

**Design and Development of an Inventory Dashboard which
will assist Umthombo Technologies in Managing the Inventory
of Marley Pipe Systems**

by

**AM Janse van Rensburg
27077978**

**Submitted in partial fulfillment of the requirements for
the degree of**

BACHELORS OF INDUSTRIAL ENGINEERING

in the

**FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION
TECHNOLOGY**

**UNIVERSITY OF
PRETORIA**

November 2011

Executive Summary

This document is the final project report of the final year project done for the Industrial and Systems Engineering department at the University of Pretoria. The project is done through Umthombo Technologies at Marley Pipe Systems.

Umthombo Technologies is a small consulting business who offers services in Supply Chain Management. Their main client is Marley Pipe Systems to whom Umthombo Technologies convey services in Supply Chain Planning and mainly Inventory Management. Marley Pipe Systems is one of the leading manufacturers of plastic pipe reticulation systems in South Africa.

Umthombo Technologies use stable databases to do the Supply Chain Planning and Inventory Management for Marley Pipe Systems. These databases consist of large Excel spreadsheets which contain all the necessary information needed to do the inventory management. Umthombo Technologies have the need for a single overview of the current inventory standings of Marley Pipe Systems. Such a view will assist them in managing the inventory levels more successfully, but unfortunately all the important information needed for the management of Marley Pipe Systems' inventory, is scattered across a large amount of spreadsheets.

This project will aid Umthombo Technologies in achieving such an overview and the aim of this project is to design and develop an Excel Based Inventory Dashboard which will assist Umthombo Technologies in managing Marley Pipe Systems' inventory levels. This Inventory Dashboard's purpose will be to provide a single view of Marley Pipe Systems' current inventory standings and reduce the time spent on searching for the required data in the large spreadsheets.

*****The privacy of Marley Pipe Systems should be taken into account and the fact that this project is only the design and development of the dashboard and not the final product. Thus it must be clear to anyone who read this document that the information being displayed in this project is not the actual values of Marley Pipe Systems*****

Table of Contents

1.	Introduction and Problem Background	1
1.1.	Background	1
1.1.1.	Company: Umthombo Technologies	1
1.1.2.	Main Client: Marley Pipe Systems	1
1.2.	Problem Statement	2
1.3.	Project Aim	3
1.4.	Project Scope	3
1.5.	Deliverables	4
1.6.	Project Plan	5
1.6.1.	Activities and Tasks	5
1.6.2.	Resources	6
1.7.	Budget	6
2.	Literature Analysis and Information Gathering	7
2.1.	Literature Review	7
2.1.1.	Introduction	7
2.1.2.	Supply Chain Planning and the Importance of Inventory	7
2.1.3.	Data Analysis and Development	11
2.1.4.	Dashboards	15
2.2.	Information Gathering	21
2.2.1.	Software	21
2.2.2.	Background on Information Available	23
3.	Data Input Gathering, Analysis and Assembly for Data Source	24
3.1.	In Depth Problem Analysis	24
3.1.1.	The Problem	24
3.1.2.	Analysis of Problem	25
3.1.3.	Concluding Analysis Phase	26
3.2.	Identifying Solution Requirements	26
3.3.	Data Input Analysis	27

3.3.1.	Current Stock	27
3.3.2.	Ordered Stock	29
3.3.3.	Sales	30
3.3.4.	Individual Items and Parent Groups	31
3.3.5.	Business Groups	31
3.3.6.	Branches.....	32
3.3.7.	Conclusion.....	33
3.4.	Data Assembly in Main Data Source	34
3.4.1.	Data Extraction from BaaN (Extract).....	34
3.4.2.	Workbook development (Transform)	37
3.4.3.	Model Inputs for Dashboard	39
3.4.4.	Dashboard Data Source	40
4.	Dashboard Design and Evaluation	41
4.1.	Solution Design	41
4.1.1.	Dashboard Layout Design	41
4.1.2.	Dashboard Display and Data Source Interaction	48
4.2.	Dashboard Solution, Evaluation and Testing	49
4.2.1.	Dashboard Solution.....	49
4.2.2.	Dashboard Evaluation and Testing	49
4.2.3.	Evaluation and Testing Conclusion	54
5.	Conclusion.....	55
6.	References	56
7.	Addendum.....	58
7.1.	Appendix A: User Inputs Table.....	58
7.2.	Appendix B: “Display_Data” sheet showing values for Stock on Hand.....	59
7.3.	Appendix C: “Display_Data” sheet showing formulas for Stock on Hand.....	60

Table of Figures

Figure 1: The Entire Inventory Management Process.	9
Figure 2: Typical Scenario Resulting from Poor Inventory Control.....	10
Figure 3: Components of Data Analysis - Interactive Model.	12
Figure 4: Analytical Thinking follows the scientific approach to problem solving.....	13
Figure 5: Web Site Templates Courtesy of Arizona State University.....	18
Figure 6: Studies show that users pay particular attention to the upper left and middle-left of a document.....	19
Figure 7: Microsoft SQL Structure (Syntex, 2010).	22
Figure 8: Stock On Hand SQL view - ERD and Code.	35
Figure 9: Excess Stock SQL view - ERD and Code.	35
Figure 10: Cancelled Sales SQL view - ERD and Code	36
Figure 11: Undelivered Sales SQL view - ERD and Code	36
Figure 12: Stock Outs SQL view - ERD and Code	37
Figure 13: Preliminary Dashboard Layout Design.....	43
Figure 14: Example view of Stock on Hand.....	44
Figure 15: Example view of Excess Stock.	45
Figure 16: Example view of Sales History.	45
Figure 17: Example view of Stock Outs.....	46
Figure 18: Main display of Dashboard View.	47
Figure 19: User input - Selecting Item.	48
Figure 20: Selected user inputs.....	49
Figure 21: Selected user inputs.....	50
Figure 22: Main View of Inventory Dashboard	51
Figure 23: Branch overview required need to be selected.....	52
Figure 24: Relevant Parent and Business Group needs to be selected.	52
Figure 25: Dashboard view showing results for user inputs.....	53

List of Tables

Table 1: Project Budget.....	6
Table 2: Simplified System Development Process.	15
Table 3: Stock on Hand & Stock Days Data Source.	38
Table 4: Excess Stock Data Source.	38
Table 5: Cancelled Sales Data Source.	38
Table 6: Undelivered Sales Data Source.	38
Table 7: Sales History Data Source.....	39
Table 8: Stock Outs & Sales at Risk Data Source.....	39

Abbreviations

KPI	Key Performance Indicators
WIP	Work In Progress
ROA	Return on Asset
IS	Information System
SQL	Structured Query Language
ERP	Enterprise Resource Planning
SoH	Stock on Hand
AMD	Average Monthly Demand
MTS	Make to Stock
MTO	Make to Order
MTOO	Make to Order Only
MTOU	Make to Order Unlimited
SSIS	SQL Server Integration Services

1. Introduction and Problem Background

1.1. Background

1.1.1. Company: Umthombo Technologies

Founded in 2000 in South Africa, Umthombo Technologies initially offered broad business development services. In 2002 the emphasis shifted to consulting services that consisted of Supply Chain and Business Accounting, with the latter including feasibility studies, business strategies and plans. Since 2008 their main focus shifted to Supply Chain Management, although they still have time to do feasibility studies and strategic business consulting from time to time.

Umthombo Technologies currently offers two divisions of Supply Chain services, namely: Supply Chain Management Consulting and Supply Chain Planning Outsourcing (in other words they perform the clients' planning on a co-source or outsource basis). Umthombo Technologies serves clients in the Automotive Industry, Building Industry and Telecom Verticals, and the clients are mostly manufacturers or wholesalers.

A brief description of the work that Umthombo Technologies is doing include Supply Chain Planning and more directly Inventory Management. Umthombo Technologies has a stable database consisting of Excel spreadsheets which they use to do the management and planning of some of their clients' Supply Chains.

1.1.2. Main Client: Marley Pipe Systems

One of Umthombo's largest clients is Marley Pipe Systems in Nigel. Marley Pipe Systems (referred to as Marley in the report) is one of the leading manufacturers of Plastic Pipe reticulation systems in South Africa. They mainly meet the needs of two areas namely Merchants and Civils. They supply to Merchants which consists of plumbing and construction where as Civils consists of civil, irrigation, mining and petrochemical industries.

Marley has manufacturing facilities at Nigel in Gauteng as well as at Port Shepstone in KwaZulu-Natal. Their distribution network includes eight branches across the country as well as sales offices in Namibia and Botswana, and an active export division selling into Africa, the Indian Ocean, Europe and Australia.

Marley is part of the Aliaxis Company and thus they are able to bring reticulation solutions and new technology from around the globe to the local market.

Umthombo Technologies is mostly based in the Midrand offices of Marley and occasionally do work in Nigel. Umthombo does Outsource Supply Chain Planning for Marley and they are mainly responsible for managing Marley's inventory. The scope of work that Umthombo covers at Marley includes a few areas namely:

- Branch Analysis
- Production Planning
- Buy out planning
- Demand planning
- Inventory Analysis

1.2. Problem Statement

Umthombo Technologies do Supply Chain Planning and mainly covers Inventory Management for Marley. They use stable databases to perform the planning and management of Marley's Inventory.

The databases they use consist of wide variety Excel spreadsheets that contain a large amount of information like item codes, item descriptions, stock quantities, items on order, items being produced etc. The information is extracted from BaaN by using SQL and importing it into Excel spreadsheets. This large amount of information contributes to the size of the spreadsheet documents and results in a number of different spreadsheets being used for Inventory Management.

The amount of spreadsheets that are used by Umthombo Technologies to manage Marley's inventory makes it difficult to complete the inventory management properly and it is difficult for Umthombo to see what the current standings of Marley's inventory are. Due to the extent and size of these spreadsheets it is currently almost impossible for such an overview. The problem thus arises that it is generally time consuming to get this kind of overview of Marley's inventory and implicates the management of the inventory.

It is an important factor for Marley that their inventory is managed sufficiently. Thus Umthombo needs a tool which they can use to get an overview of the complete standings of Marley's inventory, in other

words better Inventory visibility. This calls for the design of an Inventory Dashboard, primarily in Excel, which will provide Umthombo Technologies with this much needed overview of Marley's Inventory levels.

This Excel Based Inventory Dashboard will be a visual interface that should provide Umthombo, at a glance, with a total summary of Marley's Current Inventory Standings and all the key measures that are relevant to it.

1.3. Project Aim

The aim of this project is to develop an Excel based Inventory Dashboard for Umthombo Technologies which will assist them in managing Marley's inventory. This Inventory Dashboard must provide Umthombo Technologies with an overview of the different aspects of Marley's Inventory standings, thus creating better Inventory visibility.

The main focus is to design and develop this Inventory Dashboard to be a visual interface that consists of one view that contains certain standard aspects and key measures which are of relevance in assisting Umthombo in managing Marley's inventory. Some of these important aspects should include:

- Overview of current inventory standings in terms of:
 - Product inventory levels (Per Parent Group, Business Group, and Individual Item etc.).
 - Excess Stock levels.
 - Items on order for sales (Current Sales).
 - Cancelled/Undelivered sales.
- Anticipated Changes in Inventory levels.
- Provide Umthombo with the ability to react quickly to changes in Inventory.

1.4. Project Scope

To successfully complete the project some constraints and boundaries need to be taken into consideration. Some of these boundaries and constraints are:

- The Inventory Dashboard will only show the standings of Marley's Inventory, but will take many factors which affect the inventory into account.

- The dashboard might need to show inventory levels in terms of Quantity and Monetary value (ZAR).
- Inventory levels should be viewed for example, per Individual Item, Business Groups, Parent Groups, and individual Branches etc.
- Inventory levels of the previous months might be taken into consideration.
- The Inventory Dashboard will be developed in Excel, with information loaded from other sources such as current Spreadsheets, SQL, and BaaN etc.
- Umthombo Technologies will assess the effectiveness of the Inventory Dashboard and how well it performs in Excel. If it functions sufficiently well, they will implement it into the My Business system at Marley.
- The implementation at Marley will not form part of this project.

1.5. Deliverables

After completion, the following can be expected from the project:

- An Excel based Inventory Dashboard which:
 - Display the necessary inventory data graphically and visualizes key trends, comparisons and exceptions in terms of Marley's Inventory.
 - Display only data that is relevant to Marley's Inventory.
 - Provides predefined conclusions of the inventory levels which lessen the need of the user performing an analysis.
 - Display Inventory levels in terms of Quantity and Value.
 - A view of the inventory levels per Individual Item, Business and Parent Groups etc.
 - Improve Marley's Inventory visibility.
- An Inventory Dashboard that provide Umthombo Technologies with an overview of the Current Inventory Standings of Marley and assist them in doing Marley's Inventory Management sufficiently.
- The test phase of the Excel based Inventory Dashboard done with the assistance of Umthombo Technologies (Implementation at Marley is not relevant to this project).
- A functioning Inventory Dashboard which will assist Umthombo Technologies to do sufficient and improved management of Marley's Inventory.

1.6. Project Plan

1.6.1. Activities and Tasks

1. Prepare and communicate Project Proposal
2. Literature Study
 - Perform research on Inventory Management and Visibility.
 - Perform research on the necessary tools and techniques which will be used.
 - Perform research on Dashboards and specifically Inventory Dashboards.
3. Perform investigation on Inventory Levels and User requirements
 - Identify all factors and KPI's which will affect inventory levels of Marley.
 - Evaluate factors which will appear in the Inventory Dashboard.
 - Identify user requirements and evaluate necessary information which should be displayed on the dashboard.
 - Remove unnecessary and illogical factors and information.
4. Develop Data Source containing Dashboard Information
5. Start design of dashboard layout
 - Innovate and create dashboard layout.
 - Discuss preliminary design of dashboard with Umthombo Technologies for their input and to identify any left out needs.
 - Identify resources of necessary information which will be visible in dashboard.
6. Start building of the dashboard in Excel
 - Combine dashboard layout and information in Data Source through integration of the two.
7. Perform preliminary test and evaluation of dashboard with Umthombo Technologies
8. Identify possible flaws and problems
 - Fix and improve problems in dashboard.
9. Test final dashboard
10. Deliver and present finished Inventory Dashboard to Umthombo Technologies
11. Deliver Final Report

1.6.2. Resources

Resources that will be needed to successfully complete the project may include:

- Transportation to and from Marley's Midrand Office, where Umthombo Technologies is mainly stationed.
- Laptop.
- Stationary.
- Internet.
- Information in the form of journals, articles, books, textbooks etc.
- Constant communication with project sponsors, namely:
 - Johan van Rensburg
 - Jaco Marais
- Help with SQL from Systems Engineer, Braam Matthee.
- Constant assistance from project leader:
 - Dr. PJ Jacobs
- Constant learning of new Excel techniques.
- Sufficient time to complete project.

This is the final resource list for this project. The resources changed during the project and the number and variety increased during the course of the project.

1.7. Budget

The following is an estimate of costs expected to be incurred (by the student) during the executing of the project. The sum amount estimated to be incurred is R1000-00.

Table 1: Project Budget

Expense	Amount
Stationary	R 50.00
Research and Internet	R 250.00
Printing and Binding	R 200.00
Telephone	R 100.00
Traveling	R 300.00
Other expenses	R 100.00
Total	<u>R 1,000.00</u>

2. Literature Analysis and Information Gathering

This chapter consists of two parts namely a literature review and an information study. Firstly the literature study is done on the project topic and the essential techniques and methodology, and secondly, an information gathering which highlight the software to be used in the project and where the necessary data is located.

2.1. Literature Review

2.1.1. Introduction

This literature study gives a broad overview of the main content that is essential in this project. Research is done on the related literature, and a combination of the different classifications, techniques and methodology is identified and researched. This includes research on Supply Chain Planning and the Importance of Inventory, Data Analysis and Development, and the purpose of Dashboards. These are the three main aspects which form part of the problem in this project, and they will be discussed separately in the following sections.

2.1.2. Supply Chain Planning and the Importance of Inventory

Inventory play a significant role in Supply Chain Planning and most companies keep inventory. It exists in the Supply Chain because of a variance between supply and demand. Inventory is the goods a company purchase, produces and sells, including everything from raw materials, work in progress, supplies in operations and finished goods. Inventory forms a big part of companies as it influence ROA, supplies for fluctuations in demand and assist in predictability and uncertainty. According to Chase, Aquilano and Jacobs (2004:545), inventory is the stock of any item or resource used in an organization.

As Tony Wild states in his book (2002:1), Inventory enables a company to support the customer service, logistic or manufacturing activities in situations where purchase or manufacture of the items is not available to satisfy the demand. Lack of satisfaction could arise either because the speed of purchasing or manufacturing is too protracted, or because quantities cannot be provided without stocks.

This dissatisfaction is not only towards the customer, in other words not fulfilling demand, but towards the company itself as well. It is in the best interest of the company and its stakeholders to resolve such

inconsistency. There are a few factors related to this project, which are of great importance and need to be considered to prohibit such a lack of satisfaction in inventory, namely:

- Inventory Management
- Inventory Control
- Inventory visibility

The three areas mentioned above are all of importance in the main aim of this project, an Inventory Dashboard. An Inventory Dashboard which will assist Umthombo Technologies in managing and optimizing the Inventory of Marley. These areas will now be discussed in further detail.

Inventory Management

Inventory Management is one of the most important aspects of any company. Without inventory management it would be difficult for any company to maintain control and be able to handle the needs of their customers, (Fulfillment n.d.). Inventory Management refers to managing the stock levels of a company and can sound like a very straightforward concept; make sure you do not have too much or too little stock. Although this sounds very simple, it can be quite complex and time consuming without having the right information. If Inventory Management is done correctly, it can reduce costs being incurred and increase the revenue of a company. To achieve this, a number of elements need to be focused on to limit poor Inventory Management.

There are a few definite symptoms that allow management to identify poor Inventory Management. Stock and Lambert (2001:254) mentions the following aspects that should be used to diagnose poor Inventory Management:

- Increase in number of back orders.
- Back orders remaining constant regarding increasing investments in inventory.
- High customer turnover rate.
- Increase in number of orders cancelled.
- Periodic lack of sufficient storing place.
- Wide variance in inventory turnover among distribution centres and among inventory items.

- Deteriorating relationships with intermediaries as typified by dealer cancellation and declaring orders.
- Large quantities of obsolete stock.

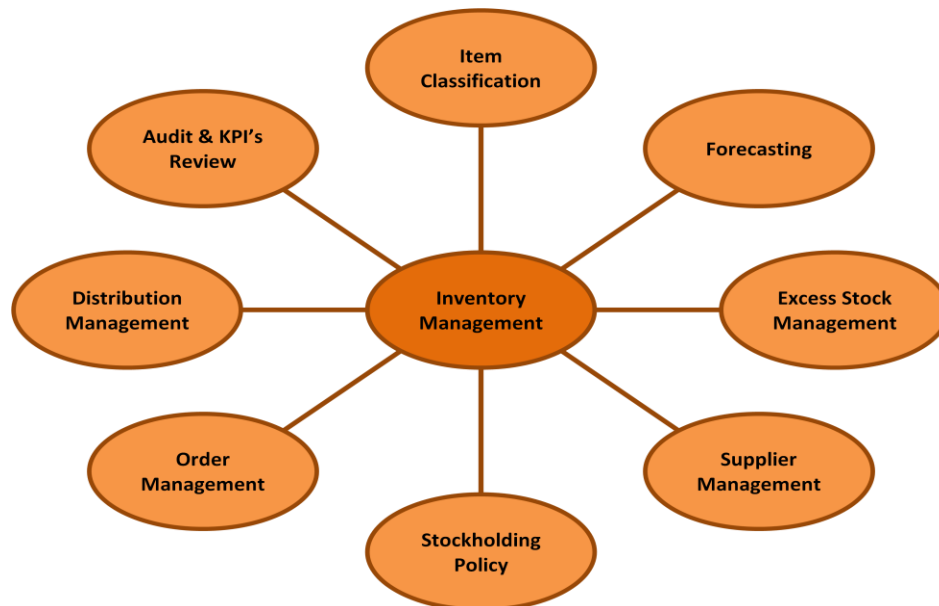


Figure 1: The Entire Inventory Management Process.

Inventory Management can be improved immensely by means of identifying these elements in the entire Inventory Management Process. Thus these elements will form a vital part in the design of an Inventory Dashboard.

Inventory Control

Inventory Control is the activity which organizes the availability of items to the customer. It coordinates the purchase, manufacture and distribution functions, too meet the marketing needs. This role includes the supply of current sales items, new products, consumables, spare parts, obsolescent items and all other supplies (Wild 2002). It refers to the events or activities that influence and manage the process which transforms the input resources and materials into the final finished goods.

Control is a necessary step on the road to optimizing inventory and requires that relevant business processes are in place to enable materials to be tracked through the system and accurate data records maintained. In this way the quantity and location of physical stock are tied to system data records (Relph, Brzeski & Bradbear 2002).

A typical scenario which arise within poor inventory control, often as a result of manual intervention, is self-perpetuating errors, as shown in Figure 2. This vicious circle must be broken before control can be taken.

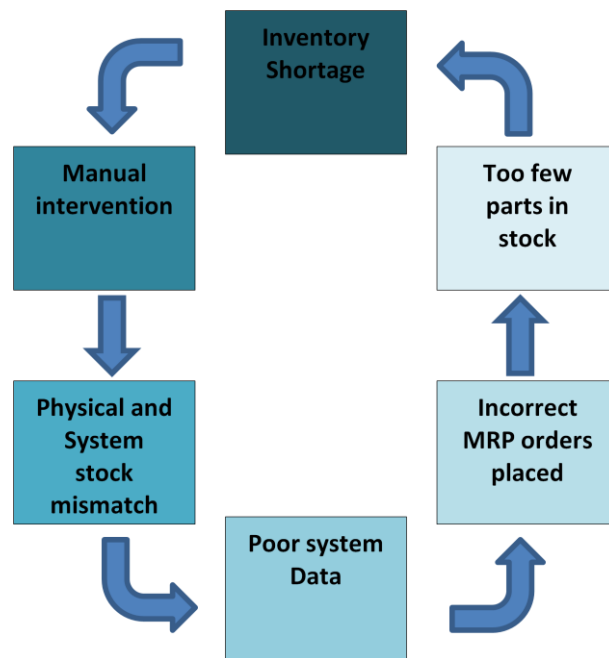


Figure 2: Typical Scenario Resulting from Poor Inventory Control.

Inventory Control is a key part of improving and managing the inventory performance of a company. This responsibility fall on the people who have an impact on inventory, and mainly the employees who conduct forecasts and planning.

Inventory Visibility

Inventory Visibility can be interpreted simply as the ability of an organization to “see” inventory on a real-time basis throughout its logistics and/or supply chain system, (Coyle, Bardi & Langley Jr. 2003). Inventory visibility is important as it enables a company to be informed about their inventory and allow them to make their supply chain as effective as possible. It supplies instant and accurate data of the current inventory, ranging from in-stock inventory to in-transit inventory, the where, what, whom and when of inventory. It assists in optimizing the end to end supply chain process and good inventory visibility holds many benefits to a company.

This is where an Inventory Dashboard can play an important role in gathering and presenting an organized view of the current inventory standings. It will in turn give a company better Inventory Visibility and Control and assist them in Managing their Inventory.

2.1.3. Data Analysis and Development

Data Analysis and Development forms a great part of this project. In this project it is necessary to perform Data Analysis on the available information and then present it in a way that is simple and easy to observe. Data Analysis in this project includes Analytical thinking and the Development side includes Information System Development. All of these topics will be addressed briefly.

Data Analysis and Analytical Structured Thinking

Data Analysis

Data Analysis is the process of examining, cleaning, converting and presenting data in such a manner, which highlights the useful and desired information needed, and suggesting the necessary conclusions and supporting the process of decision making. Data Analysis starts with the collection of data.

As presented by Miles and Huberman (1999:8-12). Data Analysis consists of three main components, namely:

- 1. Data Reduction:** Data reduction is not separate from analysis, but forms part of it. It is the researchers' decisions on which information to keep, which to throw out and which evolving story to tell. All of these decisions form part of analytical activities.
- 2. Data Display:** A display is a structured, compacted assembly of information that permits conclusion drawing and action. Designing a display of data is also part of data analysis. Choosing the rows and columns for qualitative data and deciding in which form the data should be displayed forms part of analytical activities. It can be stated as: "You know what you display" (Miles & Huberman 1999).
- 3. Conclusion Drawing/Verification:** The researcher decides what things mean from the start of data collection. As the analyst draws conclusions from the structured data, it is also verified. This need to be done to identify whether the decision is plausible and sturdy; otherwise the end result may be an unknown occurrence from an unknown truth.

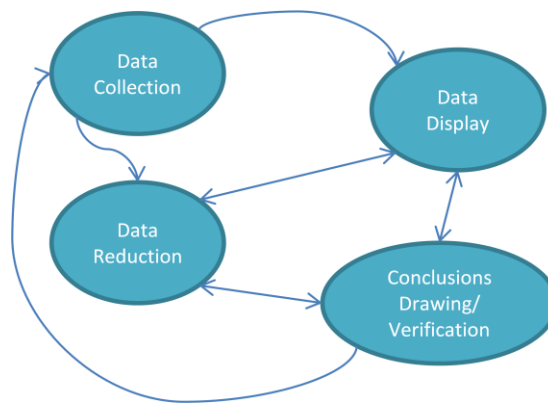


Figure 3: Components of Data Analysis - Interactive Model.

Data Reduction, Data Display and Conclusion Drawing/Verification together with Data Collection, forms an interactive cyclical process, as shown in the figure above. The researcher moves between these four nodes during Data Analysis, to collect the necessary data, reduce it to the most significant data, display this data in a way that is appropriate and easy to analyze, and finally verify the data and construct the specified conclusions. This will be used as guidelines in the design and development of the dashboard.

Analytical Structured Thinking

Analytical thinking form a crucial part of data analysis and follows a scientific approach to problem solving. Analytical thinking is a methodical step by step approach which breaks down complex problems or processes to their constituent parts, identify cause and effect patterns and analyze problems to arrive at an appropriate solution. Analytical thinking is powerful, focused, sharp, and linear and deals with one thing at a time. It works best where criteria for analysis is established.

Below is a figure that shows the scientific approach, which Analytical Thinking follows towards problem solving. This thinking includes Problem Solving, Hypothesis, Facts, Analysis and Solution.

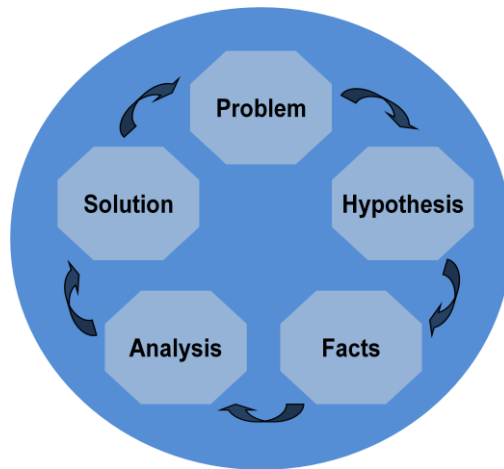


Figure 4: Analytical Thinking follows the scientific approach to problem solving.

1. **Defining the Problem:** It is important to make sure that the right problem is being solved and clear definition of the problem is critical. Defining the problem clearly improves focus and this is what drives the analytical process.
2. **Formulating the Hypotheses:** Start at the end. By identifying the solution to the problem in the beginning, will assist in the form of a roadmap for approaching the problem. This is called hypothesizing. Breakdown of the problem into root causes will assist in the hypotheses.
3. **Collecting the Facts:** Gathering the relevant data and information is a critical step in supporting the analyses required for proving or disproving the hypotheses. The facts should be identified, filtered, verified and applied.
4. **Conducting the Analysis:** The analysis provide an understanding of the issues and drivers behind the problem. Analyzing the facts will result in proving or disproving the hypotheses. It is in general better to spend time on analyzing the data and information as opposed to collecting it.
5. **Developing the Solution:** The solution is the crucial outcome of analytical thinking. The solution should fit the problem and an actual example of the solution should be run to test the effectiveness and viability of the solution.

Data Analysis and Analytical Thinking is an important element in this project. These methods will assist in identifying the necessary factors that will form part of the Inventory Dashboard design and development.

Information System Development

An Information System is an arrangement of people, data, processes and information technology that interacts to collect, process, store, and provide as output the information needed to support an organization, (Bentley & Whitten 2007). IS's come in different shapes and sizes and they are often so integrated into an organization they support, that it is difficult to distinguish between the business systems and the support IS's. Generally IS's are classified according to the functions they serve.

Bentley and Whitten (2007:7), states that IS's can be viewed from different perspectives, namely:

- The Players
- The Business Drivers
- The Technology Drivers
- And the Process used to develop the information

With regard to this project, IS's will only be viewed from the system development process.

IS development is a relevant subject to most people in an organization, as it takes several workers to assist in the development of such a system. A system Development Process is a set of activities, methods, best practices, deliverables, and automated tools that stakeholders use to develop and maintain information systems and software, (Bentley & Whitten 2007). Most System Development Processes follow a problem solving approach which typically incorporates the following general problem solving steps:

1. Identify the problem.
2. Analyze and understand the problem.
3. Identify solution requirements and expectations.
4. Identify alternative solutions and choose the best course of action.
5. Design the chosen solution.
6. Implement the chosen solution.
7. Evaluate the results.

The above mentioned steps form part of the IS Development process. As proposed by Bentley and Whitten (2007:30), these steps can be broken down into four simplified stages or phases that must be completed for any system development project. These four phases are, System Initiation, System

Analysis, System Design and System Implementation. The table below shows the correlation between the four phases and the general problem solving steps.

Table 2: Simplified System Development Process.

Simplified Phases	General Problem Solving Steps
System Initiation	1. Identify the problem (And plan solution).
System Analysis	2. Analyze the problem. 3. Identify solution requirements.
System Design	4. Identify alternative solution. 5. Design chosen solution.
System Implementation	6. Implement the chosen solution 7. Evaluate the results.

These phases will be used to great extent during the development of the Inventory Dashboard.

2.1.4. Dashboards

When thinking about management, it is very difficult to manage what you can't see. Usually you have plenty of data, but it is not in the right format. Thus you can not use the data immediately to make clear, concise and instant decisions regarding the relevant subject. The data necessary for making important decisions is not based on solid, live information.

As Hans Peter Schaefer from The Gillette Company once said, *"I want a supply-chain dashboard that looks like the dash in my 911 Carrera, with all of the dials set to my specific supply-chain metrics. And when any one goes out of tolerance, I want the dial to redline and let me drill into the specific issue, and resolve it"*. This is exactly what a dashboard should deliver to its user, end-to-end visibility.

Defining Dashboards

A dashboard is an illustration which provides its user with a glimpse into important measures relevant to a particular subject or business department. Stephen Few's definition of a dashboard is as follows, *"A dashboard is a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance"*, (2006,34).

According to Alexander and Walkenbach, dashboards have three main characteristics namely (2010):

- Dashboards are usually graphical, providing visual illustrations of key trends, comparisons and exceptions.
- It only displays appropriate information regarding the main subject of the dashboard.
- Dashboards are designed towards a specific goal or purpose with predefined conclusions and essentially reduce the need of its user to perform an analysis regarding the information.

Many people think of a dashboard as a report, but it should be kept in mind that a report is not the same as a dashboard. A report is only a document that contains data used for viewing and doing an analysis. The user needs to perform a conclusion regarding the given information using own judgment, where as a dashboard delivers an analysis to its user.

Classifying Dashboards by Role

One of the most useful ways to categorize dashboards, and the one that will be designed in this project, is by its role. In short its role is the business activity it will support. There are mainly three types of dashboards and they are classified in such a manner which significantly relates to differences in visual design. The three types of dashboards are discussed briefly below:

- **Operational:** Operational dashboards are used to monitor operational processes, events, and activities as they occur (every minute, hour, or day).
- **Tactical:** Tactical Dashboards are used to measure and analyze the performance of departmental activities, processes, and goals.
- **Strategic:** Strategic Dashboards are used to track progress toward achieving strategic objectives in a top-down fashion (e.g. a “Balanced Scorecard”).

The above mentioned types of dashboards are only a framework that describes these three dashboard types. Wayne Eckerson says in his book that it is not necessary to determine which type of dashboard you want to build before beginning a project. In reality, many dashboards don’t fit cleanly within the boundaries described. The purpose of this framework is to help you understand the various purposes for which dashboards are built and the range of functionality that they can exhibit, (2010, 121).

Dashboard Design

The main step in building and designing a dashboard is identifying the user requirements and what exactly is required from the dashboard. This includes defining your user needs and KPI's, dashboard outputs, information sources and inputs into dashboard, performance measures etc. All of these inputs for the dashboard are placed in the database of the dashboard, named the data source. The data source forms the base of the dashboard and contains all the data which is shown on the dashboard. A dashboard should be kept simple and consist only of one viewable page or screen.

It is tempting to jump into selecting layout designs, chart types, colors, fonts etc. in the development of a dashboard. But there are a few things that should be kept in mind whilst beginning the design process of a dashboard. Some are fundamental principles while other are overlooked steps in the dashboard project plan. Below are a few steps and points that should be considered, as described by Eckerson, (2010):

- Focus on the requirements and data first.
- Know your users (User requirements).
- Take design principles into consideration.
- Create a prototype.
- Perform proper testing of the dashboard.
- Improve the prototype.

Eckerson also gives two important guidelines in his book, (2010). The one is on creating displays and the other on designing charts. These two guidelines are given below:

- Guidelines for creating proper Displays:
 - Less is more.
 - Display information on a single screen.
 - Balance Sparsity and Density of important metrics on dashboard.
 - Eliminate Decoration.
 - Use an intuitive layout.

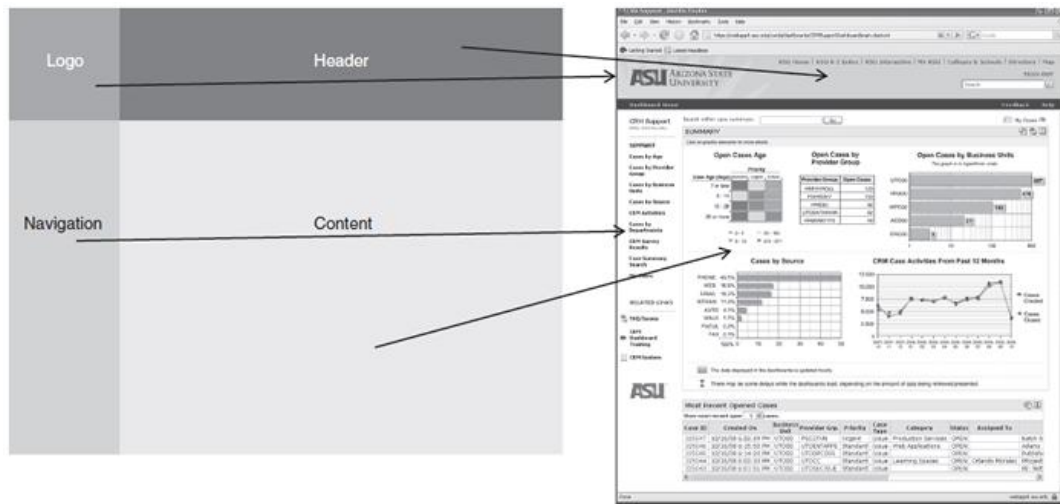


Figure 5: Web Site Templates Courtesy of Arizona State University.

- Arrange Components intelligently.
- Deemphasize design elements.
- Guidelines for designing charts:
 - Less is more.
 - Make comparison easier.
 - Use preattentive processing.
 - Predefine drill paths and interactivity.
 - Choose the right graph.

Dashboard Design Principles

Most dashboards based in Excel have only slight thought given to the effective visual design of the dashboard, and this often results in cluttered and ineffective dashboards. Luckily dashboards have been around for quite some time and there is a vast knowledgebase that contains visualization and dashboard design principles. These principles might seem like common sense, but many Excel users do not think about it quite often. Below is a number of Dashboard Design Principles, as explained by Alexander and Walkenbach, (2010, 17), which correlates with the guidelines discussed in Dashboard Design:

- Do not turn dashboard into a data repository.
- Skip the unnecessary chart junk:
 - Remove gridlines.
 - Remove borders.
 - Skip the trend lines.
 - Avoid unnecessary data labels.
 - Do not show a legend if you do not have to.
 - Remove any axis that does not add value.
- Avoid the fancy formatting:
 - Avoid colors and background fills to partition the dashboard.
 - De-emphasize borders, backgrounds, and other elements that define areas.
 - Avoid applying fancy effects, such as gradients, pattern fills, shadows, glows, soft edges, and other formatting.
 - Do not enhance dashboard with clip art or pictures.
- Limit each dashboard to one viewable page.
- Use layout and placement to draw focus:

1	1	2	3
1	1	2	2
2	2	2	3
3	3	3	3

Figure 6: Studies show that users pay particular attention to the upper left and middle-left of a document.

- Format numbers effectively:
 - Use commas to make numbers easier to read.
 - Only use decimal places if that level of precision is required.
 - Only use monetary values where necessary.
 - Format large numbers to thousands or millions place.

- Use titles and labels effectively:
 - Always include a timestamp on reporting mechanisms.
 - Always include some text indicating when the data was retrieved.
 - Use descriptive titles for each component in the dashboard.
 - Format labels to hues lighter than the ones used for the data.
- Dashboard should be well documented:
 - Add a Model Map tab to the data model.
 - Use comments and labels liberally.
 - Use colors to identify the ranges in your data model.
- Dashboard should be user friendly:
 - Intuitive.
 - Easy to navigate.
 - Prints properly.
- Dashboard should be accurate:
 - Consistency with authoritative sources.
 - Internal consistency.
 - Personal experience.

All of these principles should be considered during the design and development of a dashboard, and these will form an essential part in this project.

The visual design of a dashboard usually obscures the meaning of the data within the dashboard, and this information is in fact the main objective of a dashboard. Thus, the design of the dashboard is not about making something visually pleasing, but it is about delivering the meaning of the data.

To conclude, as in Few's book, (2006), Good dashboard design uses the least amount of ink to highlight key trends or relationships within the data. It leverages Gestalt principles of perception, preattentive processing, and other visual techniques to group, highlight or sequence what's interesting in the data and minimize the rest. It selects the right graphs to monitor performance, examine relationships, or interactively explore the data.

2.2. Information Gathering

This information gathering is an important part of this project. It includes obtaining vital information about the existing software being used by Marley. The software is going to form part of the project and a better understanding about this software is necessary. This information includes a background about the current software being used and where the necessary data is stored.

2.2.1. Software

Microsoft Excel

Microsoft Excel is a well known commercial spreadsheet application written and distributed by Microsoft. It has the basic spreadsheet features that include a grid of cells arranged in numbered rows and letter-named columns, in which supplied functions can be inserted to organize data.

As stated earlier in the document, Excel is being used by Umthombo Technologies to do the Inventory Management of Marley. Umthombo has an array of different Excel spreadsheets that contain a large amount of information. Currently this information is used to do the Inventory Management.

The Inventory Dashboard will be designed and developed in Excel. Excel dashboards are powerful, fairly easy to design and a great way to improve data visualization. Excel is very flexible and it is possible to develop a dashboard in Excel exactly the way the users want it.

Three major areas will be addressed in the project when creating the dashboard in Excel, namely:

- How to bring data into the spreadsheet.
- How to manage the data and link it to the dashboard objects, like charts and tables.
- How to design the dashboard, (Discussed earlier).

These three points will be discussed in more detail in the next chapter.

Microsoft SQL Server

Microsoft SQL Server is a relationship database server developed by Microsoft. This database software's primary function is to store data and retrieve data as requested by a user from a computer. It uses a Structured Query Language (SQL) to perform these functions. SQL provides an enterprise data integration platform with exceptional Extract, Transform, Load (ETL) capabilities, which enable companies to more easily manage their data.

The SQL package assists a company in managing any data, at any place and any time, (Symtex n.d.). Many database developers across the world have praised SQL as an existing release for increasing productivity and functionality. Below is a structure which shows the integration of SQL with other software.



Figure 7: Microsoft SQL Structure (Symtex, 2010).

Marley has SQL as a database server. They use it to extract data from their database, namely BaaN, and then load it onto Excel spreadsheets. The use of SQL Server Integration Services (SSIS) is possibly required to perform the above mentioned tasks. It is used to set up a “package” which consists of queries and codes, and is scheduled to run automatically to update the data extraction. This function will be used during the project to Extract data from the BaaN database, transform it in Excel and load it onto the Excel Dashboard. This interaction between SQL and Excel will be discussed in further detail in the next chapter.

BaaN

BaaN or Baan ERP is an enterprise resource planning (ERP) software, developed by Baan but it is now owned by Infor Global Solutions. BaaN delivers a combination of power and clarity which assists companies to:

- Manage multiple sites easily.
- Manage all their business functions.
- Tailor their system to meet specific needs.
- Produce more with existing resources.

BaaN is implemented at Marley and it is located on an Oracle database and contains all the information relating to the products, which is important to the company.

2.2.2. Background on Information Available

BaaN holds all the relevant item information and current standings of inventory within Marley. This is the main database of Marley, and it is where all the data which is of relevance to the Inventory Dashboard is stored. With the use of SQL and possibly SSIS, the necessary data will be extracted from BaaN and imported into Excel where it will be transformed into the required format to develop the data source for the dashboard.

3. Data Input Gathering, Analysis and Assembly for Data Source

The System Development Process is taken into account in the execution of this project and the Dashboard Design Steps were also kept in mind. As described in chapter two there are four main steps in the process. In chapter one the system initiation phase was done by identifying the problem and a solution to the problem. This chapter evolves around the system analysis phase which includes the analysis of the problem and identifying the requirements for the solution. The main purpose of this chapter is to describe the necessary inputs that will be used to successfully develop the data source, which forms the base of the Inventory Dashboard. The analysis of the identified requirement and the development of the data source will also be discussed in this chapter.

3.1. In Depth Problem Analysis

The main problem of this project is already defined in chapter one. An in depth analysis of the problem is done to identify all the necessary steps, inputs and data that will be used to successfully solve the problem. This information will form everything necessary for the development of the data source and will be discussed in further detail below.

3.1.1. The Problem

It is already clear what the problem is in this project, the need of an Inventory Dashboard. The need of an Inventory Dashboard is due to the fact that the information being used by Umthombo Technologies is located on a wide variety of Excel spreadsheets. Resulting in a crowded and limited view of the current inventory standings, and this prolongs the process of managing Marley's inventory.

Consequently, an Inventory Dashboard providing a single view of Marley's inventory is needed. This sounds somewhat simple but there is a lot more that need to be prepared in the design and development of such a dashboard. It is not suitable to jump away and begin designing a dashboard; this will result in a failure and an unsuccessful dashboard that does not perform its task and the purpose it is made for. An analysis is done to identify the different techniques and methods necessary to develop the data source and the dashboard.

3.1.2. Analysis of Problem

In the design and development of a dashboard one of the first steps are to focus on the user requirements and the data that is necessary to build the dashboard. This information need to be constructed in such a manner that it is useful and can be used in the dashboard and will form the main source of information to the dashboard.

This main information source of a dashboard is called the data source and it contains all the information necessary to display on the dashboard. The data source is the heart and centre of the dashboard and forms the main information source of the dashboard, and if constructed properly containing all the essential information, the dashboard will function acceptably in the end.

Developing a data source consists of the Extract, Transform and Load (ETL) process. The main development of this data source will be done in Excel, but the data which will appear in the dashboard comes from BaaN and SQL. The steps in the ETL process comprise of extracting data from a source, transforming it into an appropriate format, and then loading it into the main data display, the dashboard. The three phases of the ETL process and how it will be executed in this project will be discussed briefly below:

- **Extract:** The extraction phase will happen in BaaN and SQL. As described in chapter one, BaaN is the main data source of Marley. The data needed for this project is in BaaN and it need to be extracted. This will be done with the use of SQL, by programming extraction routines which will extract the necessary data out of BaaN and import it into Excel where it will be transformed.
- **Transform:** After the data has been extracted from BaaN and imported into Excel, it needs to be transformed into the correct format. This is an important step as the data will only appear in a certain format out of BaaN, and it is necessary to transform it into the correct format which is relevant to the layout and use of the dashboard. This transformation will be done with the use of Excel formulas and PivotTables to get the required format. When the data is in the correct format it can be loaded into the Dashboard layout, this transformed data will form the main data source of the dashboard.
- **Load:** The load phase consists of loading the transformed data into the dashboard display. This forms part of the final development phase of the dashboard and will serve as the information shown in the dashboard. This will also be done in Excel, as the dashboard is constructed and

built in Excel. The loading of the data into the dashboard will be done with the use of formulas and Macros that will be run each time the dashboard is opened therefore refreshing all the data.

The extraction and transformation of the data will be described in further detail later in this chapter. The load phase forms part of the design and building phase of the dashboard which will be done according to the design principles researched in the literature study. This together with the loading of the data into the dashboard display will be discussed further in chapter four. Before all of this can be done, the requirements for the solution and all the essential factors that need to appear in the dashboard display should be identified.

3.1.3. Concluding Analysis Phase

The analysis of the problem is done and complete and all the necessary steps, methods and techniques that will be used to build the data source as well as the dashboard are identified. The next step is to identify all the requirements for the solution, as none of the above mentioned phases of the dashboard development can be completed before it is clear what exactly should appear in the dashboard. The requirements of the dashboard will be identified and discussed next.

3.2. Identifying Solution Requirements

There are many inputs that are essential in making the dashboard successful. These inputs form all part of the information that is important to and required by Umthombo Technologies to do sufficient inventory management for Marley. Thus this information should appear in the dashboard display. By keeping Inventory Management into mind, effective research and requirements identification was done to identify the information that will form part of the dashboard.

By looking at the factors that have an effect on inventory, it can be classified into three groups, namely Current Stock, Ordered Stock and Sales. Each group contains different inputs that are required by the dashboard. The following are inputs that are of importance to the dashboard, organized into the three above mentioned groups:

- Current Stock:
 - Stock on Hand
 - Stocking Policies
 - Excess Stock

- Safety Stock
 - Allocated Stock
 - Stock Days
 - Stock Outs
- Ordered Stock:
 - Production
 - On Order and Procurement
- Sales:
 - Sales
 - Backorders
 - Returns, Cancelled Sales and Undelivered Sales
 - Past Sales
 - Forecasts (Average Monthly Demand)

It is also required of Umthombo Technologies to view the above mentioned factors in relation to the different branches of Marley as well as per individual item, parent group and business groups. Marley have a main production plant and warehouse in Nigel, and about nine other branches across South Africa. It is also of importance that the monetary value of some of the above factors must be shown. All of the above mentioned elements will now be discussed in further detail.

3.3. Data Input Analysis

3.3.1. Current Stock

Current stock implies to all the stock that are required to appear on the dashboard that are currently in Marley inventory. The factors in the current stock group and how they function within Marley will now be discussed briefly.

Stock on Hand (SoH)

Stock on Hand represents the current items that Marley have in their inventory. This includes all the items located in inventory, such as finished goods, goods ordered and arrived in inventory etc, everything which is ready to be sold, in other words it is current inventory levels. Stock on Hand is a key factor to appear on the dashboard.

Stocking Policies

Marley have two main stocking policies, namely Make to Stock (MTS) and Make to Order (MTO). There are specific items that should be kept in inventory, as they are Make to Stock, where as other items are Make to Order, and inventory should not be kept of these MTO items. However, MTO can be split into two areas, namely Make to Order Only (MTOO) and Make to Order Unlimited (MTOU). For MTOO only the order amount is produced, while with MTOU the minimum production run amount is produced. This should be taken into account for inventory management and might be an important factor to display on the dashboard.

Excess Stock

Excess stock is also one of the most important factors that should appear on the dashboard. Excess stock is excessive items which are located in inventory and can result from poor procurement and management of the inventory. Excess stock is briefly calculated as follows, demand and safety stock subtracted from stock on hand. The excess stock value of each item should be minimized as much as possible, as it is associated with loss of revenue.

Safety Stock

Safety stock is an important factor to consider during inventory management, even though it might not appear on the dashboard, it still forms an integral part of Marley inventory. Safety stock is held due to an uncertainty in demand and lead times, and to form an insurance against stock outs. Production and procurement of Marley items are done according to forecasts, which are in reality different from the real demand, and the purpose of safety stock is to absorb the difference, although there should only be safety stock for MTS items, as MTO items should not have safety stock.

Allocated Stock

Allocated stock might not appear on the dashboard but it is important to consider during inventory management. Allocated stock appears occasionally in Marley Inventory, since there are orders being generated but the items have not yet been withdrawn from the storage. Allocated stock forms part of the calculation of excess stock, and is therefore still vital.

Stock Days

Stock days are defined as the number of days of stock you have opposed to current sales. This is an important value to be viewable for each individual branch of Marley, and it is calculated as follows:

$$[(Total\ Stock\ Value\ of\ Branch / Total\ Cost\ of\ Sales\ per\ Branch) * 30]$$

This value gives you an idea of how the stock and sales of a specific branch is performing. If the stock value increases but the stock days have declined, then you know that sales have increased at that branch, and vice versa. This is essential as you can measure the performance of a specific branch and how the inventory levels of that branch influence its performance in terms of sales. This might be an essential element to show on the inventory dashboard.

Stock Outs

Stock Outs are calculated within a profitability program which was generated by Marley. In short, Stock Outs are the number of times a certain item's inventory level moves below a predefined benchmark per month. This is then used to calculate the Sales at Risk due to the Stock Outs during the month. These two values are of great importance, as it should be kept as low as possible.

3.3.2. Ordered Stock

Ordered stock implies to the items that are currently on order or being produced by Marley. This is also known as Production Orders, as some of the items bought from outside suppliers, still need to be assembled at Marley. The ordered stock is important as it is what supplies the inventory levels of Marley. It contains two areas namely production and procurement which will be discussed briefly below.

Production

Marley produce a wide variety of pipe products. The items are produced on a daily basis, either because of a predefined schedule created according to production planning, for the MTS items, or for orders that is made for MTO items. It is important for Umthombo Technologies to know what items are currently being produced as it is used to plan and determine the proper inventory levels.

On order / Procurement

Several of the items which Marley sell in South Africa are not produced by themselves. These items are purchased from abroad and then sold by Marley in South Africa. The procurement is a division on its own however, in the end these items being imported forms part of the entire inventory of Marley. Therefore, the amount of items being ordered is just as important as the amount being produced.

3.3.3. Sales

Sales are as it states, the current amount of Marley products sold during the month and the previous months, including all other factors that play part in relation to the sales. The factors that form part of the sales of Marley will be discussed briefly below.

Current Sales

The current sales are exactly what it state, the current item sales of Marley. Marley have ten branches across the country from where they generate sales, as well as sales being produced to merchants. It is important to view the sales of each item as it reduces inventory and is an important element in managing Marley inventory and might have to appear on the dashboard.

Backorders and Stock Outs

Backorders are placed under sales as it is sales generated against an item whose current stock levels can not fulfill the demand of that sale. These are items that ran out of stock but there are sales generated against that item. As mentioned earlier there is a highly sophisticated profitability calculation which Marley use to calculate the number of stock outs for an item, as well as the Sales at Risk of the specific Stock Out. This influence inventory as the backorders and stock outs need to be kept in mind when planning the inventory. It is necessary to know this information as it forms part of the elements necessary for managing Marley inventory.

Returns, Cancelled Sales and Undelivered Sales

Returns, Undelivered Sales and Cancelled Sales are also essential factors to consider as all of them have a direct impact on the inventory levels of Marley. Returns are sold items which are returned due to defects, Cancelled Sales are sales which were generated but then cancelled by the buyer, and Undelivered Sales are items sold but not yet delivered to the buyer. All of these affect the inventory levels of Marley and it is crucial to consider these for the Inventory Dashboard.

Past Sales

Past sales are the sales history of Marley over the previous months. This is important for the inventory management as it is used in a seasonality tool which calculates the AMD, which is used to calculate the sales forecasts and in turn is used in planning the production and procurement of Marley. This is an important element to consider during inventory management and it might be necessary to view the sales over the previous three, six or twelve months on the dashboard.

Forecasts (Average Monthly Demand)

As stated above, forecasts are calculated by use of the AMD values used in the production and procurement planning. Forecasts are predetermined values calculated according to the previous month's sales of Marley. These factors are essential as they all form part of the sales and inventory planning of Marley.

3.3.4. Individual Items and Parent Groups

It is furthermore vital to Umthombo Technologies to view the inventory levels of each individual item available in Marley's entire item list. This is necessary to view the current inventory standings of a certain item. Each of the items located within the item list is also sorted into different Item and Parent Groups. An Item Group is an Item range that forms part of a Parent Group, which represents a marketplace. Many Item Groups can be found within a Parent Group.

For example, Civil Pressure Pipes are the marketplace (Parent Group), and many different types and classes of civil pressure pipe (Item Groups) can be found within the marketplace. It is important to view the inventory standings of the Parent Groups; however, it might not be necessary to drill into the different Item Groups that form part of the specific Parent Group.

3.3.5. Business Groups

Marley have four Business Groups to whom they sell their products and these groups portray the different types of businesses and clients who purchase their products. Marley items are organized into these groups according to the buyers and type of products.

These Business Groups are Merchant, Contractor, Agent and Specified, and will be discussed briefly below:

- **Merchant:** Merchant includes businesses that do trade in the products of Marley. Examples are businesses like Builders Warehouse, Chamberlain etc. The items that are bought by these merchants included in this group.
- **Contractor:** Contractor includes businesspeople like building contractors and developers who use Marley's products during their developments. All items used by these contractors and developers are included in this group.
- **Agent:** Agent includes specific products which are demanded by agents who do purchases for other businesses.
- **Specified:** Products included into this group comprise all of Marley specialized products. An example of such a product is, Petroplas, which is made for petrochemical uses.

The above mentioned Business Groups are of great importance to Marley and it is essential to Umthombo Technologies to view the inventory standings of the items organized into these groups. This might be an important factor to visualize on the dashboard.

3.3.6. Branches

Marley's main production plant is located in Nigel and their distribution network across the country includes nine other branches. These branches include:

- Bloemfontein
- Cape Town
- Durban
- George
- Nelspruit
- East London
- Port Elizabeth
- Polokwane
- Midrand

It is important for Umthombo Technologies to view the inventory standings of each of these branches, as these are part of the total inventory of the company. It is also necessary as branch analysis forms part of Umthombo Technologies' services to Marley. These branches will form part of the main view of the dashboard, and it will be possible to view the inventory standing of each branch individually.

3.3.7. Conclusion

All of the above mentioned factors are identified as elements that have an effect on inventory and it should be kept in mind for the inventory dashboard. Unfortunately it will not be possible to show all of these elements on the dashboard, as it is important not to overload a dashboard with data and the dashboard should comprise of only one viewable screen.

All the elements mentioned above have been analyzed and broken down into the most significant elements which are necessary to appear on the inventory dashboard in the end. These major elements include:

- SoH and Stock Days
- Excess Stock
- Stocking Policies
- Production and Sales Orders
- Sales History
- Cancelled Sales
- Undelivered Sales
- Stock Outs and Sales at Risk
- Parent Groups
- Business Groups
- Branches

The major elements above will now be located within the database of Marley. This will include the extraction of the data and loading it into Excel spreadsheets, creating the main data source for the dashboard.

3.4. Data Assembly in Main Data Source

The major elements identified above, which will be viewed on the dashboard display, will be located within BaaN and the necessary SQL code will be developed. This will be used to extract the essential information, relating to these major elements, from BaaN and placing it into Excel spreadsheets. The data will then be transformed in Excel with the use of formulas and PivotTables to obtain the necessary format, resulting in the development of the dashboard data source.

3.4.1. Data Extraction from BaaN (Extract)

Data Availability

All the necessary data which is identified for the use in the dashboard is located within Marley's database and is available for use. The only difficulty is whether or not the data is in the correct format to be extracted. The first possibility is that the data is still in "raw format", thus only located within BaaN. If it is the case, the necessary SQL extraction routines and SSIS need to be developed to extract the data. Otherwise, the second possibility is that there are SQL extraction routines and views already developed, which is currently used by Marley to extract the data from BaaN. These extraction routines can then be used to extract the data.

An availability analysis and the required research are done to determine the availability of the essential data necessary for the data source development. It is clear that the required data is available and the necessary extraction routines have already been developed for internal use by Marley.

Unfortunately due to the manner in which Marley execute their Production and Sales Orders, it is currently not possible during this project to show the information on the dashboard.

SQL Views for Extraction

SQL extraction routines have already been developed by Marley and the necessary data for the dashboard data source is located within the SQL server database. This data is stored in tables within the SQL database. SQL views will be used to create a view of all the relevant data necessary for the dashboard data source.

The views are SQL extraction routines developed to present data from combined SQL tables into a standardized view. This view will then be imported into Excel to form the base data source for the

dashboard. ERD's are also constructed to show where the SQL view get the data from and the interaction between the different SQL tables to generate the view. The view was developed with the help of the Systems Manager at Marley.

The relative SQL views for each of the essential areas were developed and the ERD as well as the SQL code for each of the views are shown below. This is only to show how SQL uses the different tables to match and join the specific data which is needed to generate each view.

Stock On Hand

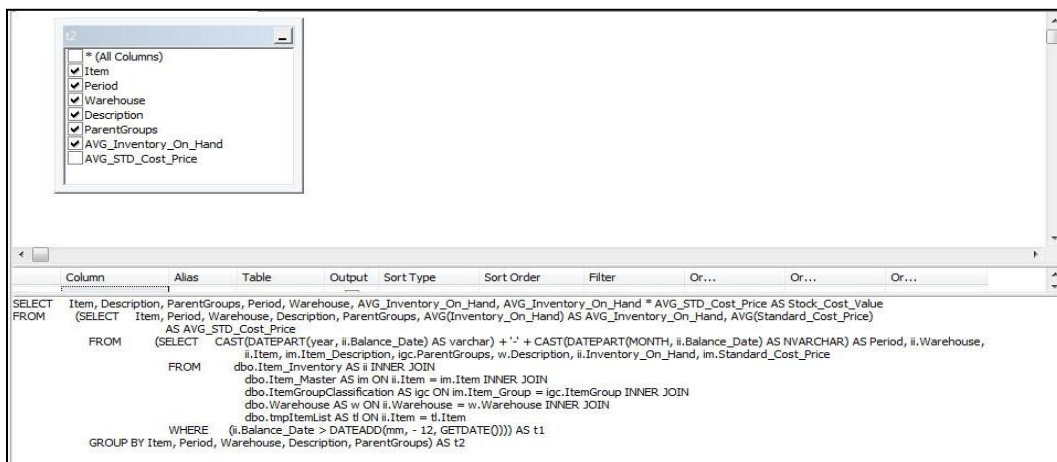


Figure 8: Stock On Hand SQL view - ERD and Code.

Excess Stock

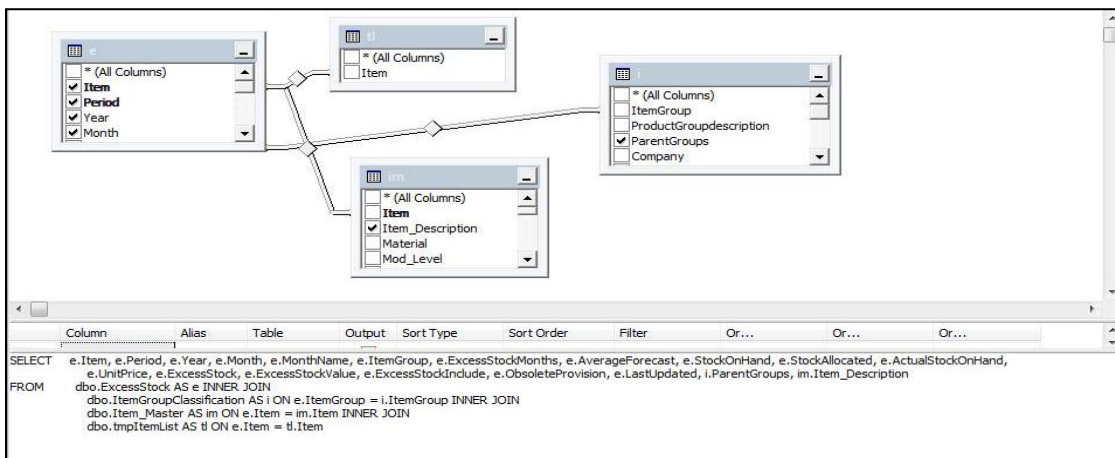


Figure 9: Excess Stock SQL view - ERD and Code.

Cancelled Sales

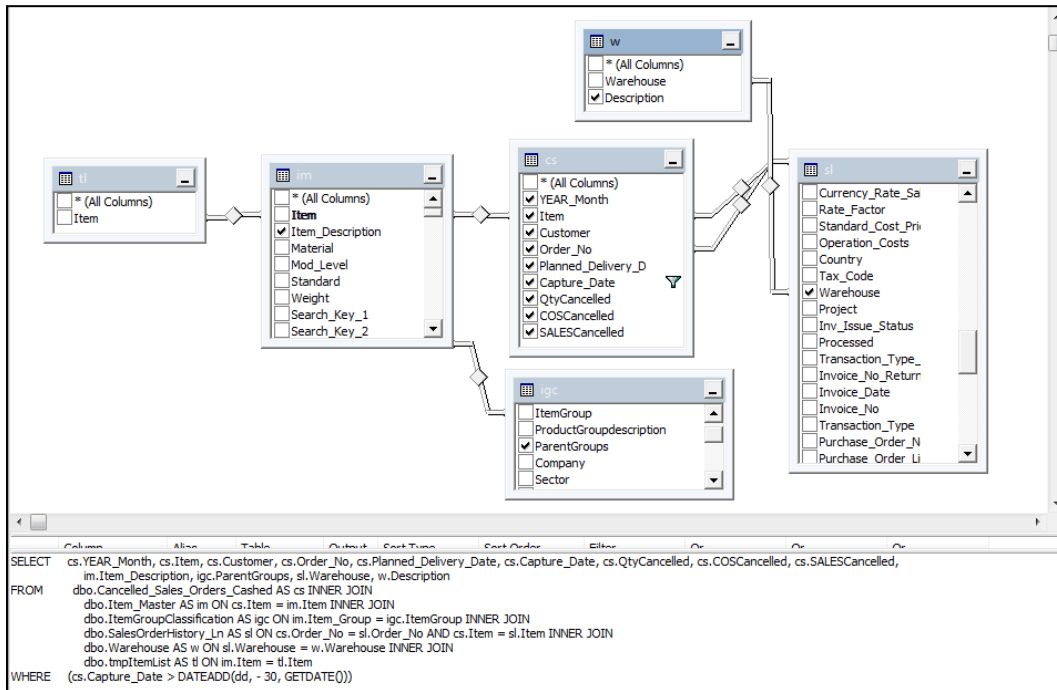


Figure 10: Cancelled Sales SQL view - ERD and Code

Undelivered Sales

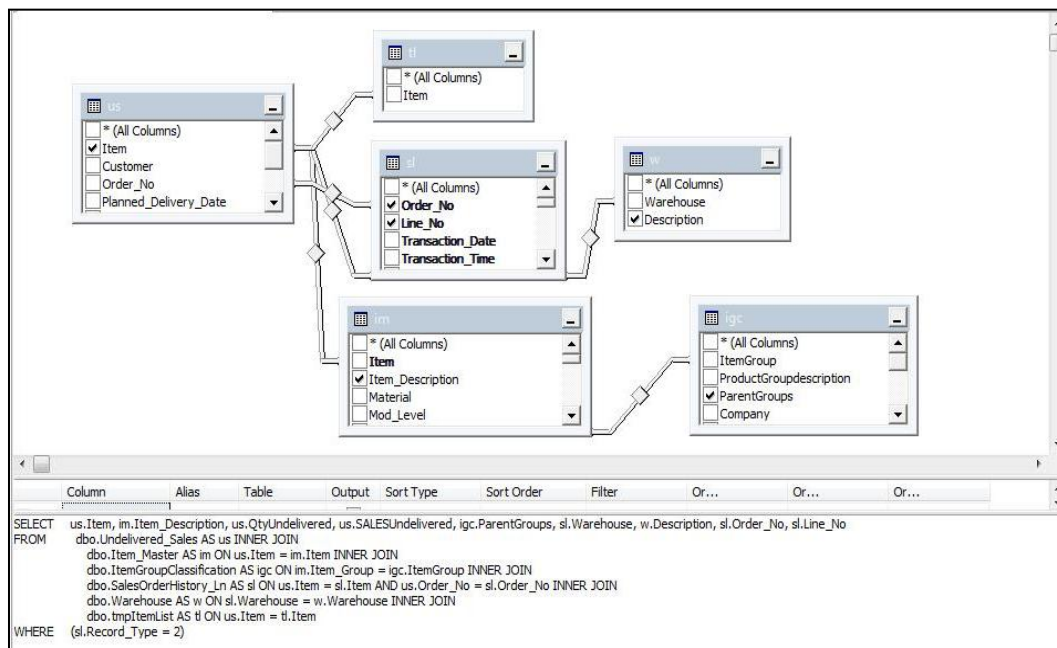


Figure 11: Undelivered Sales SQL view - ERD and Code

Stock Outs

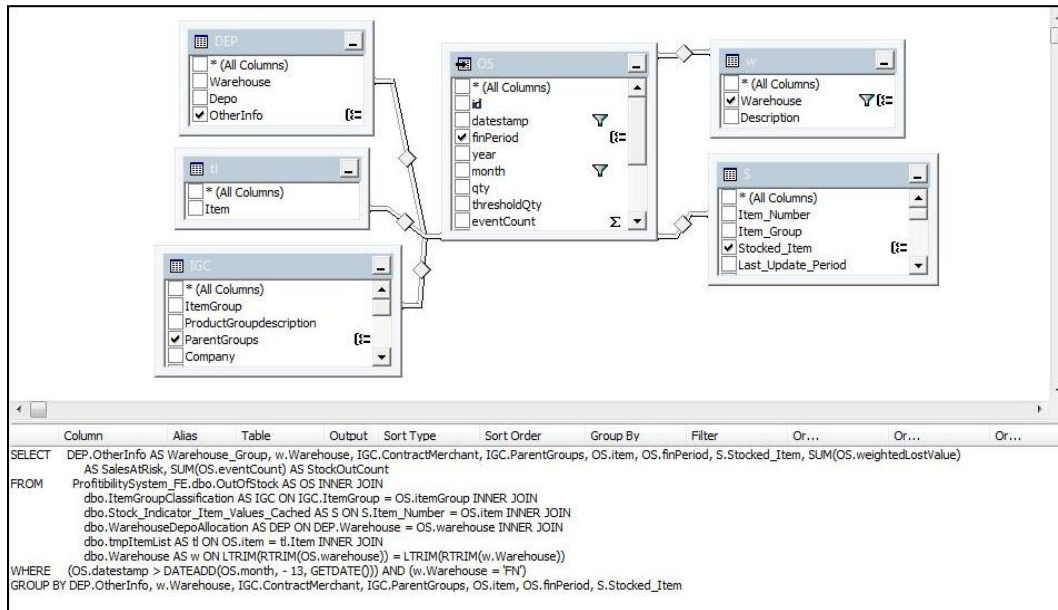


Figure 12: Stock Outs SQL view - ERD and Code

Sales History

The Sales History was extracted with the use of a Pivot Table into the dashboard spreadsheet. This PivotTable acquire the data from the SalesStats spreadsheet used for the forecasting that Umthombo do for Marley.

Extracted Data

The important data for the dashboard which have been extracted from SQL with the use of SQL views are dumped into Excel in the form of tables and Pivot Tables. This is nearly the preferable format which is necessary to load the data into the dashboard view. The Pivot Tables will be used to simply display only the preferred data as there is data included in the views which is not desired.

3.4.2. Workbook development (Transform)

The tables which are imported into Excel from the SQL views are now transformed into the required format in order to display only the essential information necessary for the dashboard. The headings of each of the main tables will be shown to give an idea of the data that will be used and displayed in the dashboard view.

The main data source of the dashboard consists of the following tables:

Stock on Hand and Stock Days

Period	Item	Item Description	Branch	Parent Groups	Stock Quantity	Stock Value	Stock Days
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Table 3: Stock on Hand & Stock Days Data Source.

Excess Stock

Period	Item	Parent Groups	Business Group	Excess Stock	Excess Stock Value
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

Table 4: Excess Stock Data Source.

As seen in this table, it will not be possible to view excess stock per branch, as all of the branches acquire stock from the production plant in Nigel. Thus excess stock will only be viewed on a company level as a whole.

Cancelled Sales

Item	Parent Groups	Business Group	Warehouse	Quantity Cancelled	Cost of Sales Cancelled	Period
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Table 5: Cancelled Sales Data Source.

Undelivered Sales

Item	Parent Groups	Business Group	Warehouse	Quantity Undelivered	Sales Undelivered
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

Table 6: Undelivered Sales Data Source.

Sales History

Item	Parent Groups	Business Group	Monthly Sales Quantity	Monthly Sales Values
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Table 7: Sales History Data Source.

Identical to excess stock, sales history will only be viewed on a company level. All the sales generated by a specific branch will be replenished from the production plant in Nigel by sales orders, thus taking only company sales into account.

Stock Outs and Sales at Risk

Item	Parent Groups	Business Group	Warehouse	Stock Out Count	Sales at Risk Value	Period
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Table 8: Stock Outs & Sales at Risk Data Source.

The above shown tables form part the main data source of the dashboard. Each of these tables is located in a separate sheet within the Inventory Dashboard Excel book. This is done to arrange the data accordingly and keep the data source structured and organized.

3.4.3. Model Inputs for Dashboard

There are a few inputs from the user which can be entered into the dashboard enabling the user to filter the data being displayed on the dashboard. The inputs which the user can select to filter the data with will consist of the Following:

- Specific branch or a total company overview.
- Specific Item.
- Specific Parent Group.
- Specific Business Group.

These four inputs are the only elements of the dashboard which the user will be able to change and filter the information being displayed with. A view of the Excel table “*Inputs*”, used in the data validation for the user inputs can be viewed in Appendix A.

3.4.4. Dashboard Data Source

The main data source of the dashboard is now in place. The views which were created in SQL and then imported into Excel in the form of tables were used to transform the imported data into the required format necessary to use and display on the dashboard. The data can now be used to display on the dashboard.

4. Dashboard Design and Evaluation

This is an important chapter of the project as it involves the design of the final dashboard display as well as the interaction of the data source and the dashboard, presenting the final Inventory Dashboard. This is the practical application of the solution to the problem which has been described and analyzed in chapter one and three. This chapter includes the third and fourth steps of the System Development Process, namely System Design and System Implementation respectively. This will include the final design of the dashboard display, the interaction between the data source and the dashboard, and the final evaluation of the dashboard.

As stated above, during the Implementation phase of the System Development Process, only an evaluation of the dashboard will be done, and not the implementation.

4.1. Solution Design

The design of the dashboard display was done with the Dashboard Design Steps and Principles in mind, as discussed in chapter two. The steps were followed and the requirements of the dashboard were identified first, as in chapter three. The next steps are to identify what exactly would the user like to have displayed on the dashboard, as well as designing the dashboard layout.

The dashboard layout design as well as the interaction between the data source and the dashboard display will now be discussed.

4.1.1. Dashboard Layout Design

The views required by Umthombo which will display the information essential in assisting them in managing Marley's Inventory will now be discussed. Examples of what is required of the views will be developed as well as a design layout of the final dashboard.

Necessary views

The necessary views that should appear on the dashboard need to be identified. Each of these views will display the information of the major elements identified in chapter three. The views are divided into four main areas which will appear on the dashboard, respective of the information it will display.

The four areas with the respective information each one will display are as follows:

- Stock on Hand
 - Current Stock on Hand in value and quantity, as well as the trend.
 - Stock day's current count and trend.
 - Stocking Policy.
 - Inputs from the user (Item, Parent Group, Business Group and Branch).
- Excess Stock
 - Excess Stock trend in value.
 - Current Excess Stock in value and quantity.
- Sales
 - 12 month Sales History in quantity and value.
 - Current Sales in quantity and value.
 - Cancelled Sales for previous and current month, in quantity and value.
 - Current Undelivered Sales in quantity and value.
- Stock Outs
 - 12 month trend of Stock Outs and Sales at Risk.
 - Current number of Stock Outs.
 - Current Sales at Risk value.

This summarizes the four display areas of the dashboard as well as the content which will appear in each area. This can now be used to design the layout of the dashboard, as it is clear what exactly need to be displayed.

Design of Dashboard Layout

A preliminary design of the layout for the Inventory Dashboard was done. This layout is designed with use of the Dashboard Design Principles as guidelines and the layout was constructed according to the four areas discussed above. In this design it can be seen that each area with its relevant information is shown, as well as an area where the user will enter the input data. The preliminary design of the dashboard view is shown below:

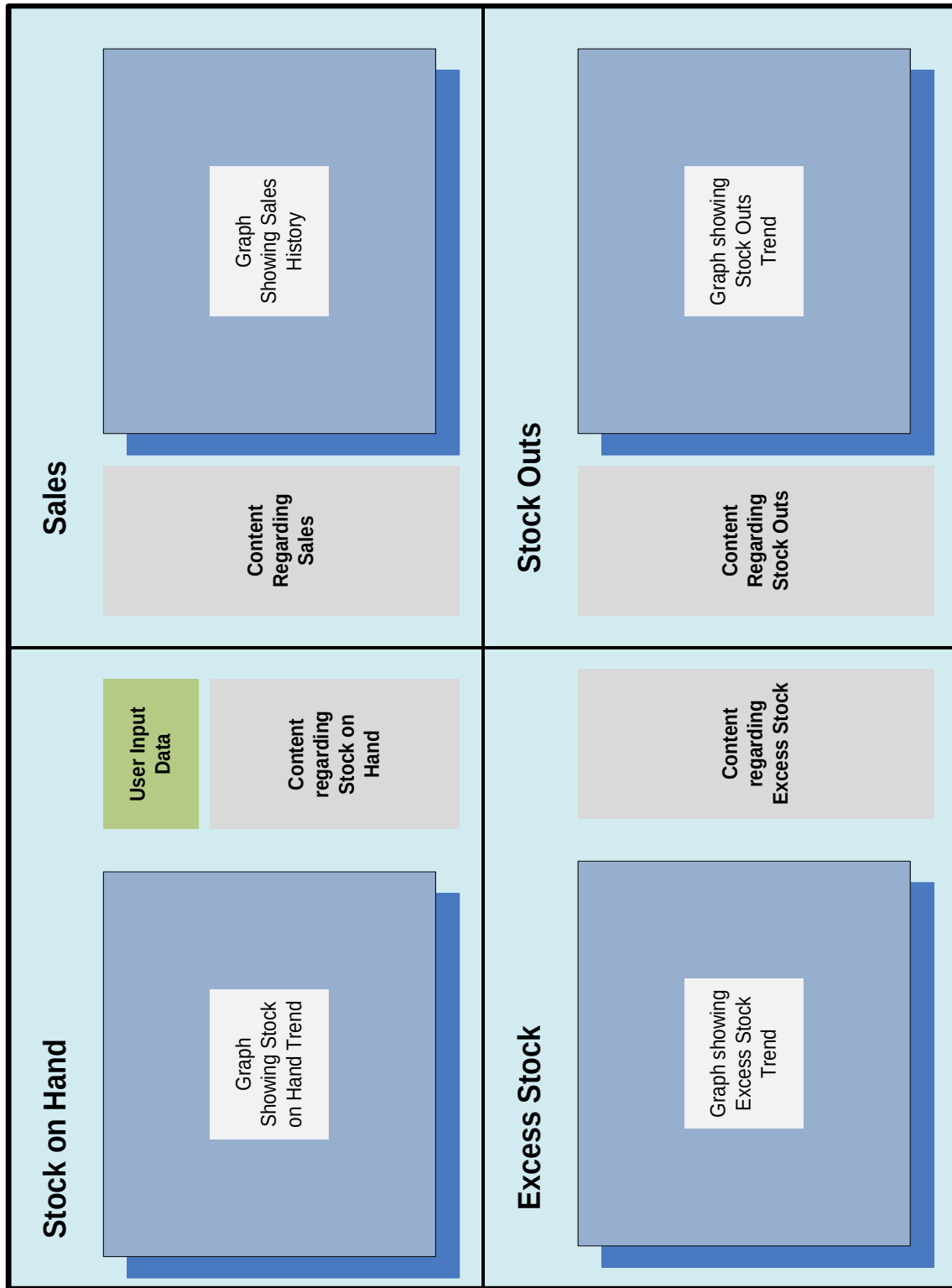


Figure 13: Preliminary Dashboard Layout Design.

Example of views

The four areas on the dashboard display will now be shown in more detail. Each view is designed and developed to evaluate if the layout is acceptable and whether or not the correct information is displayed in the view. An example of each view was designed according to the preliminary dashboard layout and each one show how its relevant information will be displayed.

Stock on Hand

As seen in the figure below, the Stock on Hand view will contain a graph showing the twelve month trend of Stock on Hand and Stock Days. It will also contain a User Input area, where the user can select which specific Item, Parent Group, Business Group or Branch's information the whole dashboard should display. It will show Item Description, the Stocking Policy for the selected Item as well as the Current Stock on Hand and Stock Days.

User Inputs	
Item	Items
Parent Group	Parent Groups
Business Group	Business Groups
Branch	All Branches

Note

Item Description:

Current SoH
Quantity:
Value:

Current Stock Days
Count:

Stocking Policy

Figure 14: Example view of Stock on Hand.

Excess Stock

The Excess Stock view will contain a graph showing the twelve month trend of Excess Stock over the whole company. It will also show the current month's Excess Stock quantity and value. This can be seen in the figure below.



Figure 15: Example view of Excess Stock.

Sales History

The Sales History View will contain a graph showing the twelve months Sales History as well as the current month's Sales quantity and value. It will also show the Cancelled Sales of the current month and previous month in quantity and value. Undelivered Sales for the current month will also be shown in quantity and value. This is shown in the figure below.

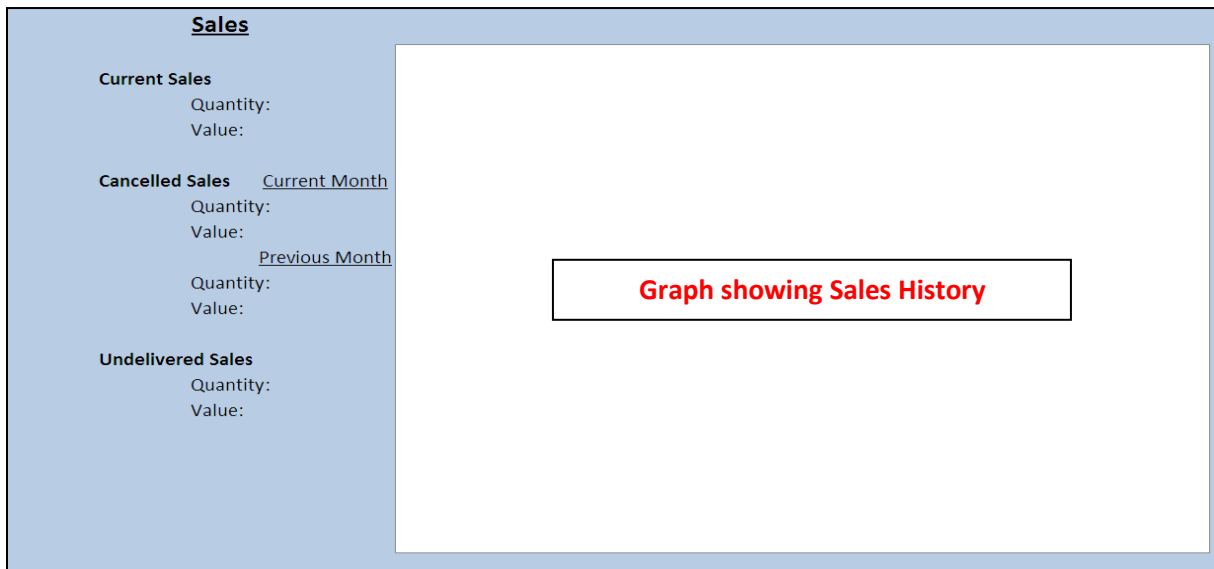


Figure 16: Example view of Sales History.

Stock Outs

The Stock Outs view will contain a graph showing the twelve month trend of Stock Outs count as well as the Sales at Risk value. The number of Stock Outs and the Sales at Risk for the current month will also be displayed. This is shown in the graph below.

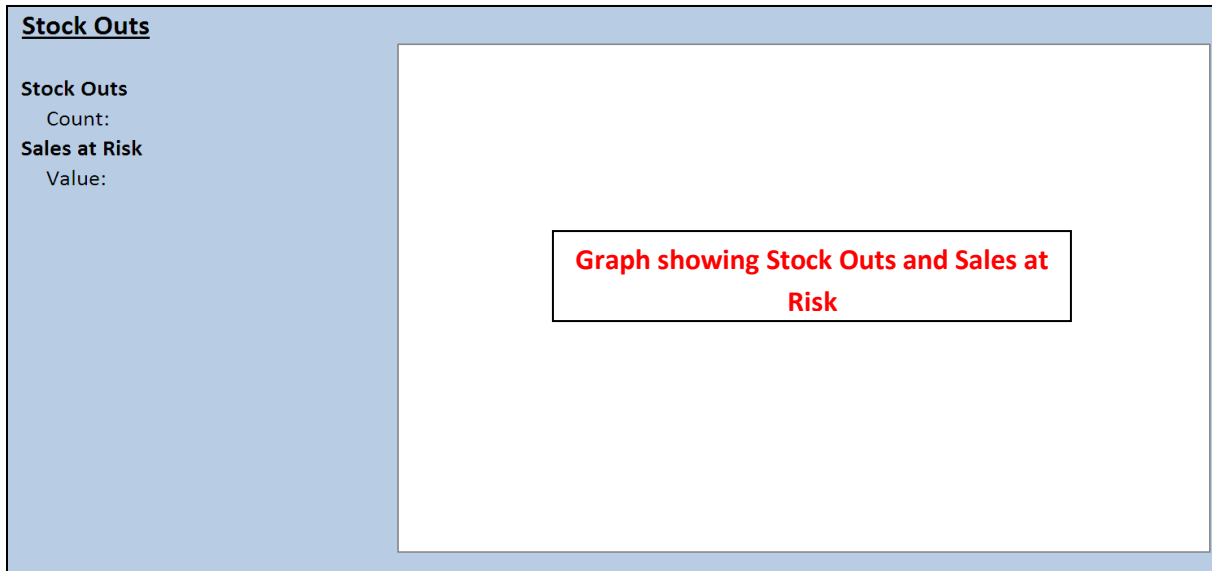


Figure 17: Example view of Stock Outs.

Each of the above views show its relevant content and it is discussed how the content will be displayed on the specific view. Briefly this is the outputs of the dashboard display. With this done, the Final Dashboard Display Layout can be developed.

Final Dashboard Layout

The final dashboard layout design was developed by using the preliminary dashboard design layout and the four example views shown previously. The four views were incorporated into one overall view, resulting in the greatly required overview of Marley's inventory. The dashboard layout was developed to display the views with their relevant content shown in detail, as seen in a snapshot of the Inventory Dashboard below:

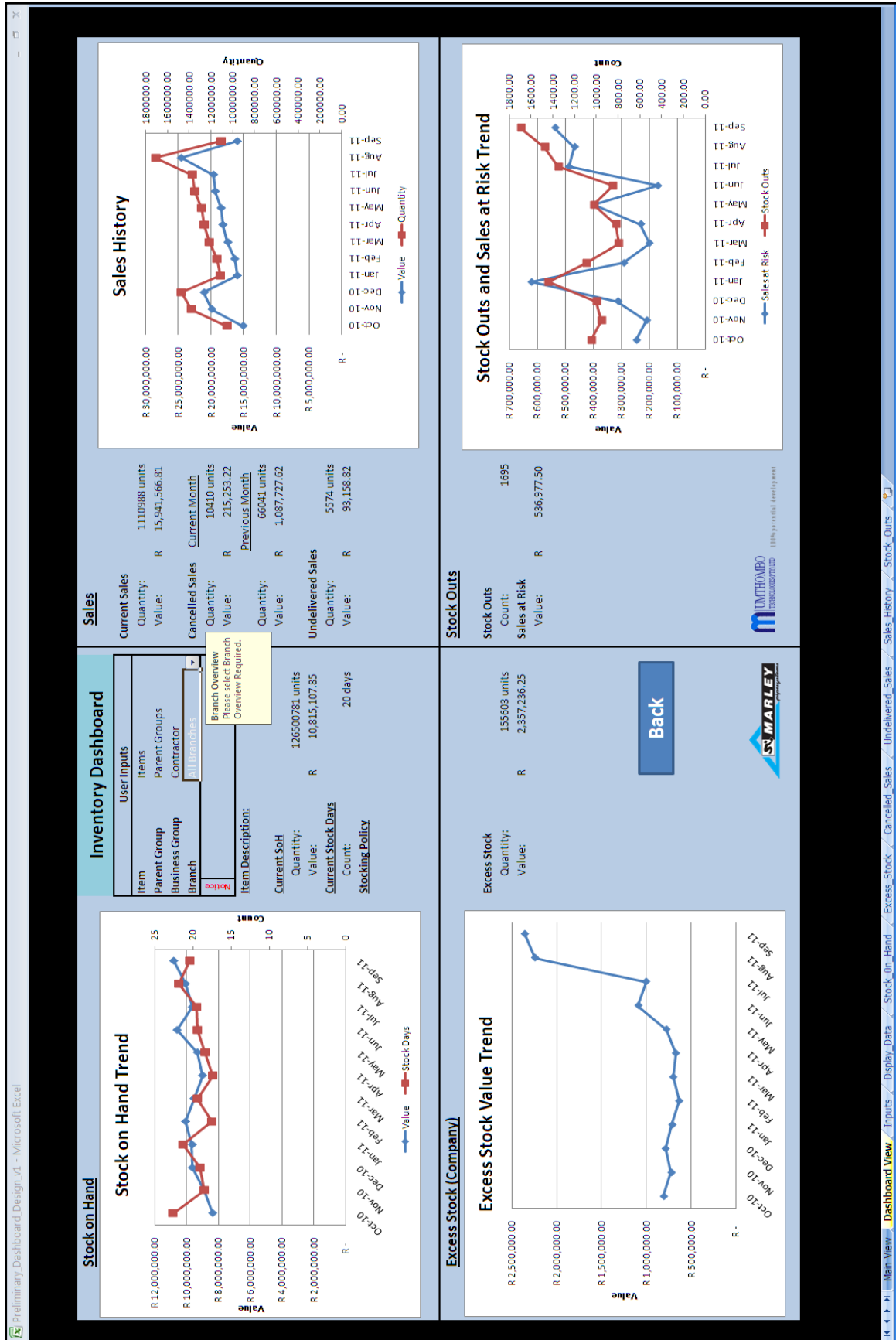


Figure 18: Main display of Dashboard View.

4.1.2. Dashboard Display and Data Source Interaction

The interaction between the Dashboard display and the data source tables is relatively simple. Firstly the user needs to select the Item, Parent Group, Business Group and Branch of which the dashboard should display inventory information. This data is located in a sheet named “*Inputs*”, which contain lists of all the input values from which the user can select. This is done with the use of Data Validation in Excel, enabling the user to select from a drop down list which Item’s, Parent Group’s etc. information should be displayed. This can be seen in the figure below:

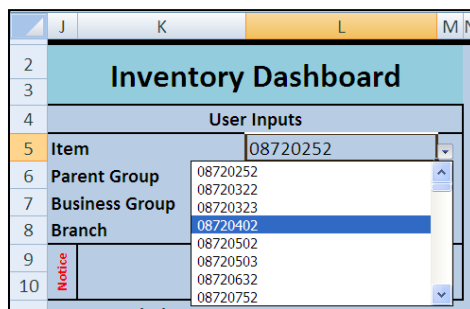


Figure 19: User input - Selecting Item.

The Inventory Dashboard Excel book also contains a sheet named “*Display_Data*”. All the data currently being displayed on the dashboard view is calculated in this sheet by using the input data from the user. Most of the calculations are done with the Excel function “*sumifs*”. What this calculation does is add the cells in a range specified by a given set of conditions or criteria.

For example take Figure 20 into consideration. The figure shows that the user selected Item 08720252 from Parent Group HDPE Small Bore and in the Contractor Business Group. To calculate the trend of the Stock on Hand graph, the “*sumifs*” function adds the values in a Named Range, namely “*SoH_Value*” which is located in the “*Stock_On_Hand*” sheet, for the specified Item, Parent Group, Business Group and over all the branches in a specific month. This is done for the previous twelve months as well, creating the trend.

	J	K	L	M
2	Inventory Dashboard			
3				
4	User Inputs			
5	Item	08720252		
6	Parent Group	HDPE Small Bore		
7	Business Group	Contractor		
8	Branch	All Branches		
9	Notice			
10				

Figure 20: Selected user inputs.

These inputs can be changed according to the specific information the user requires and the relevant calculation will be done for those specific inputs. The same calculation is also done for Excess Stock, Sales, and Stock Outs. A similar method is used for calculating the Cancelled Sales and Undelivered Sales values being displayed on the dashboard view.

This is a rundown of how the Inventory Dashboard views and the Dashboard data source interact including how the data is loaded into the view. In the addendum a view is added containing snapshots of the “Inputs” and “Display_Data” sheets. These are in Appendix A, B and C respectively. Appendix B shows the “Display_Data” sheet for SoH and Appendix C show a portion of the same table containing the formulas.

4.2. Dashboard Solution, Evaluation and Testing

4.2.1. Dashboard Solution

The final dashboard design and development is now complete. All the necessary information were identified, analyzed, extracted with the use of SQL and then transformed into the required format in Excel, resulting in the data source. The dashboard layout design was then done and a preliminary design was created and from this preliminary design the final dashboard layout was developed. After the design layout was finished, the interaction between the dashboard data source and the dashboard display was done. Completing all of these phases resulted in developing the Final Inventory Dashboard.

4.2.2. Dashboard Evaluation and Testing

Evaluating and testing the Inventory Dashboard developed in this project is essential because important decisions and evaluations concerning Marley’s Inventory Management might be made from this

dashboard. Thus it is required to ensure that the dashboard functions properly and that it is accurate with the relevant data. This is done to firstly evaluate the dashboard and whether or not it returns the correct outputs on the display. And secondly the functionality of the dashboard is tested.

Dashboard Evaluation

An evaluation of the Inventory Dashboard was done to ensure that the dashboard displays the correct data. This is essential as important Inventory Management decisions might be made by using this Inventory Dashboard. The evaluation was done by selecting different combinations in the user input area, for example by selecting a company overview, a single item, a specific item in a specific branch etc. Such as in the figure below:

	J	K	L	M
2	Inventory Dashboard			
3				
4	User Inputs			
5	Item	08720252		
6	Parent Group	HDPE Small Bore		
7	Business Group	Contractor		
8	Branch	All Branches		
9	Notice			
10				

Figure 21: Selected user inputs.

A specific combination is selected and the results shown by the dashboard is documented. The input data from the user is then used to filter each of the tables from which the data is calculated and the exact information is documented. The information documented from the dashboard is then compared to the manually documented information. This was done several times with different user input data and the correct information was displayed every time. Thus the Inventory Dashboard is displaying the correct information, resulting in a properly functioning dashboard on the information level.

Dashboard Functionality Testing

A functionality test of the Inventory Dashboard is done to ensure that the dashboard functions properly and without any faults. A quick run through of the dashboard is done to test all the inputs that can be changed, ensure that all the graphs change when the inputs are changed and to give an overview of how the dashboard functions.

Before the Dashboard view is shown, it is important to show the Main view of the dashboard. The main view is shown when the Excel Dashboard book is opened and gives an overview of the company profile. The macros and SQL connections then need to be activated. The main view consists of all the branches as well as the central company, namely Marley as a whole. This view enables the user to select the branch or overall company view of which the inventory data should be shown. The figure below shows the Main view of the dashboard.

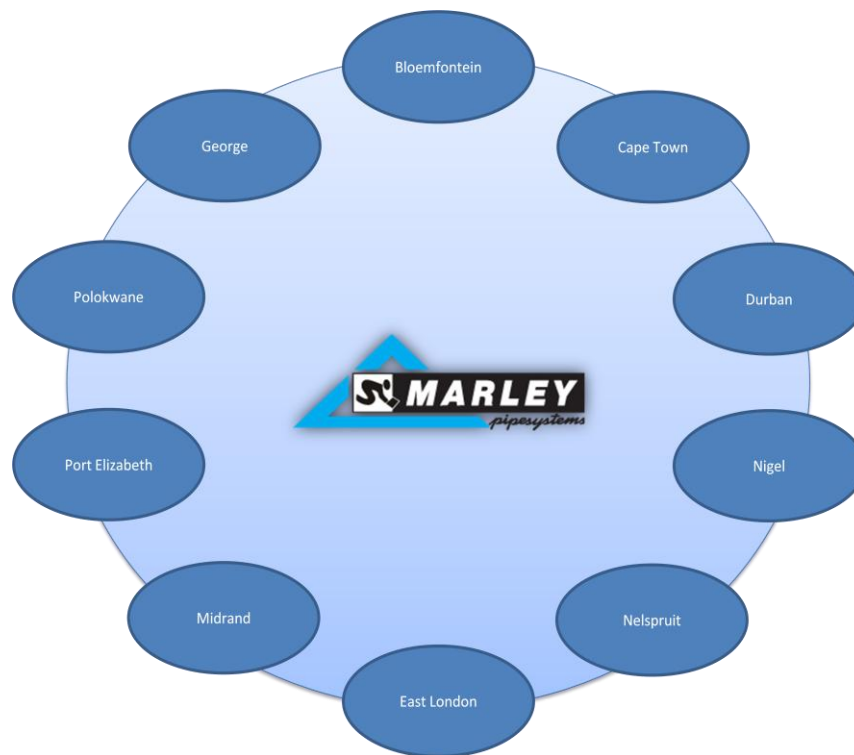


Figure 22: Main View of Inventory Dashboard

When the user selects a specific branch or the company overview the Dashboard View is displayed. The whole overview of the company's inventory standing is then shown and as seen in Figure 23 below, the dashboard then asks the user to select the branch of which the information should be shown, or simply a view over all the branches.

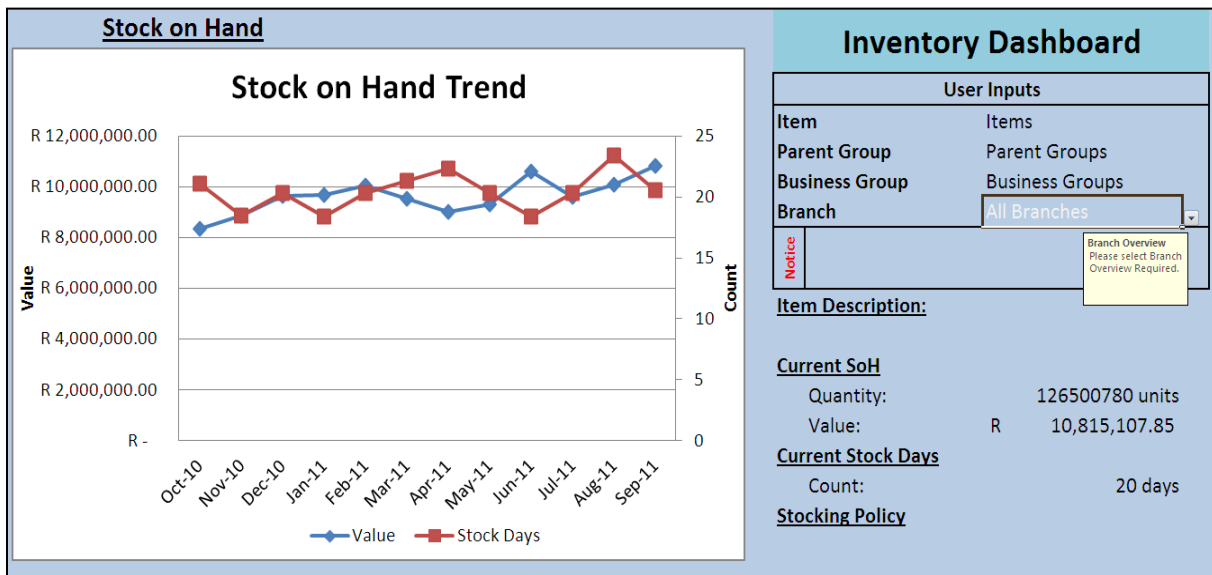


Figure 23: Branch overview required need to be selected.

For this example the user selects Item 08720252 over all the branches. The dashboard then asks the user to select the relevant Parent Group and Business Group for the specific Item. This is shown below:

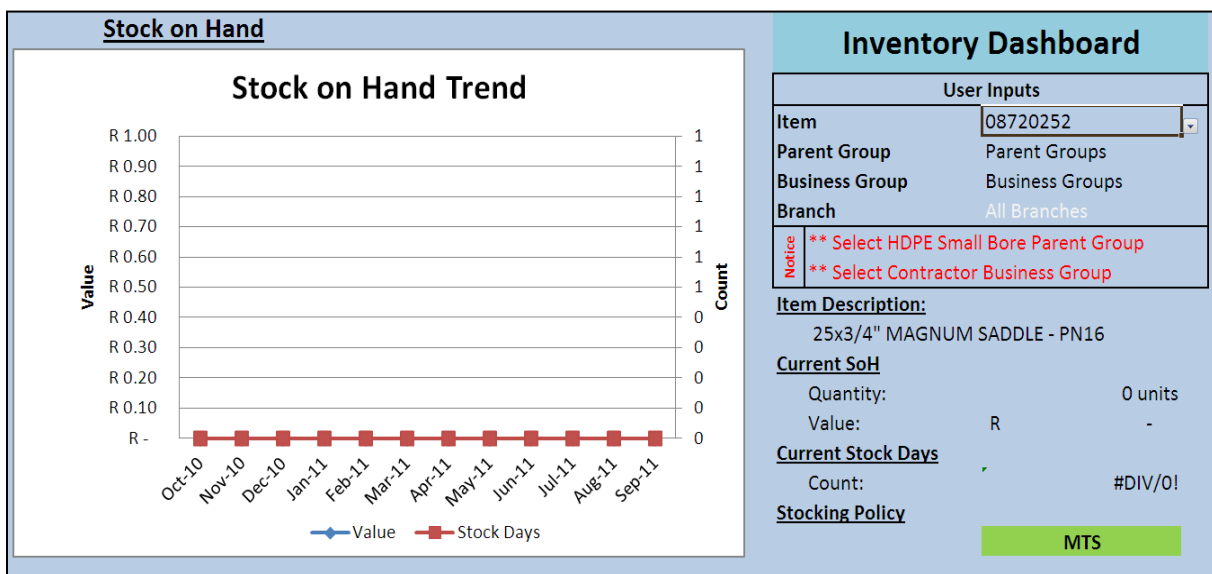


Figure 24: Relevant Parent and Business Group needs to be selected.

The user then selects the relevant Parent and Business Groups. The information for the specific item over the whole company is then displayed on the dashboard, as seen below:

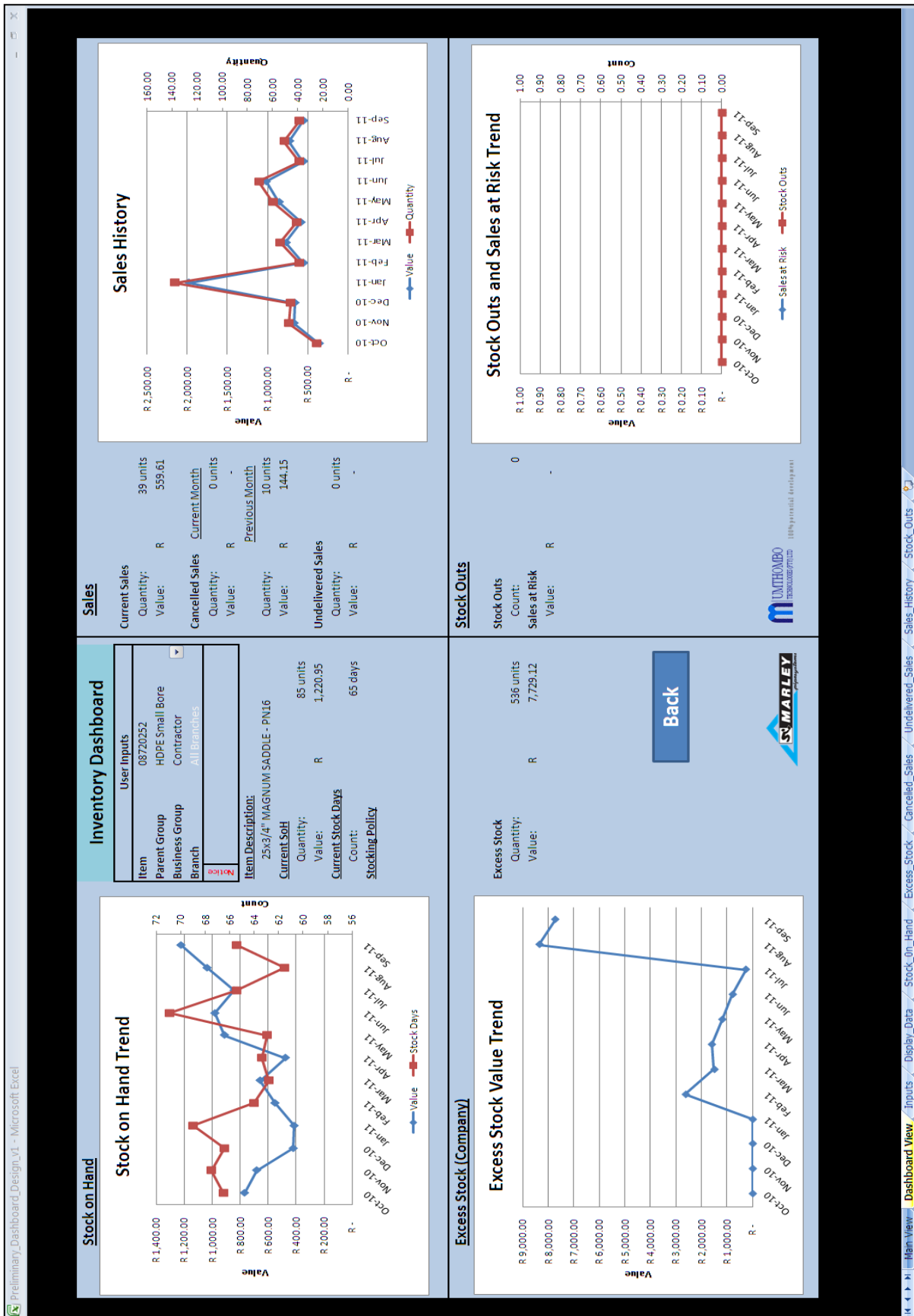


Figure 25: Dashboard view showing results for user inputs.

The user can then use this data to determine what the current inventory standings are, in terms of the selected item, parent group, business group etc. When the user wants to see the different branches of Marley, the “Back” button can be selected to return to the main view of the Inventory Dashboard.

Several combinations of inputs were selected to ensure that the dashboard functions properly during all the different user inputs which can be selected. The results of the testing phase were positive and the Inventory Dashboard functioned properly throughout the whole test.

4.2.3. Evaluation and Testing Conclusion

This concludes the evaluation and testing of the Inventory Dashboard. It is clear that the dashboard displays the correct data and that it functions properly throughout every user input being changed. Umthombo managed and executed the whole testing and evaluation phase and they concluded that the dashboard is functioning exceptionally well. They checked all the results of the tests and identified some small errors which were corrected. Umthombo approved the design of the Inventory Dashboard and also acknowledged the functionality and effectiveness of the dashboard.

This project only include the design and development of the Inventory Dashboard and it is possibly not the only solution to the problem, nor is it the best way to solve the problem, as there are many solutions to a specific problem. But it is the best solution suited to Umthombo and their requirement for managing Marley’s inventory.

Umthombo is satisfied with the Inventory Dashboard and considers implementation and further integration of the dashboard at Marley. This implementation did not form part of this project.

5. Conclusion

Inventory Management is an important aspect to any company, especially for a company such as Marley Pipe Systems who produce a vast amount of products of which many is kept in inventory. Without inventory management it would be difficult for such a company to maintain control and keep track of their inventory levels and this can have devastating results. Thus it is of great importance to Marley that their inventory levels are managed properly. This raises the problem with Umthombo Technologies whom is responsible for managing Marley Pipe Systems Inventory.

Umthombo Technologies sponsored this project with the hope that they will attain the benefit of a tool which will assist them in managing Marley Pipe Systems inventory. Therefore the crux of this project is to develop an Inventory Dashboard which will assist Umthombo Technologies in delivering better inventory management services to Marley Pipe Systems. The entire Inventory Dashboard is developed in Excel, due to the fact that Umthombo Technologies use Excel to do the inventory planning and since Excel has great operating capabilities and user friendliness.

If Umthombo Technologies implement this Inventory Dashboard it will enhance the manner in which they do inventory management. This Inventory Dashboard will provide them with a single overview of Marley Pipe Systems' inventory and give them better inventory visibility. The Inventory Dashboard will also reduce the time spent on doing the inventory planning of Marley Pipe Systems as they only need one spreadsheet to do an analysis of the inventory standings, and not numerous other bulky spreadsheets. All of this in turn will improve Umthombo Technologies' services.

Due to the fact that the dashboard is developed in Excel, the only manner in which it will improve savings for Umthombo Technologies is by the manner in which it will enhance the inventory management of Marley Pipe Systems and the savings generated by improving their inventory levels.

Therefore, according to the manner in which this Inventory Dashboard will assist Umthombo Technologies in doing inventory management for Marley Pipe System, it can be concluded that if this dashboard is utilized correctly, it might hold great value to Umthombo Technologies as well as Marley Pipe Systems as it will assist Umthombo Technologies in improving the inventory levels of Marley Pipe Systems.

6. References

Alexander, M & Walkenbach, J 2010, *Excel Dashboards and Reports*, John Wiley & Sons.

Amrine, HT, Ritchey, JA, Moodie, CL & Kmec, JF 2004, *Manufacturing Organization and Management*, 6th edn, Prentice Hall.

Bentley, LD & Whitten, JL 2007, *Systems Analysis and Design for the Global Enterprise*, 7th edn, MCGraw-Hill Irwin.

Cachon, GP & Fisher, M 2000, 'Supply Chain Inventory Management and the Value of Shared Information', *Management Science*, vol 46, no. 8, pp. 1032-1048.

Chase, RB, Aquilano, NJ & Jacobs, RF 2004, *Operations Management for Competitive Advantage*, 10th edn, McGraw-Hill Companies.

Coyle, JJ, Bardi, EJ & Langley Jr., JC 2003, *The Management of Business Logistics - A Supply Chain Perspective*, 7th edn, South-Western, a division of Thomson Learning.

Dennis, A, Wixom, BH & Tegarden, D 2007, *Object-Oriented Systems Analysis and Design With UML*, 3rd edn, Wiley.

Eckerson, WW 2010, *Performance Dashboards: Measuring, Monitoring and Managing your Business*, 2nd edn, John Wiley & Sons.

Few, S 2006, *Information Dashboard Design: The Effective Visual Communication of Data*, O'Reilly Media.

Fulfillment, S, *Southern Fulfillment Services*, <http://www.southernfulfillment.com/articles/order-fulfillment/inventory-management/the_importance_of_inventory_management.htm>, The Importance of Inventory Management.

Infocaptor, *Infocaptor*, viewed August 2011, <<http://www.infocaptor.com/dashboard/free-dashboard-design-and-development>>.

Langley Jr., JC, Coyle, JJ, Gibson, BJ, Novack, RA & Bardi, EJ 2009, *Managing Supply Chains - A Logistics Approach*, 8th edn, South-Western, a Part of Cengage Learning.

Miles, MB & Huberman, MA 1999, *Qualitative Data Analysis*, 2nd edn, Sage Publications Inc.

Müller, M 2011, *Essentials of Inventory Management*, 2nd edn, AMACOM.

Relph, DG, Brzeski, W & Bradbear, G 2002, 'The First Steps to Inventory Management', *IOM Control Journal*, vol 28, no. 10.

Relph, DG, Brzeski, W & Bradbear, G 2003, 'Profesional Inventory Management', *IOM Control Journal*, vol 29, no. 5.

Schaefer, Hans Peterr - The Gillette Company , 'What a Dashboard should deliver'.

Schönsleben, P 2003, *Integral Logisticsc Management: Planning and Control of Comprehensive Supply Chains*, 2nd edn, CRC Press.

Stock, JR & Lambert, DM 2001, *Strategic Logistics Management*, 4th edn, McGraw-Hill Publishing Co.

Stumpf, RV & Teague, LC 2004, *Object-Oriented Systems Analysis and Design With UML*, Prentice Hall.

Symtex, *Symtex*, viewed 25 August 2011, <<http://www.symtex.co.uk/database-services/sql-server-consultancy/>>.

Wild, T 2002, *Best Practice in Inventory Management*, 2nd edn, Butterworth-Heinemann, UK.

7. Addendum

7.1. Appendix A: User Inputs Table.

Items	Parent Groups	Business Groups	All Branches
08720252	HDPE Small Bore	Merchant	BBL
08720322	Compression Fittings	Contractor	BCT
08720323	Mouldings	Agent	BDU
08720402	Building Pipe	Specialized	BGE
08720502	Rain Water		BNE
08720503	Building Buyouts		BEL
08720632	Hot & Cold Fittings		BPE
08720752	HDPE Large Bore		BPI
08720753	Valves		FN
08720903	Civil Buyouts		BMR
08721102	Petrol		
08721106	Pressure Pipe		
510.160	Civil Non Pressure Pipe		
510.200			
510.250			
510.320			
510.400			
510.500			
510.630			
510.900			
511.20B			
511.20C			
511.25B			
511.25C			
511.25D			
511.32C			
511.32D			
511.32E			
511.40E			
511.50E			
511.50F			
511.50G			

7.2. Appendix B: “Display_Data” sheet showing values for Stock on Hand.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		SoH													
2	#N/A			Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11
3	#N/A	All	Value	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
4			Quantity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5		Not Item	Value	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
6			Quantity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7		Not Item. PG	Value	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
8			Quantity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9		Company	Value	R 8,361,205.56	R 8,876,150.08	R 9,639,244.72	R 9,662,431.46	R 10,063,837.55	R 9,531,647.45	R 9,008,861.51	R 9,317,714.76	R 10,597,724.17	R 9,618,615.84	R 10,078,223.94	R 10,815,107.85
10			Quantity	609133.47	126500780.51	126500780.51	126500780.51	126500780.51	126500780.51	126500780.51	126500780.51	126500780.51	126500780.51	126500780.51	126500780.51
11		Specific Item	Value	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
12			Quantity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	****	Parent Group	Value	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -	R -
14			Quantity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15		Display	Value	R 8,361,205.56	R 8,876,150.08	R 9,639,244.72	R 9,662,431.46	R 10,063,837.55	R 9,531,647.45	R 9,008,861.51	R 9,317,714.76	R 10,597,724.17	R 9,618,615.84	R 10,078,223.94	R 10,815,107.85
16			Quantity	609,133.47	126,500,780.51	126,500,780.51	126,500,780.51	126,500,780.51	126,500,780.51	126,500,780.51	126,500,780.51	126,500,780.51	126,500,780.51	126,500,780.51	126,500,780.51
17															
18		All = Item per PG per Branch													
19		NotItem = Parent Group per Branch													
20		NotItem&PG = Specific Branch													
21		Company = Company Overview													
22		Specific Item													
23		Specific Parent Group													

7.3. Appendix C: “Display_Data” sheet showing formulas for Stock on Hand.

SIN		=IF(AND('Dashboard View'!\$L\$5=Inputs!\$A\$1,'Dashboard View'!\$L\$6=Inputs!\$B\$1,'Dashboard View'!\$L\$8=Inputs!\$D\$1),Display_Data!D9,IF(AND('Dashboard View'!\$L\$5=Inputs!\$A\$1,'Dashboard View'!\$L\$8=Inputs!\$D\$1),Display_Data!D13,IF(AND('Dashboard View'!\$L\$5=Inputs!\$A\$1,'Dashboard View'!\$L\$6=Inputs!\$B\$1),Display_Data!D7,IF('Dashboard View'!\$L\$5=Inputs!\$A\$1,Display_Data!D5,IF('Dashboard View'!\$L\$8=Inputs!\$D\$1,Display_Data!D11,D3))))))		
	B	C	D	E
1	SoH			
2			=2010/10	40483
3	All	Value	=SUMIFS(SoH_Value2,SoH_Item2,'Dashboard View'!\$L\$5,SoH_PG2,'Dashboard View'!\$L\$6,SoH_Branch2,'Dashboard View'!\$L\$8,SoH_Date2,D\$2)	=SUMIFS(SoH_Value2,S
4		Quantity	=SUMIFS(SoH_Quantity2,SoH_Item2,'Dashboard View'!\$L\$5,SoH_PG2,'Dashboard View'!\$L\$6,SoH_Branch2,'Dashboard View'!\$L\$8,SoH_Date2,D\$2)	=SUMIFS(SoH_Quantity
5	Not Item	Value	=SUMIFS(SoH_Value2,SoH_PG2,'Dashboard View'!\$L\$6,SoH_Branch2,'Dashboard View'!\$L\$8,SoH_Date2,D\$2)	=SUMIFS(SoH_Value2,S
6		Quantity	=SUMIFS(SoH_Quantity2,SoH_PG2,'Dashboard View'!\$L\$6,SoH_Branch2,'Dashboard View'!\$L\$8,SoH_Date2,D\$2)	=SUMIFS(SoH_Quantity
7	Not Item. PG	Value	=SUMIFS(SoH_Value2,SoH_Branch2,'Dashboard View'!\$L\$8,SoH_Date2,D\$2)	=SUMIFS(SoH_Value2,S
8		Quantity	=SUMIFS(SoH_Quantity2,SoH_Branch2,'Dashboard View'!\$L\$8,SoH_Date2,D\$2)	=SUMIFS(SoH_Quantity
9	Company	Value	=IF(AND('Dashboard View'!\$L\$5=Inputs!\$A\$1,'Dashboard View'!\$L\$6=Inputs!\$B\$1,'Dashboard View'!\$L\$8=Inputs!\$D\$1),SUMIF(SoH_Date2,Display_Data!D2,SoH_Value2))	=IF(AND('Dashboard Vi
10		Quantity	=IF(AND('Dashboard View'!\$L\$5=Inputs!\$A\$1,'Dashboard View'!\$L\$6=Inputs!\$B\$1,'Dashboard View'!\$L\$8=Inputs!\$D\$1),SUMIF(SoH_Date2,Display_Data!D2,SoH_Quantity2))	=IF(AND('Dashboard Vi
11	Specific Item	Value	=SUMIFS(SoH_Value2,SoH_Item2,'Dashboard View'!\$L\$5,SoH_PG2,'Dashboard View'!\$L\$6,SoH_Date2,Display_Data!D\$2)	=SUMIFS(SoH_Value2,S
12		Quantity	=SUMIFS(SoH_Quantity2,SoH_Item2,'Dashboard View'!\$L\$5,SoH_PG2,'Dashboard View'!\$L\$6,SoH_Date2,Display_Data!D\$2)	=SUMIFS(SoH_Quantity
13	Parent Group	Value	=SUMIFS(SoH_Value2,SoH_PG2,'Dashboard View'!\$L\$6,SoH_Date2,Display_Data!D2)	=SUMIFS(SoH_Value2,S
14		Quantity	=SUMIFS(SoH_Quantity2,SoH_PG2,'Dashboard View'!\$L\$6,SoH_Date2,Display_Data!D2)	=SUMIFS(SoH_Quantity
15	Display	Value	=IF(AND('Dashboard View'!\$L\$5=Inputs!\$A\$1,'Dashboard View'!\$L\$6=Inputs!\$B\$1,'Dashboard View'!\$L\$8=Inputs!\$D\$1),Display_Data!D7,IF('Dashboard View'!\$L\$5=Inputs!\$A\$1,Display_Data!D5,IF('Dashboard View'!\$L\$8=Inputs!\$D\$1,Display_Data!D11,D3))))))	=IF(AND('Dashboard Vi
16		Quantity	=IF(AND('Dashboard View'!\$L\$5=Inputs!\$A\$1,'Dashboard View'!\$L\$6=Inputs!\$B\$1,'Dashboard View'!\$L\$8=Inputs!\$D\$1),Display_Data!D10,IF(AND('Dashboard View'!\$L\$5=Inputs!\$A\$1,'Dashboard View'!\$L\$8=Inputs!\$D\$1),Display_Data!D11,D3))))))	=IF(AND('Dashboard Vi
17				
18	All = Item per PG per Branch			
19	NotItem = Parent Group per Branch			
20	NotItem&PG = Specific Branch			
21	Company = Company Overview			
22	Specific Item			
23	Specific Parent Group			

This table shows the formulas which are used for the Stock on Hand calculations. The two bottom rows calculate which of the top rows' data should be displayed. A look-up from the dashboard view then gets the information from this row and displays it on the dashboard view.