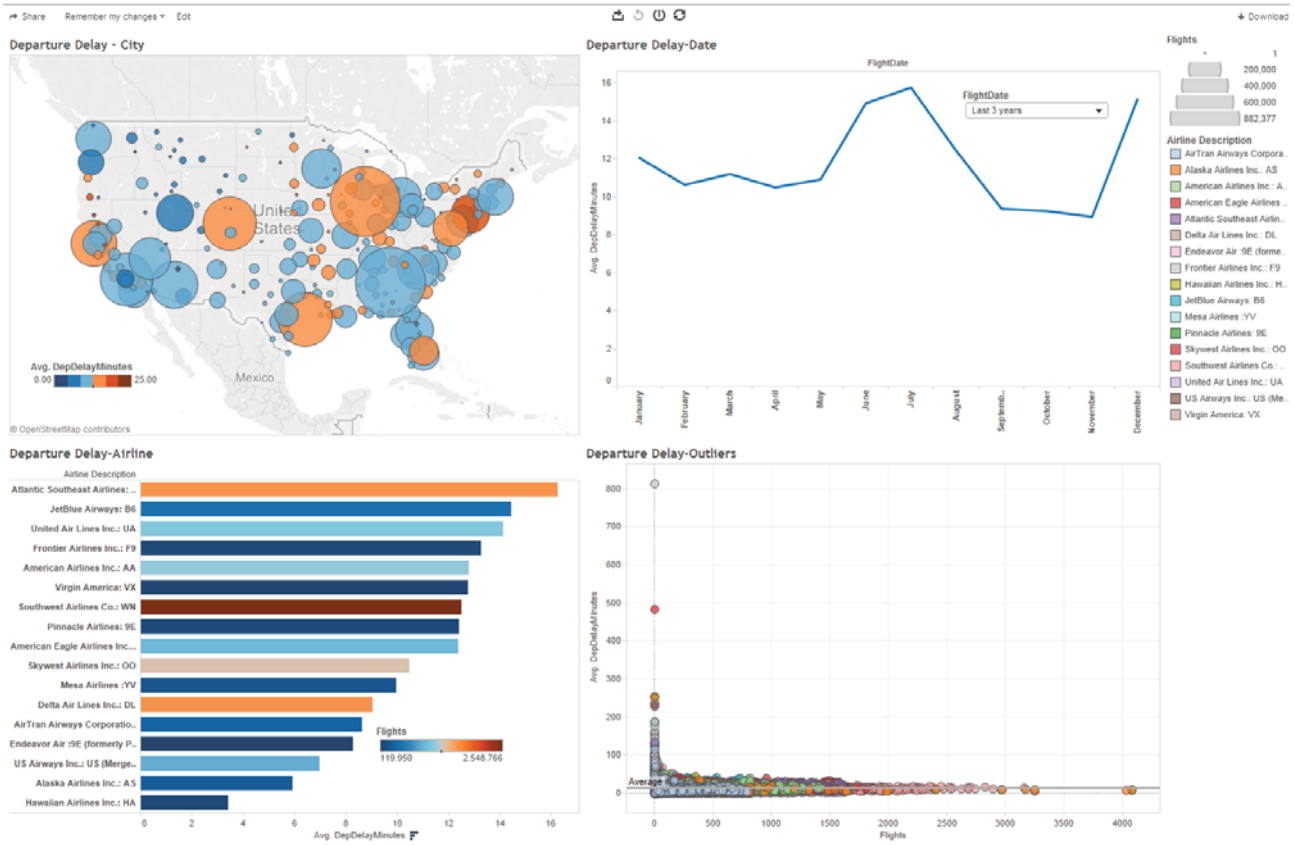


Figure 43: Web-based Tableau Predictive Analytics Outputs (Tableau, 2015).

Figure 44: Desktop Tableau Main View (Tableau, 2015).

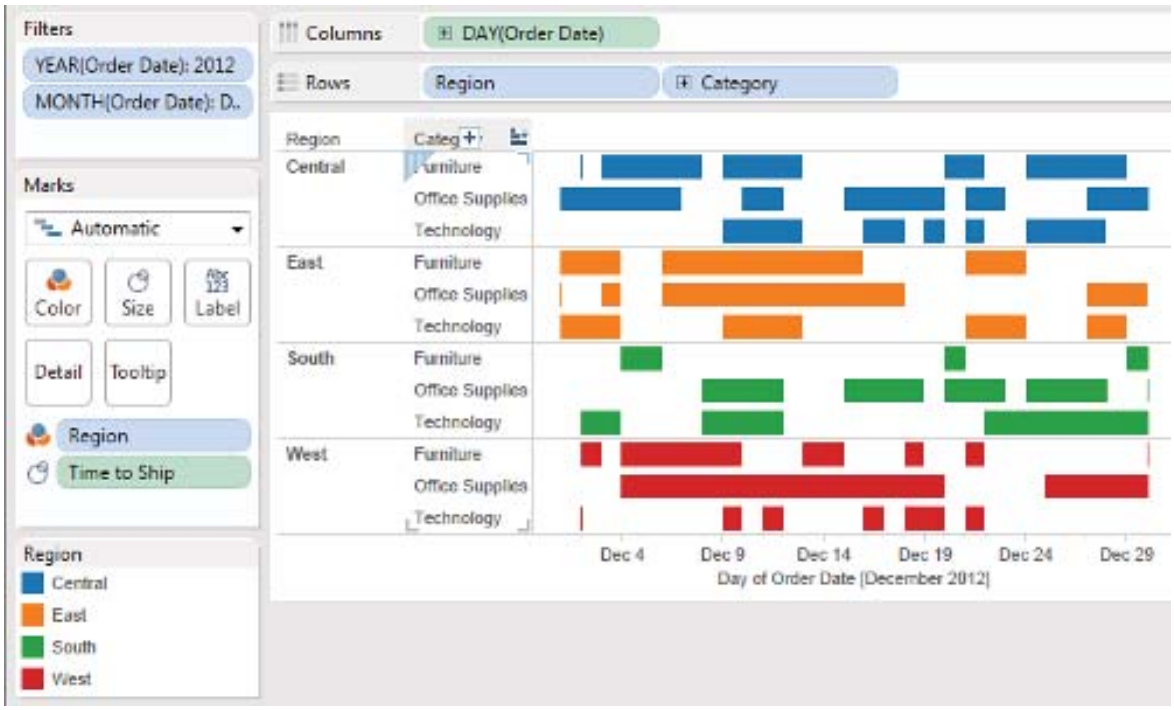


Figure 45: Desktop Tableau Project Management (Tableau, 2015).

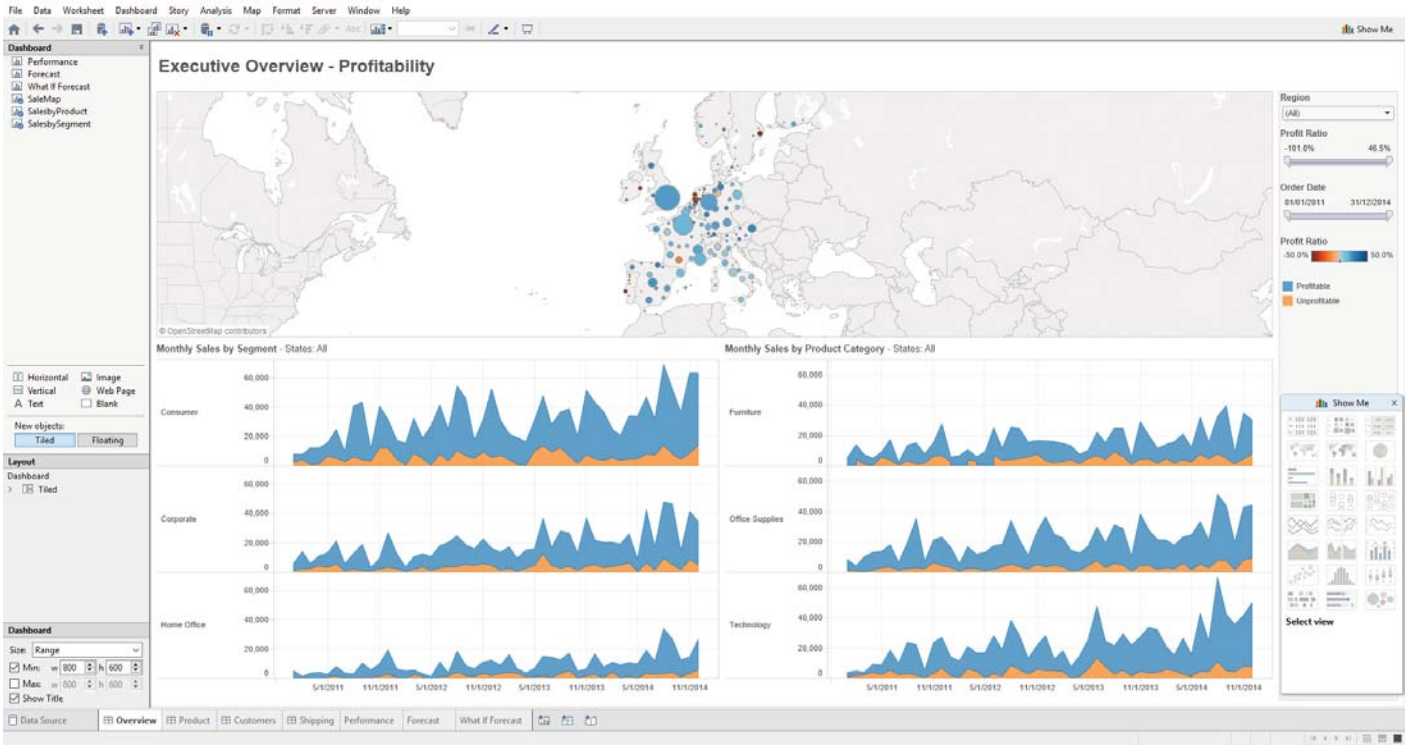


Figure 46: Desktop Tableau Dashboard Overview (Tableau, 2015).

Figure 47: Tableau Product Drill-Down Display (Tableau, 2015).

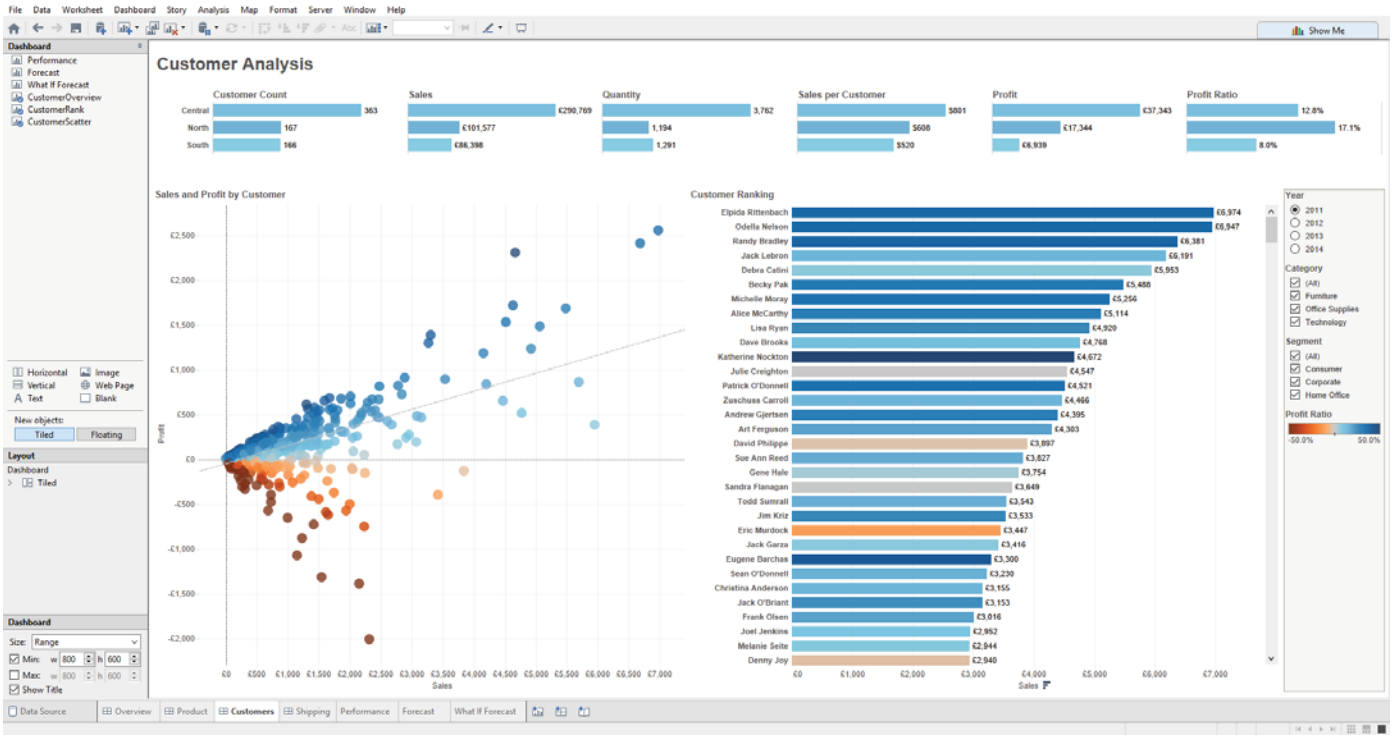


Figure 48: Tableau Consumer Analysis (Tableau, 2015).

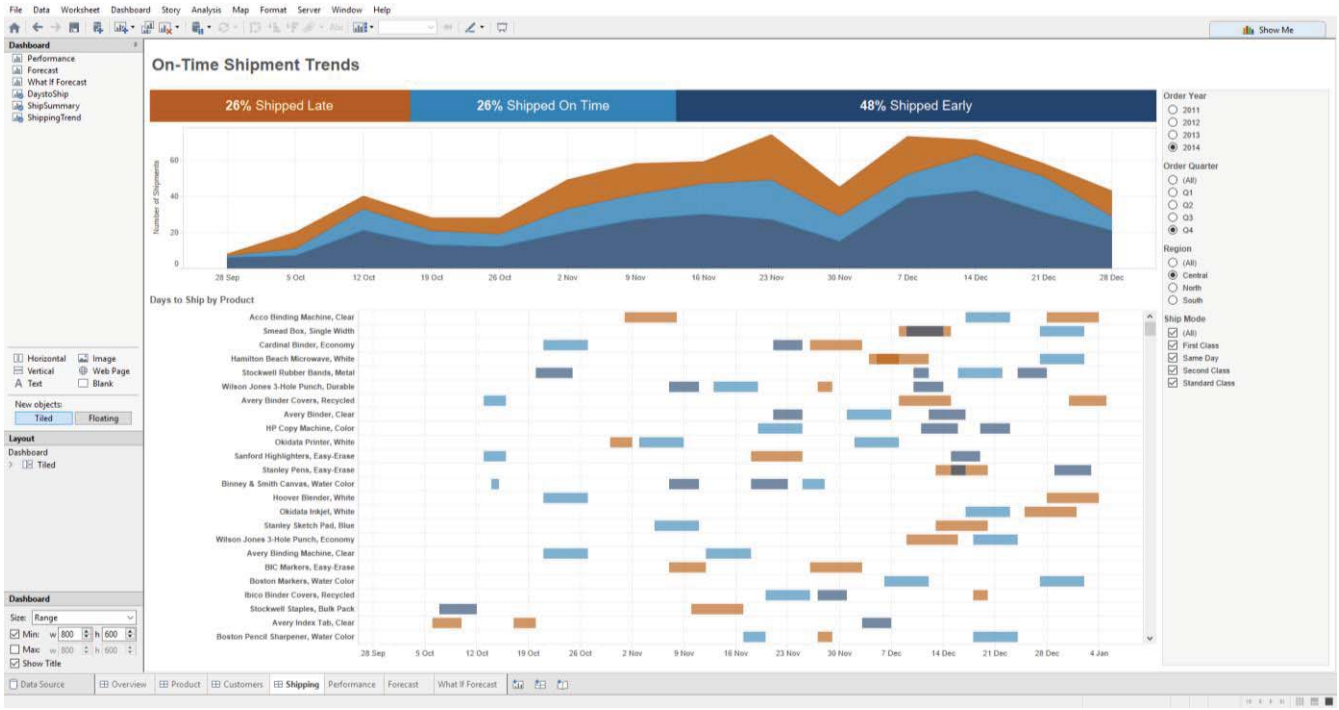


Figure 49: Tableau Trend Analysis (Tableau, 2015).

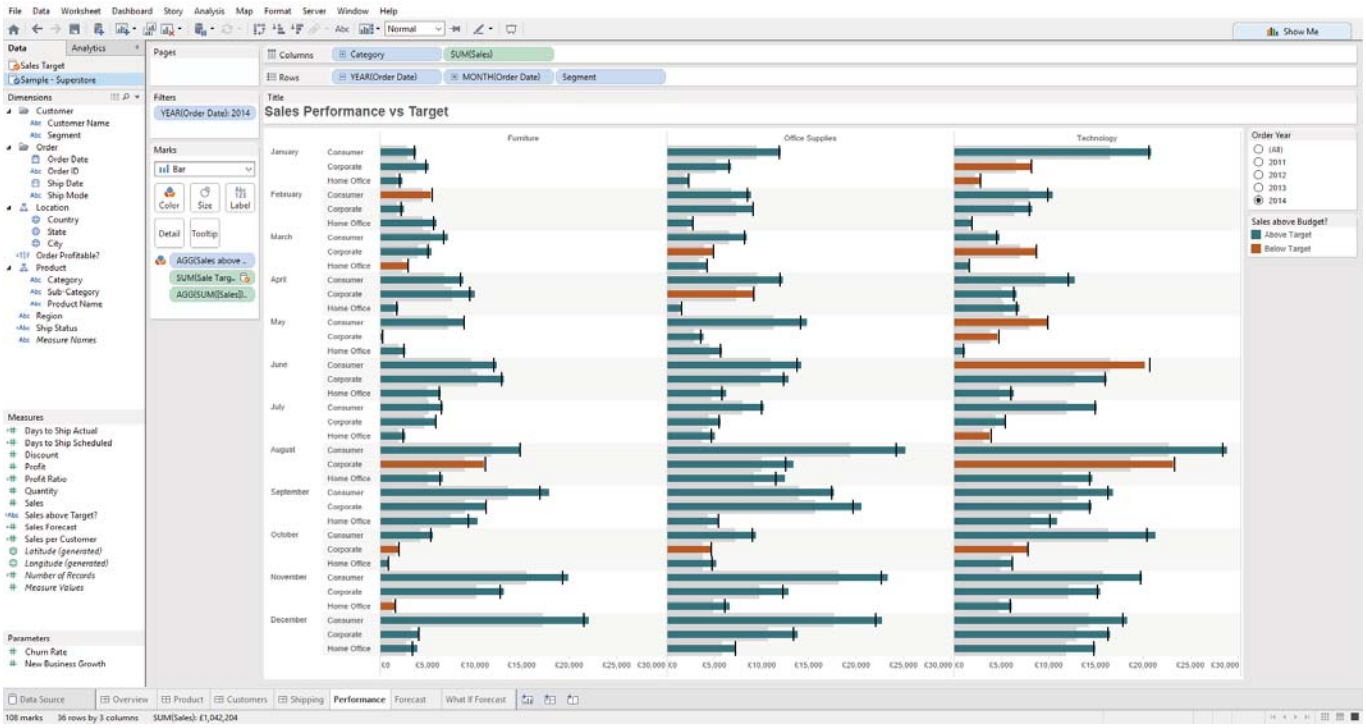


Figure 50: Tableau Performance Measurement (Tableau, 2015).

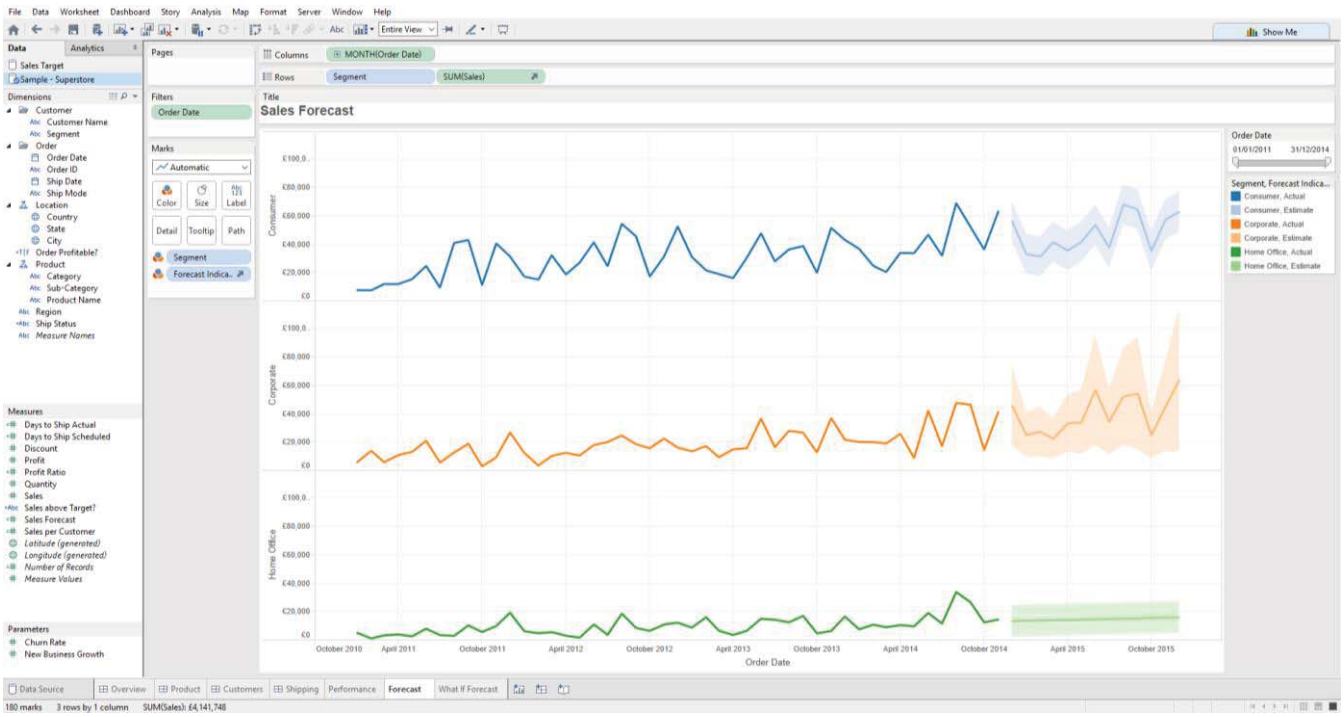


Figure 51: Tableau Forecasting (Tableau, 2015).

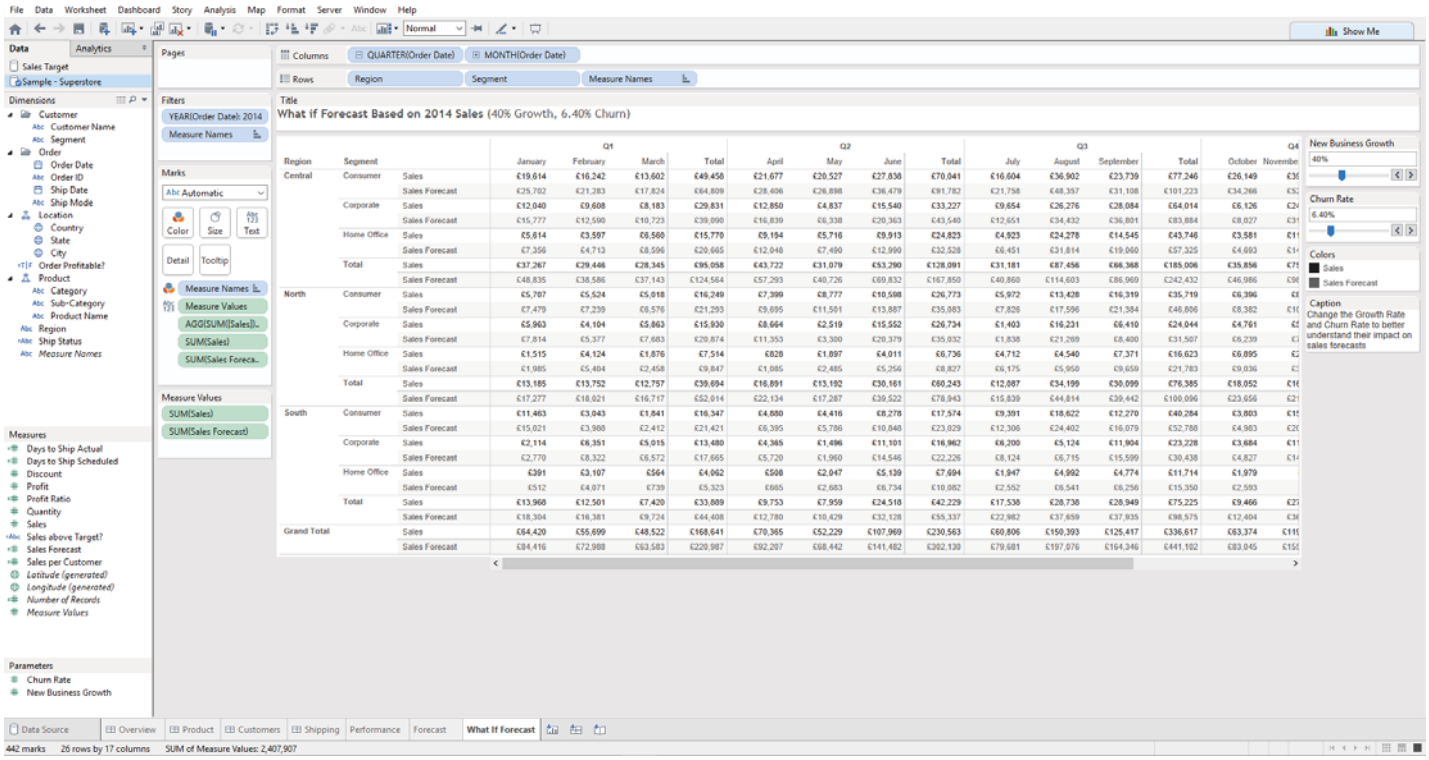


Figure 52: Tableau What if Analysis (Tableau, 2015).

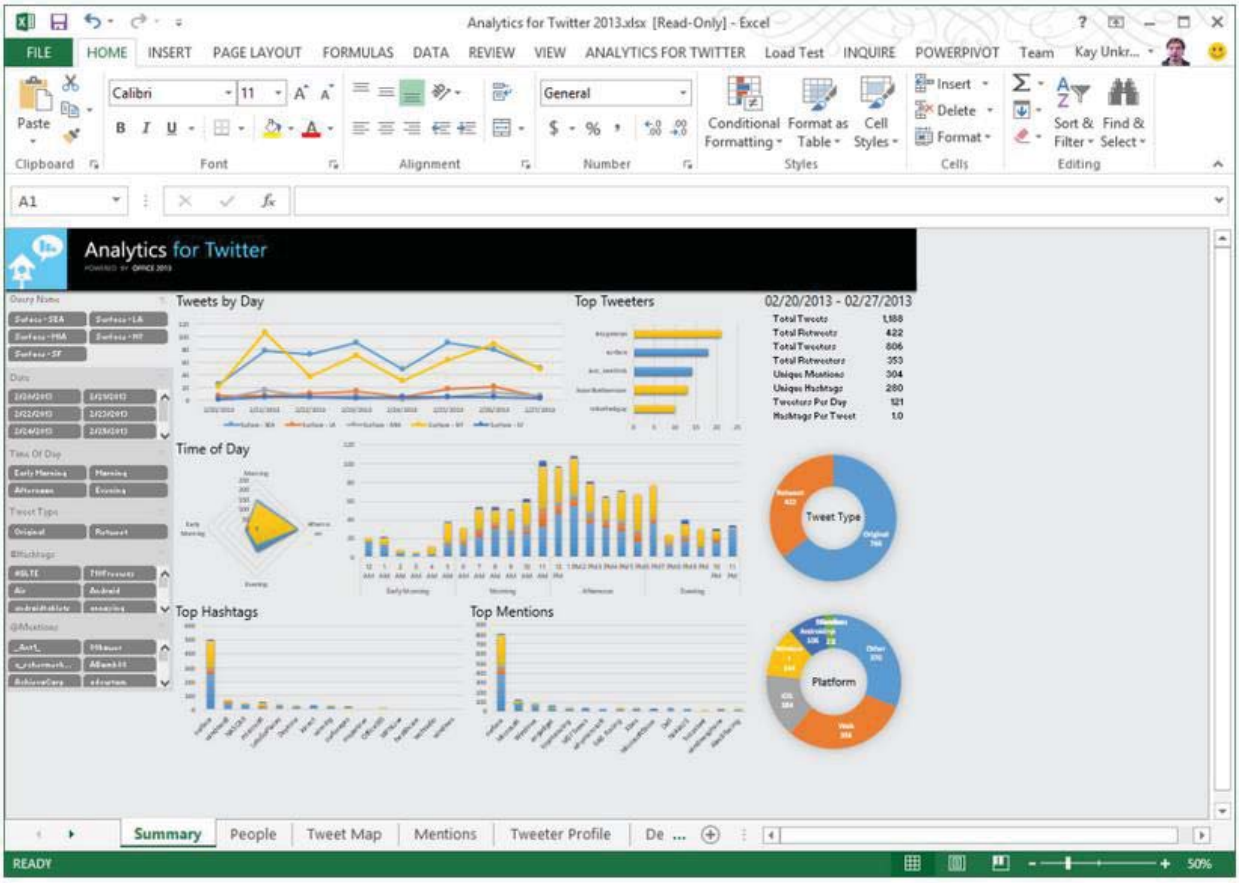


Figure 53: Tableau Date Export to Excel (Tableau, 2015).

Figure 54: Tableau Mobile and Web-Based Platform Views (Tableau, 2015).

Appendix H: End-User Satisfaction Survey Results

Table 70: End-User Satisfaction Survey Results Summary

	Survey Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	The system provides the precise information needed.	4	5	5	4	5	3	3	4	3	4	3	5	3	4
2	The system provides comprehensive reports.	5	5	5	5	5	3	4	4	4	3	4	5	4	4
3	The system provides sufficient information.	4	4	5	5	5	4	4	3	3	4	4	5	4	4
4	The system is error free.	3	3	4	4	4	3	4	3	4	4	4	4	5	5
5	The system provides accurate information.	5	4	5	5	4	3	5	4	3	3	3	4	4	3
6	The information provided by the system is dependable.	4	4	5	4	4	4	4	4	4	4	3	4	5	4
7	The output is presented in a useful format.	4	4	4	4	4	4	5	5	4	4	4	5	4	3
8	The information is clear and concise.	4	4	4	4	4	4	5	5	4	4	4	5	4	3
9	The format of the output is satisfactory.	4	4	4	4	4	4	4	4	4	3	3	5	4	3
10	The system is easy to use.	4	4	3	4	3	3	3	4	4	3	4	4	3	4
11	It is easy to get the system to do what you want it to do.	5	4	4	4	3	3	4	4	4	3	4	3	4	4
12	Interacting with the system is clear and easy to learn.	4	4	4	3	3	3	4	4	4	3	4	4	4	4
13	The system provides up to date information.	5	5	5	5	4	4	4	3	3	3	3	4	4	4
14	The system provides information in a timely manner.	5	5	5	5	4	4	4	3	3	3	3	4	4	4
15	The system operates at a satisfactory pace.	4	4	5	4	3	4	4	3	3	4	3	4	3	3
16	The system is easily modified.	4	4	5	4	4	3	3	4	4	4	4	5	4	4
17	Customisable windows are easily moved and edited.	5	4	5	5	4	3	3	4	4	4	4	5	3	3

Appendix I: Tableau Training Modules

Table 71: Tableau Training Modules (Tableau, 2015)

Tableau Training Modules	
On-demand: Introduction Live online level: Introductory	Connecting to live versus extracting Entering dimensions and measures Crosstab and exporting data Quick table calculations Dashboards Sorting Building views Distributing content
On-demand: Tableau interface Live online level: Basic	Menus and toolbar Data window Sheet tabs Dashboards and stories Shelves and cards
On-demand: Distributing and publishing Live online level: Advanced	Exporting images and PDFs Opening workbook files Secure publishing Distribution methods
On-demand: Connecting to data Live online level: Advanced	Connect to data screen Connect to tables Connect to multiple tables Connecting to databases and advanced features: • Custom SQL • Joins vs data blending • Data source filters Editing metadata and saving data sources Using and refreshing extracts Joint types Additional data blending: • Data blending and calculations • Working with null values • Asterisks solution Data blending: • Connecting to Google analytics • Google analytic use cases • Google analytics data extracts Connecting to salesforce Connecting to cubes: • KPIs • Grouping • Connecting
On-demand: Visual analysis Live online level: Advanced	Getting Started with Visual Analytics Drill Down and Hierarchies Sorting Grouping Additional Ways to Group Creating Sets Working with Sets Ways to Filter Using the Filter Shelf Quick Filters Where Tableau Filters Filtering for Top and Top N Additional Filtering Topics Parameters

On-demand: Dashboards Live online level: Advanced	Getting Started with Dashboards and Stories Building a Dashboard Dashboard Layouts and Formatting Dashboard Interactivity using Actions Dashboard Best Practices Story Points
On-demand: Data mapping Live online level: Advanced	Getting Started with Mapping Maps in Tableau Editing Unrecognized Locations Expanding Tableau's Mapping Capabilities Custom Geocoding Polygon Maps WMS: Web Mapping Services Background Images
On-demand: Calculations Live online level: Advanced	Getting Started with Calculations Calculation Syntax Introduction to LOD Expressions Intro to Table Calculations Modifying Table Calculations Aggregate Calculations Date Calculations Logic Calculations Number Calculations String Calculations Type Calculations Parameters Conceptual Topics with LOD Expressions Aggregation and Replication with LOD Expressions Nested LOD Expressions How to Integrate R and Tableau Using R within Tableau
On-demand: Tableau server Live online level: Advanced	Getting Started with Tableau Server and Tableau Online Interacting with Content on Tableau Server and Tableau Online Publishing to Tableau Server and Tableau Online Web Authoring Navigating the Tableau Mobile App Interacting with Content in the Tableau Mobile App Tableau Server Administrative Overview Installing and Configuring Tableau Server Understanding Schedules and Subscriptions Authorization and Permissions Data Security with User Filters Data Server Upgrading Tableau Server Tabadmin: Administrative Tableau Command Line Utility

On-demand: Tableau online Live online level:	Getting Started with Tableau Server and Tableau Online Interacting with Content on Tableau Server and Tableau Online Publishing to Tableau Server and Tableau Online Web Authoring Navigating the Tableau Mobile App Interacting with Content in the Tableau Mobile App Tableau Online Administrative Overview Data Connections with Tableau Online Authorization and Permissions Data Security with User Filters Data Server Tabcmd: Tableau Command Line Utility
On-demand: Chart creation Live online level:	Cleaning Data by Bulk Re-aliasing Bollinger Bands Waterfall Charts Bump Charts Benford's Law Funnel Charts Box Plots Pareto Charts Control Charts Treemaps, Word Clouds and Bubble Charts
On-demand: API Live online level:	Extract API Introduction Extract API Connecting to Data REST API Javascript API Intro and Embed Javascript API Switching Views Javascript API Filtering and Selecting Javascript API Asynchronous Programming Javascript API Event Listeners Javascript API Advanced Filtering Javascript API Utility Functions

References

Agostino, R. (2004). Business intelligence: solving the ERP overload. Retrieved 12 March, 2015, from www.crystaldecisions.com/jump/crystal_cfo/pdf/crystal_cfo_project_voll.pd

American Association, A. (2011). Integrated Roadside Vegetation Management Decision Support System Cost Savings Better Decisions Time Savings *Guidelines for Vegetation Management (1st Edition)*: American Association of State Highway and Transportation Officials (AASHTO).

Analitics, L. (2013). Business Intelligence Defined. Retrieved 04/25, 2015, from http://www.logianalytics.com/bi-encyclopedia/

Badri, M. A., Davis, D., Davis, D. (2001). A comprehensive 0–1 goal programming model for project selection *Journal of Project Management* (Vol. 19, pp. 243–252).

Blumberg, R. a. S. A. (2003). "More than Search", DM Review. *13*(3), 42-47.

Bowden, J. (2014). Data Visualization Tools – A Feature Analysis. August 3, 2014. 2015, from http://www.business2community.com/big-data/data-visualization-tools-feature-analysis-0963101#5MCpflvVfodO8RGv.99

Brightedge. (2013). Customizable Dashboards - Instant Visibility & Effortless Communication with One-Click SEO Reporting. from http://www.brightedge.com/search-engine-analytics/customizable-seo-dashboards

Business-Software.com. (2015). *Top 10 Business Intelligence Software Report, Comparison of the Leading Business Intelligence Software Vendors* (pp. 4). Retrieved from http://c3330831.r31.cf0.rackcdn.com/top_10_bi.pdf

Calisir, F., & Calisir, F. (2004). The relation of interface usability characteristics, perceived usefulness, and perceived ease of use to end-user satisfaction with enterprise resource planning (ERP) systems. *Computers in human behavior, 20*(4), 505-515.

Capterra. (2015). Capterra, The Smart Way to Find Business Software. Retrieved 2015/06/01, 2015, from http://www.capterra.com/business-intelligence-software/#infographic

Chin, W. W., & Lee, M. K. (2000). *A proposed model and measurement instrument for the formation of IS satisfaction: the case of end-user computing satisfaction.* Paper presented at the Proceedings of the twenty first international conference on Information systems.

Chou, D. C., Bindu Tripuramallu, H., & Chou, A. Y. (2005). BI and ERP integration *Information Management & Computer Security* (Vol. 13, pp. 340-349).

Commerce, C. E. (2014, 2014/01/29). A High level introduction to CEC Stratware. Retrieved 8 August, 2015, from http://www.stratacare.com/wp-content/uploads/2014/07/StrataCare-MBR-Software-StrataWare-July-2014.pdf

Doll, W. J., & Torkzadeh, G. (1991). The measurement of end-user computing satisfaction: theoretical and methodological issues *MIS quarterly* (pp. 5-10).

Dresner, H. (2013). Dresner Study Reveals High Expectations for Growth of Mobile Business Intelligence. February 5, 2013. from http://sandhill.com/article/dresner-study-reveals-high-expectations-for-growth-of-mobile-business-intelligence/

Dresner, H. (2015). Mistakes organisations make with BI selecton. January 4, 2015 from http://searchdatamanagement.techtarget.com/definition/business-intelligence

Hashmi, N. (2004). "BI for sale" www.intelligenterp.com/feature/hashmiOct20.shtml.

Herschel, R. T. (2012, 31 March 2012). Organizational Applications of Business Intelligence Management: Emerging Trends.

Janssen, C. (2010). What does On-Premises Software mean? Retrieved 2015-04-26, from http://www.techopedia.com/definition/26714/on-premises-software

Lucas, H. C., Moore Jr., J.R. (1976). A multiple-criterion scoring approach to information system project selection. Infor*., 14*(1), 1-12.

Mahmood, M. A., Burn, J. M., Gemoets, L. A., & Jacquez, C. (2000). Variables affecting information technology end-user satisfaction: a meta-analysis of the empirical literature. *International Journal of Human-Computer Studies, 52*(4), 751-771.

McCabe, L. (2010). What is Business Intelligence, and Why Should You Care? July 30, 2010. 2015, from http://www.smallbusinesscomputing.com/News/Software/article.php/3896051/What-is-Business-Intelligence-and-Why-Should-You-Care.htm

Morisio, M., Seaman, C. B., Parra, A. T., Basili, V. R., Kraft, S. E., & Condon, S. E. (2000). *Investigating and improving a COTS-based software development.* Paper presented at the Proceedings of the 22nd international conference on Software engineering.

Moss, L. T., & Atre, S. (2003). *Business intelligence roadmap: the complete project lifecycle for decision-support applications*: Addison-Wesley Professional.

Motivity. (2015). Business Intelligence Executive Dashboards. Retrieved 12 March, from https://motivitysolutions.com/bi/dashboards/

Mukherjee, S., & Jennings, T. (2014). Ovum Decision Matrix: Selecting a Business Intelligence Solution, 2014–2015. http://www.sas.com/content/dam/SAS/en_us/doc/analystreport/ovum-decision-matrix-bi-105875.pdf

Mulcahy, R. (2007, 2007). Business Intelligence topics covering definition, objectives, systems and solutions. 6 March 2007. from http://www.cio.com/article/2439504/business-intelligence/business-intelligence-definition-and-solutions.html?page=3

MuleSoft. (2015). A Major Shift with Hybrid Cloud Integration. 2015, from https://www.mulesoft.com/resources/esb/hybrid-cloud-integration-solutions

Negash, S. (2004). Business intelligence. *The Communications of the Association for Information Systems, 13*(1), 54.

Pat Phelan. (2006, 10 April). Estimating the Time and Cost of ERP Implementation Projects Is a 10-Step Process. from https://www.gartner.com/doc/491429/estimating-time-cost-erp-implementation

Piercy, N., & Giles, W. (1989). Making SWOT analysis work. *Marketing Intelligence & Planning, 7*(5/6), 5-7.

Rouse, M. (2010). Software as a Service. August 2010. from http://searchcloudcomputing.techtarget.com/definition/Software-as-a-Service

Rouse, M. (2014). Ad-hoc Analysis. from http://searchbusinessanalytics.techtarget.com/definition/ad-hoc-analysis

Rudin, K., & Cressy, D. (2003). Will the Real Analytic Application Please Stand Up?" DM Review. *13*(3).

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International journal of services sciences, 1*(1), 83-98.

Sahay, B., & Ranjan, J. (2008). Real time business intelligence in supply chain analytics. *Information Management & Computer Security, 16*(1), 28-48.

Santhanam, R., Kyparisis, G.J. (1996). A decision model for interdependent information system project selection. *European Journal of Operational Research, 89*, 380–399.

Sarrayanan, S. (2014). Data Collection. 11/12/2014. from https://msdn.microsoft.com/en-us/library/bb677179.aspx

Schniederjans, M. J., Wilson, R.L. (1991). Using the analytic hierarchy process and goal programming for information system project selection. *Information & Management, 20*, 333–342.

Software-Advice. (2015). Compare Business Intelligence Software Tools. *Business Intelligence Software.* Retrieved 26 July, 2015, from http://www.softwareadvice.com/

Solutions, M. (2015). Business Intelligence Enterprise Reporting. Retrieved 2015-04-25, from https://motivitysolutions.com/bi/reporting/

Sperotto, F. (1994). In the footsteps of Homo Industrialis. from http://www.scielo.org.za/scielo.php?pid=S2224-78902015000200002&script=sci_arttext&tlng=pt

Tableau. (2015). Data Visualisation Gallery. Retrieved 24 September, 2015, from http://www.tableau.com/products/online-cloud-analytics

TrustRadius. (2014). The Buyer's Guide to Business Intelligence Software. 33.

Wei, C.-C., Chien, C.-F., & Wang, M.-J. J. (2005). An AHP-based approach to ERP system selection. *International journal of production economics, 96*(1), 47-62.

Whitten, J., & Bentley, L. (2005). Systems Analysis and Design Methods (Vol. 7): McGraw-Hill/Irwin.

Whitten, J. L., & Bentley, L. D. (2007a). Systems Analysis and Design Methods (Vol. 7, pp. 460-463). New York: McGraw-Hill.

Whitten, J. L., & Bentley, L. D. (2007b). Systems Analysis and Design Methods (Vol. 7, pp. 215-224). New York: McGraw-Hill.

Whitten, J. L., & Bentley, L. D. (2007c). Systems Analysis and Design Methods (Vol. 7, pp. 77). New York: McGraw-Hill.

Whitten, J. L., & Bentley, L. D. (2007d). Systems Analysis and Design Methods (Vol. 7, pp. 175-211). New York: McGraw-Hill.

WWISE. (2010). World Wide Industrial & Systems Engineers User Competancy Training Matrix. Retrieved 24 September, 2015, from http://www.wwise.co.za/qms-templates.html

Yurgosky, P. (2012). Beyond Dashboards: Business Intelligence Tools for Program Analysis and Reporting.