

UNIVERSITY OF ECONOMIC AND LAW
FACULTY OF INFORMATION SYSTEMS



REPORT OF PROJECT

PROJECT NAME:

**BUSINESS INTELLIGENCE SOLUTIONS FOR PURCHASING
PROCESS OF ADVENTURE WORKS CYCLE**

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Subject: Business Intelligence

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APPRECIATION

First of all, we would like to sincerely thank Mr. Nguyen Van Ho for allowing us to carry out the topic of strengthening subject knowledge in general, supported by Mr. Nguyen Van Tuyen - a technical lecturer who helped the group in the practice part, implementing the project and Mr. Nguyen Anh Nhat-tutor provided practical knowledge of the subject. However, there will inevitably be shortcomings in the knowledge that the team would like to practice and research to become more and more perfect in the implementation process. We promise to constantly learn and try to constantly hone our intellect, and cultivate more professional knowledge to become a better version of ourselves in the future.

From Group 4 – Otto - K19406C with admiration and respect

COMMITMENT

We can commit this is the research of the whole group. The research results and conclusions in the project are honest, not duplicated from any source and in any way. During the project implementation, we consulted some relevant documents to confirm the reliability of the topic. The references to sources have been cited and recorded following the regulations.

Ho Chi Minh City, May 2022

Group 4 – Otto - K19406C

TASK ASSIGNMENT SHEET

No.	Student Name	Task Name	% Completed
1	Phan Thị Hiền Mai	Keep track of various tasks and oversee all activities within a team. Analysis Data with PowerBI Write content in the report.	100%
2	Cao Huỳnh Thị Mỹ Nguyên	Collect information about the project. Analysis Data with SSAS technology. Write content in the report.	100%
3	Nguyễn Thị Duyên	Design Data Warehouse. Collect information about the project. Write content in the report.	100%
4	Hoàng Thị Tân Thanh	Write content in the report. ETL Data Warehouse Synthesize and edit other members' content. Summarizing the report's content. Design Powerpoint presentation.	100%
5	Phạm Văn Nguyễn	Collect information about the project. Format the report in Word. Write content in the report.	100%

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LIST OF ACRONYMS

No.	Abbreviation	Explanation
1	AWC	Adventure Works Cycles
2	BI	Business Intelligence
4	OLTP	Online Transaction Processing
5	OLAP	Online Analytical Processing
6	ETL	Extracts - Transforms - Load
9	SQL	Structured Query Language
10	SSAS	SQL Server Integration Service
11	SSIS	SQL Server Analysis Service
15	DW	Data Warehouse
16	KPI	Key Indicator Performance
17	MDX	Multi-dimensional Expression
18	IT	Information Technology

INTRODUCTION

Technology affects almost every aspect of 21st-century life, from communications, security, and retail, to food access and productivity. With the invention of the Internet of Things, Artificial Intelligence, Cloud Computing, and Big Data have made breakthroughs in the field of technology and people have been able to automate several efficient business processes. Thanks to technology, businesses have been able to create competitiveness in the market. In this project, the team will implement a BI solution to assist Adventure Works Cycle company in the purchasing decision process to ensure efficiency and efficiency as well as save company resources.

CHAPTER 1: PROJECT OVERVIEW

1.1. Business case for the project

In this project, the project team will work with Adventure Works Cycles, the fictitious company on which the AdventureWorks sample databases are based, which is created by Microsoft for studying and researching. About the context, Adventure Works is a multinational company and has a large scale. The company's product line includes 97 different brands of bikes, grouped into three categories: mountain bikes, road bikes, and touring bikes. The company is not only selling bicycles, but it also provides accessories, clothing, and components. Many of those things are made by vendors, so AdventureWorks stands as a reseller.

The customers of Adventure Works include over 700 stores and over 19000 individuals worldwide and its vendors are quantified around 100 vendors. The company manufactures and sells metal and composite bicycles to North American, European, and Asian commercial markets. While its base operation is located in Bothell, Washington with 290 employees, several regional sales teams are located throughout their market base. There are 2 business models in Adventure Works which are retail stores that sell bikes, and internet sales that serve individual customers. Usually, Adventure Works sells in bulk to retail stores, which acts as resellers for its products.

At present, Adventure Works Cycles is looking to broaden its market share by targeting its sales to its best customers, extending its product availability through an external website, and reducing its cost of sales through lower production costs.

The function which our team manages to work within this project is called "Purchasing" – a department which is responsible for the company's purchasing activities ensures adequate and timely supply of raw materials for production, goods for commercial activities. Purchasing is an activity that has a very important role

because it helps businesses balance their budgets, control revenue and expenditure, and ensure that business operations will be "profitable".

The main activities of this department are purchasing planning, building purchasing standards, researching, selecting suppliers, managing purchase contracts, controlling inventory, creating purchase orders and paying suppliers. Especially. In a manufacturing company like AWC, purchasing needs to procure all the materials needed first, then with all the “ingredients” gathered, the production department and sales department can start their work after.

To better understand the project, our team built a business case to give the project a better overview as well as summarize the problems that the BI solutions for the purchasing process will solve:

Project Business Case			
Project Name	Business Intelligence solutions for Purchasing process of Adventure Works Cycle		
Project Sponsor	Head of Sales Brian Walker	Project Manager	Phạm Nguyễn
Date of project Approval	1/4/2022	Last Revision Date	28/05/2022
Contribution to Business Strategy	<p>This business strategy will help contribute:</p> <ul style="list-style-type: none">● Enables organizations to leverage supplier relationships, support decision-making in purchasing, and select the right suppliers in need.● Allows access to the data, searches for suppliers in detail and quickly.		

	<ul style="list-style-type: none"> ● Improve productivity and restocking. ● Provide organizations with historical perspectives on business performance and provide predictive analysis of future operations. Thus, organizations can determine the volume of products in need and the real-time for purchasing. ● Boost sales by eliminating stock-out. ● Data is updated in real-time so other departments can see the relevant information they need to improve their processes. ● Collaborate better with the other departments and Finance in particular, as well as consolidate its strategic position within the company.
Options Considered	<p>Options considered included:</p> <ol style="list-style-type: none"> 1. Build a BI/DW system that fits the company's situation 2. Recommend some BI tools which help the company analyze the existing data (could train staff in need)
Benefits	<ul style="list-style-type: none"> ● Improve better sales strategy ● Reduce inventory costs. ● Increase supplier intimacy
Timescales	<p>According to the initial analysis, the system will take about 2 months to deploy the project.</p>

Costs	Software = \$20.778 Hardware = \$110.000 Total estimated cost = \$130.778
Expected Return on Investment	Year 1 = \$68.500 Year 2 = \$68.500 Year 3 = \$68.500 Year 4 = \$68.500 Year 5 = \$68.500
Risks	The system cannot meet all the needs of the sales team or the needs of customers There are additional costs incurred The project may be last longer than expected

Table 1. Business Case

1.2. Objectives of the project

1.2.1. General Objective

To build, deploy and operate business intelligence solutions to provide timely metrics, reports, and proactive alerts, enabling companies to reach their strategic goals by making substantiated decisions. In addition, the project will provide a comprehensive system of functions to meet the needs of clients, ready access to high-quality, relevant information, improve process optimization and resource management, leverage purchasing intelligence for value and performance. make intelligent, data-driven decisions, facilitate interdepartmental support and coordination.

1.2.2 Specific Objectives

- Enables organizations to leverage supplier relationships, support decision-making in purchasing, and select the right suppliers in need.
- Allows access to the data, search for suppliers in detail and quickly.
- Improve productivity and restocking.
- Provide organizations with historical perspectives on business performance and provide predictive analysis of future operations. Thus, organizations can determine volume of product in need and the real-time for purchasing.
- Boost sales by eliminating stock-out.
- Data is updated in real-time and so other departments can see the relevant information they need to improve their processes.
- Collaborate better with the other departments and Finance in particular, as well as consolidate its strategic position within the company.

1.3. Research Objects

- **Company:** A fictitious, multinational manufacturing company called Adventure Works Cycles.
- **Product and services providing:** Bicycle and several components, accessories and clothing are purchased from outside from vendors.
- **Database:** AdventureWorks Database is a sample database for Microsoft SQL Server 2008 to 2014. AdventureWorks database supports standard online transaction processing scenarios for a fictitious bicycle manufacturer - Adventure Works Cycles. Scenarios include Manufacturing, Sales, Purchasing, Product Management, Contact Management, and Human Resources. Due to the specification of the project, the project team only works in the Purchasing area

including the Purchasing team and relevant data that provided by the AdventureWorks database to meet the needs of the project

- **OLTP Database version:** 2014.
- **Sample Data Warehouse version:** 2014.

1.4. Scope of the project

The main functional scope is to support the Purchasing department in product purchasing process (a small process of Procurement) in an effective and efficient way. With the historical data collected in the Adventure Work database, the project will count on the data to generate precious and helpful information presented in the report to improve the decision-making of the department. Furthermore, the scope is about planning, analyzing, and evaluating the output information based on the relevant data and tools

1.5 Value and desired outcome of the project

By analyzing the company's situation and interviewing the managers of the Adventure Work Cycle company to take some specific outcomes of the BI solution, here are the list of things about the value and desired outcome of the project

- See reseller customer orders by year by customer territory, regardless of the sales rep assigned to the territory.
- See sales according to the new territory assignments, all the way back through history.
- Updating the higher-level data can drill down to detailed orders for individual reps.
- List of the customers in their territory ranked by orders.
- When any information in the price list changes, the system must update and report to the sales representatives to flag the changes and special offers.

- Advanced customer care systems can track calls by complaint type, product, sales area and customer to know customer satisfaction and product quality.
 - Upgraded international support trading system with English translated description below the products.
 - The system could analyze the report and provide the sales reps with almost all the information they need in a standard format with just a few keystrokes, providing standard information about the time zone changes of the customer. customers can get direct support from the head office quickly.
 - Easy access to basic sales data for the whole field organization.
 - Flexible reporting and analysis tools.
 - All the data in one place (especially sales and forecast data).
- ➔ The project implementation is expected to break even on the investment in three years and is expected to reach a profit of about \$68.500 per annum

1.6 Structure of project

Chapter 1: Introduction - Overview of the business case, related objectives, research scope of the project and expected outcome of the project.

Chapter 2: Theoretical basis –An introduction chapter on the definition relevant to a Business Intelligence area revolves around definition of Business Intelligence, ETL, Data Warehouse & Data Mart, Schemas, KPI, MDX language, OLAP technique and Business Data Analytics techniques to build a Business Intelligence support decision-making system and solution.

Chapter 3: Requirements analytics and introduction to BI solution - Analyze business requirements, technical requirements, and BI solutions needed for this project. 20

Chapter 4: Building data warehouse and integrating data - Detail about the building data warehouse process for the purchasing module as well as integrate data from the Adventureworks2014 data sample into our data warehouse.

Chapter 5: Data analytics – Implementation of SSAS technology and the MDX and OLAP technique to make a presentation for the information from the Data Warehouse and visualizing them in to help the manager make a better decision.

Chapter 6: Visualization and Forecasting - Visualize the requirements and significations of the report according to data in the data warehouse we built and using some BI tools to conclude statistical reports.

Chapter 7: Conclusion and future works - Present the results of the topic, the limitations of the topic, the practical meaning, and the next development direction of the topic.

CHAPTER 2: THEORETICAL BASIS

2.1 Overview about BI

2.1.1 What is BI?

Business intelligence (BI) is a technology-driven process for analyzing data and presenting useful information to help executives, managers and other end users make informed business decisions. The potential benefits of using BI tools include accelerating and improving decision-making, optimizing internal business processes, increasing operational efficiency, driving new revenues and gaining competitive advantage over business rivals. BI systems can also help companies identify market trends and spot business problems that need to be addressed. In short, BI technologies allow a business to view their operations, past, present and future. Over the past few years, BI has evolved to include more processes and activities to help improve performance. These processes include:

- **Data mining:** Using databases, statistics and machine learning to uncover trends in large datasets.
- **Reporting:** Sharing data analysis to stakeholders so they can draw conclusions and make decisions.
- **Performance metrics and benchmarking:** Comparing current performance data to historical data to track performance against goals, typically using customized dashboards.
- **Descriptive analytics:** Using preliminary data analysis to find out what happened.
- **Querying:** Asking the data specific questions, BI pulling the answers from the datasets.
- **Statistical analysis:** Taking the results from descriptive analytics and further exploring the data using statistics such as how this trend happened and why.

- **Data visualization:** Turning data analysis into visual representations such as charts, graphs, and histograms to more easily consume data.
- **Visual analysis:** Exploring data through visual storytelling to communicate insights on the fly and stay in the flow of analysis.
- **Data preparation:** Compiling multiple data sources, identifying the dimensions and measurements, preparing it for data analysis.

2.1.2 BI Architecture

Business intelligence architecture is a term used to describe standards and policies for organizing data with the help of computer-based techniques and technologies that create business intelligence systems used for online data visualization, reporting, and analysis.

One of the BI architecture components is data warehousing. Organizing, storing, cleaning, and extraction of the data must be carried by a central repository system, namely data warehouse, that is considered as the fundamental component of business intelligence.

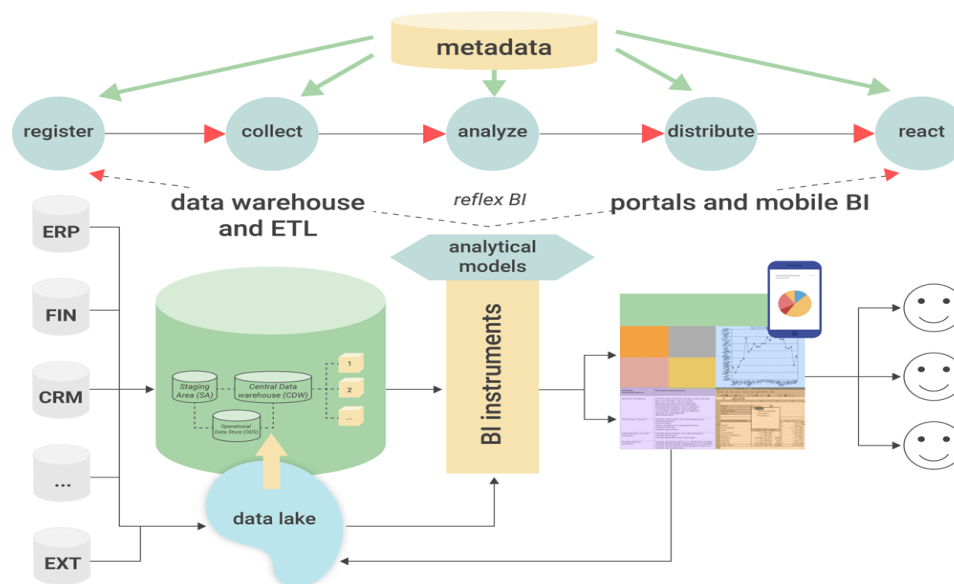


Figure 1. BI Architecture

The key elements of a business intelligence architecture are:

- Source systems
- ETL process
- Data modelling
- Data warehouse
- Enterprise information management (EIM)
- Appliance systems
- Tools and technologies

2.1.3 Advantage of BI in enterprises

Business intelligence processes help company or enterprise organize the data so it can be easily accessed and analyzed. Decision makers can then dig in and get the information in need quickly, empowering them to make informed decisions. A few ways that business intelligence can help companies make smarter, data-driven decisions:

- **Identify ways to increase profit:** BI tools can analyze inefficiencies and help expand margins. Aggregated sales data help companies to understand their customers and empowers sales teams to develop better strategies about where budgets should be spent.
- **Analyze customer behavior:** BI software can help companies understand customer behaviors and patterns. Most companies are taking customer feedback in real time and this information can help businesses retain customers and reach new ones. These tools may also help companies identify buying patterns, which help customer experience employees anticipate needs and deliver better service.
- **Compare data with competitors:** The ability to manage and manipulate a large amount of data is a competitive edge in itself. Furthermore, budgeting, planning, and forecasting is an incredibly powerful way to stay ahead of the competition, goes way beyond standard analysis, and is also easy to perform with BI software.

Businesses can also track their competitor's sales and marketing performance and learn how to differentiate products and services.

- **Track performance:** Businesses can gauge employee productivity, revenue, overall success as well as department-specific performances. It can uncover strengths and weaknesses since BI tools help organizations understand what's working and what isn't. Setting up alerts is easy and can help track these metrics and help busy executives stay on top of the KPIs that matter the most to their business.
- **Optimize operations:** BI tools unify multiple data sources, which help with a business's overall organization so that managers and employees spend less time tracking down information and can focus on producing accurate and timely reports. Armed with up to date and accurate information, employees can focus on their short and long-term goals and analyze the impact of their decisions.
- **Predict success:** Competitors move quickly and it's important for companies to make decisions as quickly as possible. Failure to issues with accuracy and speed could lead to lost customers and revenue. Organizations can leverage existing data to deliver information to the right stakeholders at the right time, optimizing time-to-decision
- **Spot market trends:** Identifying new opportunities and building out a strategy with supportive data can give businesses a competitive edge, directly impact long-term profitability, and gives the full scope of what is happening. Employees can leverage external market data with internal data to detect new sales trends by analyzing customer data and market conditions, as well as spotting business problems.
- **Discover issues or problems:** Data is rarely squeaky clean and there are many ways that discrepancies and inaccuracies can show up – especially with a hacked together “database”. Businesses that take care of collecting, updating and creating quality data are typically more successful. With BI software, companies

can aggregate different data sources for a fuller picture of what is happening with their business.

2.1.4 BI Strategy for Business

A BI Strategy is a roadmap that enables businesses to measure their performance and seek out competitive advantages and truly "listen to their customers" using data mining and statistics. Success occurs from systematically approaching the project with a defined BI strategy, including discovery, planning, and measured execution.

The BI strategy needs to first align with the business goals and vision. With business intelligence, data can drive transformation in the organization. This initiative will place trusted, relevant data in the hands of employees so informed decisions can be made every day. The Blueprint below will show some crucial steps to build a BI strategy:

- *Choose a sponsor*
- *Choose a BI platform*
- *Identify the key stakeholders and get them involved*
- *Assemble a BI team*
- *Define a scope of BI*
- *Prepare data infrastructure*
- *Develop a business intelligence roadmap*

2.2 ETL Process

2.2.1 What is ETL?

Extraction-Transformation-Loading (ETL) tools are pieces of software responsible for the extraction of data from several sources, their cleansing, customization and insertion into a data warehouse

As the databases grew in popularity in the 1970s, ETL was introduced as a process for integrating and loading data for computation and analysis, eventually becoming the primary method to process data for data warehousing projects.

ETL provides the foundation for data analytics and machine learning workstreams. Through a series of business rules, ETL cleanses and organizes data in a way which addresses specific business intelligence needs, like monthly reporting, but it can also tackle more advanced analytics, which can improve back-end processes or end user experiences. ETL is often used by an organization to:

- ***Extract*** - Extract the data from multiple data sources and connectors
- ***Transform*** - Transform it using the power and scalability of the target cloud platform
- ***Load*** - Load it into the cloud data warehouse

2.2.2 Why do we need ETL?

The importance of ETL in an organization is in direct proportion to how much the organization relies on data warehousing. ETL tools collect, read, and migrate large volumes of raw data from multiple data sources and across disparate platforms. They load that data into a single database, data store, or data warehouse for easy access. They process the data to make it meaningful with operations like sorting, joining, reformatting, filtering, merging, and aggregation. Finally, they include graphical interfaces for faster, easier results than traditional methods of moving data through hand-coded data pipelines.

ETL tools break down data silos and make it easy for your data scientists to access and analyze data and turn it into business intelligence. In short, ETL tools are the first essential step in the data warehousing process that eventually lets you make more informed decisions in less time

2.2.3 ETL Process

ETL processes the streaming data in a very traditional way. It is mainly used for data cleansing, data processing and data loading into the target database. Data analytics and machine learning work streams are built on top of ETL. Here the loaded data is meaningful data that will be used by the end user for different purposes. Below are the main three stages of an ETL Process – a paradigm to process data:

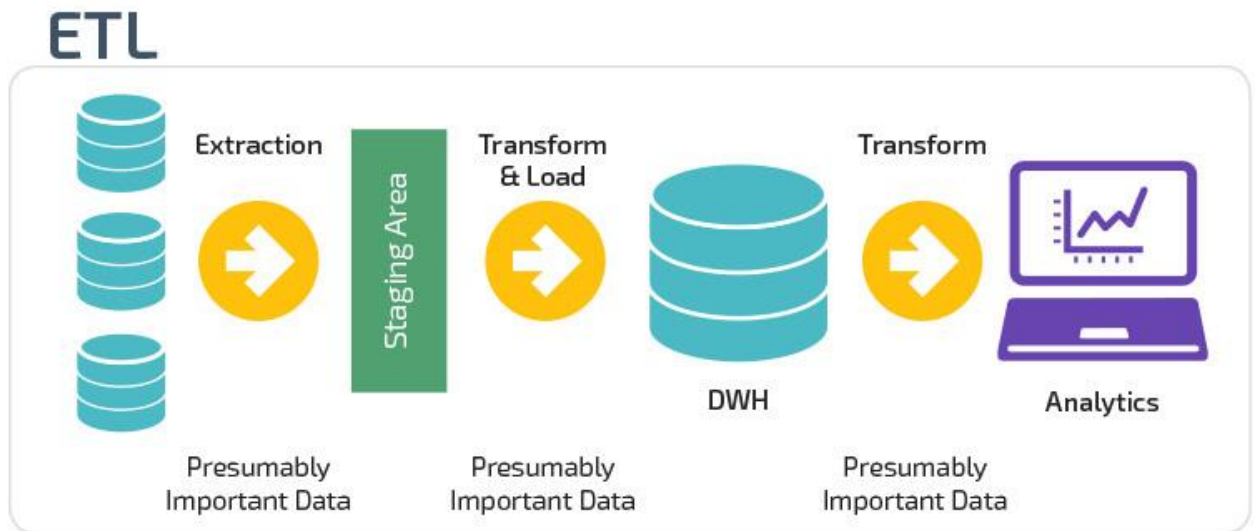


Figure 2. ETL Process

a. Extraction

Data is captured/extracted from the legacy systems according to the business intelligence requirements with the help of various data analysis tools. The most important step for a successful ETL Process is to extract data and process data from various data sources and Data engineers are responsible to extract data periodically. What to extract depends on the available data sources and business requirements.

To filter the raw data, validation rules are applied in the Extraction process. The extraction process may have to modify the validation rules to accept data for moving to the next phase based on business requirements. It is not a one time process, changes are applied from the source at a regular time period.

There are various methods available to apply changes on extracted data from multiple data sources:

- Notifying System
- Incremental Update
- Full Extraction
- Online Extraction

It is not necessary to store data directly to the traditional data warehouses sometimes according to requirement it is stored into the “*Warehouse Staging Area*” which is a temporary data storage part of the Data Warehouse. During this stage, we are allowed to generate audit reports for data diagnosis.

b. Transformation

Extracted Data needs to be transformed into a structured format that is compatible with the predefined Data Warehouse format while ensuring the data quality.

In this phase, a set of rules are applied to transform data into meaningful and structured data which will be used to gain business processes.

It includes following steps that are applied to transform data:

- **Cleaning:** Data Mapping of particular values by code (i.e. null value to 0, male to ‘m’, female to ‘f’) to ensure data quality.
- **Deriving:** Generate new values using available values (e.g. Total from price and quantity).
- **Sorting:** Sort data according to some specific value for fast retrieval.
- **Joining:** Integrate data elements of multiple sources and generate default values (lookup & merge) while maintaining data quality.

- Generate *surrogate key* values for uniformity in semantics and performance.
- **Validation:** During refreshment of DW, some values may be changed which would cause inconsistency in DW. By applying validation rules, we can preserve old values in other fields and replace the original value with new values to handle the “Slowly Change Dimension” problem. There are also more solutions available for this problem nowadays.

After completion of each step, data will be stored into a staging area for further processing. In case of any failure, the transformation process will be resumed from staging.

c. Loading

Structured/Transformed data will be loaded to its appropriate table in the Data Warehouse.

Data consistency must be maintained because records may be updated at loading time also the referential integrity should be maintained to preserve data consistency.

The Loading stage could also be used to load data and migrate data to Data Marts (Subject Oriented Data). Loading of transformed data can be performed in two ways:

- Record by record
- Bulk Load

Bulk load is the most preferable strategy to load data in the warehouse in order to improve performance since it provides less overhead than Record by record strategy.

To improve query performance data tables should be partitioned while loading data to the target system. Table partitioning may depend on time interval strategy (intervals like year, month, quarter etc.).

2.3 Data warehouse and Data mart

2.3.1 What are Data warehouse and Data mart?

a) Data Warehouse

A Data Warehouse collects and manages data from varied sources to provide meaningful business insights. It is a collection of data which is separate from the operational systems and supports the decision making of the company. In Data Warehouse data is stored from a historical perspective. The data in the warehouse is extracted from multiple functional units. It is checked, cleansed and then integrated with Data warehouse system.

Three main types of Data Warehouses (DWH) are:

- Enterprise Data Warehouse (EDW]
- Operational Data Store
- Data Mart

b) Data Mart

A data mart is a simple form of a Data Warehouse. It is focused on a single subject. Data Mart draws data from only a few sources. These sources may be central Data warehouse, internal operational systems, or external data sources. A Data Mart is an index and extraction system. It is an important subset of a data warehouse. It is subject-oriented, and it is designed to meet the needs of a specific group of users. When compared Data Mart vs Data Warehouse, Data marts are fast and easy to use, as they make use of small amounts of data.

There are three types of data marts:

- Ependent
- Independent
- Hybrid

2.3.2 Snowflake and Star schemas

- **Star schema** is the type of multidimensional model which is used for data warehouse. In star schema, the fact tables and the dimension tables are contained. In this schema fewer foreign-key join is used. This schema forms a star with fact table and dimension tables.
- **Snowflake Schema** is also the type of multidimensional model which is used for data warehouse. In snowflake schema, the fact tables, dimension tables as well as sub dimension tables are contained. This schema forms a snowflake with fact tables, dimension tables as well as sub-dimension tables.

NO	Star Schema	Snowflake Schema
1.	In star schema, the fact tables and the dimension tables are contained.	While in snowflake schema, the fact tables, dimension tables as well as sub dimension tables are contained.
2.	Star schema is a top-down model.	While it is a bottom-up model.
3.	Star schema uses more space.	While it uses less space.
4.	It takes less time for the execution of queries.	While it takes more time than star schema for the execution of queries.

5.	In star schema, Normalization is not used.	While in this, both normalization and denormalization are used.
6.	The design is very simple.	The design is complex.
7.	The query complexity of star schema is low.	While the query complexity of snowflake schema is higher than star schema.
8.	Its understanding is very simple.	While it's understanding is difficult.
9.	It has fewer number of foreign keys.	While it has more number of foreign keys.
10.	It has high data redundancy.	While it has low data redundancy.

Table 2. Schema Comparison

2.3.3 Who needs Data warehouse and Data mart?

a) Data warehouse

DWH (Data warehouse) is needed for all types of users like:

- Decision makers who rely on mass amount of data
- Users who use customized, complex processes to obtain information from multiple data sources.
- It is also used by the people who want simple technology to access the data
- It also essential for those people who want a systematic approach for making decisions.

- If the user wants fast performance on a huge amount of data which is a necessity for reports, grids or charts, then Data warehouse proves useful.
- Data warehouse is a first step If you want to discover ‘hidden patterns’ of data - flows and groupings.
- Some of the most common areas where data warehouses are used: Airline, Banking, Healthcare, Public sector, Investment and Insurance sector; Retail chain, Telecommunication, ...

b) Data Mart

A data mart is created and managed by the specific business department that intends to use it. As these tasks happen within their respective departments, the teams don't need access to all enterprise data.

2.3.4 Advantages and disadvantages of Data warehouse

a) Advantages

- Speedy Data Retrieving
- Error Identification & Correction
- Easy Integration
- Analytical tool support
- Real-time performance
- Security
- Auditing support

b) Disadvantages

- Time Consuming Preparation
- Difficulty in Compatibility

- Maintenance Costs
- Limited Use Due to Confidential Information

2.4 KPIs

2.4.1 KPIs Definition

"A quantifiable measure used to evaluate the success of an organization, employee, etc. in meeting objectives for performance."- Oxford's Dictionary

Key Performance Indicators (KPIs) are the main instruments of Business Performance Management. KPIs are the measures that are translated to both the strategy and the business process. These measures are often designed for an industry sector with the assumptions about business processes in organizations. Organizations use KPIs to evaluate success at reaching targets. High-level KPIs may focus on the overall performance of the business, while low-level KPIs may focus on processes across departments like sales, marketing, HR, or support.

2.4.2 The advantages and disadvantages of KPIs

a. The advantages of KPIs

- ***Quick understanding of complex statues:*** There are two things many organizations can probably agree on: efficiency is important, and time is money. KPIs are incredibly useful for assessing the many intertwining processes and activities going on in organizations that can help save time and increase efficiency in management.
- ***Goal formulation and implementation measurement:*** Goal setting is an important management tool. Goals only make sense when their implementation and progress can also be measured. This is why KPIs are the tool of choice for goal - setting and progress monitoring: they help define the steps that are needed to reach particular goals and are ideally embedded into broader strategic considerations.

- ***Increasing in communication efficiency:*** Communication takes time, particularly in complex and unpredictable situations. In a VUCA world, communication is key to ensuring quick adaptation to new circumstances. KPIs can boost efficiency in communication when a sound (team) mental model is in place. In other words, when groups share understandings and visions of how to achieve certain tasks, agreeing on KPIs can boost teamwork, morale and output
- ***Sound basis for decision-making:*** One of the biggest issues in decision-making is bias. This is particularly evident in the field of management. When properly formulated, KPIs can help minimize bias and focus on facts and figures. This form of evidence-based management helps increase the quality of decisions and reduces uncertainty by managing risks.
- ***Ease of formulation and devise:*** KPIs are not complex in themselves – in fact they are easy to create and to “set up”. A brief analysis of the situation at hand is the starting point to creating a key performance indicator

b. The disadvantages of KPIs

- ***Oversimplification of issue complexity:*** The main mechanism behind using a KPI is the aggregation of complex information into one number that reflects the entity’s status. While this simplifies complexity, it can also lead to the loss of important information. This is crucial to be aware of in decision-making
- ***Forgery:*** KPIs reflect the status of an entity on a high level – their use is usually not questioned and numbers stand as they stand. This makes KPIs an easy target for manipulation
- ***Misinterpretation:*** Organizational management and organizational processes using key performance indicators requires a well-aligned team or group within the organization who all share the same understanding of the KPI. If this is not the case, misinterpretations and misunderstandings can take place, which not only hamper decision-making efforts but can also lead to team conflict.

- ***One KPI is usually not sufficient to understand the whole entity:*** While one of the advantages of KPIs is simplicity, there are two sides to this: simplicity may lead people to believe that KPIs are also easy to understand and analyze, and that it is consequently also easy to draw conclusions from KPIs. This is not the case. Organizations are usually much more complex than one single KPI can grasp. Consequently, it is important to look at a set of KPIs and to consider their shortcomings

2.4.3 Categories of KPIs (Purchasing, Production, Sales, or HR)

a) Purchasing KPI

In the past, purchasing departments were sometimes regarded as potential sources of minor cost savings (usually through cost reduction), rather than sources of value creation and strong return on investment (ROI). But through the use of modern automation technology and the widespread adoption of more nuanced evaluation of data gathered from Key Performance Indicators (KPIs), everything from inventory control to supply chain management can be tracked as a source of both substantial savings *and* continuous improvement.

Not all purchasing KPIs are created equal, of course. Identifying and tracking the most lucrative and productive indicators will give your procurement department the information it needs to streamline your procurement processes, improve efficiency, and achieve a better procurement ROI. To maximize value, efficiency, and cost management throughout the procurement cycle, focus on these KPIs:

Purchase Order KPIs	Supplier KPIs	Procurement ROI KPIs
<ul style="list-style-type: none"> • Purchase Order Cycle Time • Average Cost of Processing a Purchase Order 	<ul style="list-style-type: none"> • Number of Vendors • Supplier Capacity 	<ul style="list-style-type: none"> • Cost Avoidance • Cost Reduction

<ul style="list-style-type: none"> • Purchase Orders Processed Electronically 	<ul style="list-style-type: none"> • Supplier Compliance Rate 	<ul style="list-style-type: none"> • Total Procurement ROI
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Table 3. Purchasing KPIs

b) Production KPI

Nowadays, the controlling and optimizing the whole production process, ensuring that the equipment works at an optimal level, and maintenance costs continually decrease, are essential elements of positive growth in the industry. Turning to manufacturing analytics is a certain way that this growth can be achievable by utilizing interactive metrics and automating many aspects of data management. Creating reports, combining multiple data sources, and consolidating various touchpoints is possible thanks to modern KPI software. Here is the complete list of the production KPIs:

- Production volume
- Production downtime
- Capacity utilization
- On standard operating efficiency
- Overall operation efficiency
- Overall equipment effectiveness
- Machine downtime
- Unscheduled down time
- Machine set up time
- Inventory turns
- Inventory accuracy
- Quality
- Rework
- Scrap
- Fail audits
- On-time delivery
- Customer returns
- Training hours
- Employee turnover
- Reportable health & Safety incidents
- Revenue per employee
- Profit per employee
- Return on assets
- Maintenance cost

c) Sales KPI

Sales key performance indicators (Sales KP) will enable organizations/enterprises to manage the sales more effectively and optimize as well as analyze every single sales process in detail. Here is the complete list of the sales KPIs:

- Sales growth
- Sales target
- Customer acquisition cost
- Average revenue per unit
- Customer lifetime value
- Customer churn rate
- Average sales cycle length
- Lead-to-Opportunity ratio
- Opportunity-to-Win ratio
- Lead conversation ratio
- Number of sales opportunities
- Sales opportunity score
- Average purchase value
- Revenue per sales rep
- Profit margin per sales rep
- Upsell & Cross- Sell rates
- Incremental sales by campaign

d) Human Resource KPI

Human Resources key performance indicators (HR KPIs) are HR metrics that are used to see how HR is contributing to the rest of the organization. This means that a KPI in HR measures how successful HR is in realizing the organization's HR strategy.

The HR strategy follows the organizational strategy. In other words, HR KPIs mirror organizational performance for HR, as they are defined based on the HR outcomes that are relevant to achieve business goals. These business goals are often formulated in the Balanced Scorecard. A list below will show some components of HR KPIs:

- Absence rate
- Absence cost
- Benefits satisfaction
- Employee productivity rate
- Employee satisfaction index
- Employee engagement index
- Employee innovation index
- Internal promotion rate
- Percentage of cost of the workforce
- Quality of hire
- Net promotion score
- Turnover rate
- Involuntary turnover rate
- Unwanted turnover rate
- Training effectiveness
- 90-day quit rate

2.5 MDX language for analyzing multidimensional data and OLAP

2.5.1 What is MDX language?

Multidimensional Expressions (MDX) is a query language for handling multidimensional data. Microsoft uses this language to work with these types of data sets in server analysis. Multidimensional data is created when the contents of a data set exceed two dimensions, and when traditional Structured Query Language (SQL) no longer serves as a sufficient extractor

2.5.2 OLAP technique

Data warehousing and on-line analytical processing (OLAP) are essential elements of decision support, which has increasingly become a focus of the database industry. Many commercial products and services are now available, and all of the principal database management system vendors now have offerings in these areas. Decision support places some rather different requirements on database technology compared to traditional on-line transaction processing applications.

To facilitate this kind of analysis, data is collected from multiple data sources and stored in data warehouses then cleansed and organized into data cubes. Each OLAP cube contains data categorized by dimensions (such as customers,

geographic sales region and time period) derived by dimensional tables in the data warehouses. Dimensions are then populated by members (such as customer names, countries and months) that are organized hierarchically. OLAP cubes are often pre-summarized across dimensions to drastically improve query time over relational databases.

2.5.3 MDX method and structure

As the SELECT statement in MDX specifies a result set that contains a subset of multidimensional data returned from the cube, to define this set an MDX query must contain the following clauses:

- **WITH clause:** allows to calculate of the named sets during the processing of the SELECT and WHERE clauses;
- **SELECT clause:** identifies which dimension members will be included in each axis for the MDX query structure;
- **FROM clause:** names the queried cube and determines which multidimensional data source to use for filling SELECT MDX statement result set.
- **WHERE clause:** defines which dimension or member is used as a slicer dimension (the slicer usually refers to the axis formed by the WHERE clause).

2.6 Azure Analysis Service

Azure Analysis Services is a fully managed platform as a service (PaaS) that provides enterprise-grade data models in the cloud. Use advanced mashup and modeling features to combine data from multiple data sources, define metrics, and secure your data in a single, trusted tabular semantic data model. The data model provides an easier and faster way for users to perform ad hoc data analysis using tools like Power BI and Excel.

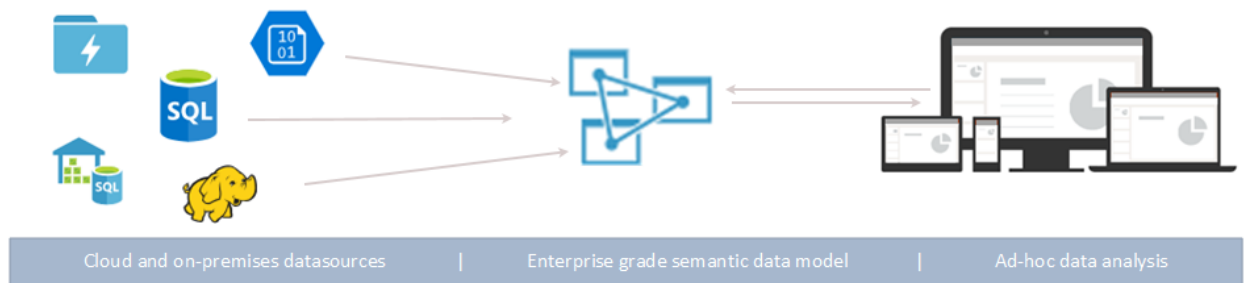


Figure 3. Azure Analysis Service

❖ **Features**

- **Get started quickly and scale with efficiency**

Use Azure Resource Manager to create and deploy an Azure Analysis Services instance within seconds, and use backup restore to quickly move your existing models to Azure Analysis Services and take advantage of the scale, flexibility and management benefits of the cloud. Scale up, scale down, or pause the service and pay only for what you use.

- **Transform complex data into one version of the truth**

Combine data from multiple sources into a single, trusted BI semantic model that's easy to understand and use. Enable self-service and data discovery for business users by simplifying the view of data and its underlying structure.

- **Match performance to the speed of business**

Reduce time-to-insights on large and complex datasets. Fast response times mean your BI solution can meet the needs of your business users and keep pace with your business. Connect to real-time operational data using Direct Query and closely watch the pulse of your business.

- **Provide secured access anytime, from anywhere**

Make sure only authorized users can access your data models, no matter where they are, with role-based security and Azure Active Directory support. With 99.9% availability, your users can access critical information when they need it.

- **Accelerate time to delivery**

Release your BI solutions in a predictable and highly-secured way. Use the robust application lifecycle management capabilities to govern, deploy, test, and deliver your BI solution quickly and with confidence.

- **Develop in a familiar environment**

Focus on solving business problems, not learning new skills, when you use the familiar, integrated development environment of Visual Studio. Easily deploy your existing SQL Server 2016 tabular models to the cloud.

CHAPTER 3: REQUIREMENTS ANALYTICS AND INTRODUCTION TO BI SOLUTION

3.1. Business processes of Purchasing

3.1.1 Purchasing department

A purchasing department is the division of a company that's responsible for acquiring the goods and services the business requires to operate. Some companies refer to purchasing departments as procurement departments or buying departments. These units are often an important part of helping companies meet their daily needs and their long-term strategic goals. How much responsibility a department has can vary on the size of the company, but they often help monitor the supply chain and help manage vendor contracts to keep the company's operations efficient.

3.1.2 The purpose of Purchasing

A company's purchasing department may have a large influence on its ability to reach its strategic and daily operational goals. The purchasing department will be responsible for selecting suppliers, negotiating and managing long-term contracts, monitoring supplier performance, ordering suppliers and maintaining good relationships with them. For example, its ability to acquire enough materials at the right time, in the right quantity, in the right quantity while lowering costs can allow a company to raise its profits, lower its expenditures and achieve growth. Purchasing departments can use their contacts with suppliers to improve the overall quality of a business' product and lower risks in a company's operations by effectively managing these relationships.

Purchasing departments manage a variety of roles in a company, depending on its type or size. Some of their additional functions and roles include:

- 1. Assessing the needs of their company*
- 8. Obtaining subsidies and benefits*

- | | |
|--|----------------------------------|
| <i>2. Conducting research</i> | <i>9. Maintaining compliance</i> |
| <i>3. Comparing and negotiating prices</i> | <i>10. Improving quality</i> |
| <i>4. Coordinating deliveries</i> | <i>11. Managing budgets</i> |
| <i>5. Managing supplier relationships</i> | <i>12. Developing strategies</i> |
| <i>6. Managing competition</i> | <i>13. Maintaining records</i> |
| <i>7. Monitoring performance</i> | |

3.1.3 Purchasing process

The purchasing process is a procedure for buying goods and services.

Traditionally, the purchasing process is a cycle, with each step requiring the exchange of information and various approvals to move forward. Every business will have its own unique touches to add, but generally speaking, the purchasing process follows a well-established pattern of events.

The kinds of purchases may not be the same. Some of the purchase types are:

- Individual or Personal Purchases
- Commercial Purchases
- Industrial Purchase
- Government Purchase

Here are the 9 Steps of a Purchasing Process

Step 1: Examination of the needs

The procurement squad describes the requirement needed.

Step 2: Purchase Requisition to Purchase Order

The purchasing process includes the part of ‘ ‘purchasing’ with a purchase request given to the purchasing manager or department of purchasing by a team,

individual, or other departments. The purchase request or requisition includes the complete detail on the products or services to be acquired.

Step 3: Review and Approval of the Purchase Order

The approved purchase orders are transmitted to the accounting team for verifying the funds whether it exists in a correct budget or not to cover the order of the item.

a) Pre-Screening Process

This method includes the cancellation criteria. It can be based on specific geographic location, technical skills, etc. The first selection is followed through various criteria analysis for evaluation of the left candidates.

b) Precise analysis of each one

A person purchasing something establishes some criteria and examines the performance of every company. Though, the importance of each criterion varies. For the routine purchase, prices and timelines are the main attributes before the reputation of the supplier.

For the goods that need changes in the internal operating process, the main criteria are the suppliers; adaptability, technical help, reliability of the goods. It is best to find the total cost of commercial condition and acquisition. Before that, it is necessary to ask the suppliers for precise costing. The payment terms must be acceptable. Lastly, it is vital to ensure that the timeline is correct.

Adaptability, sustainability, and financial security are the key factors that you should take into account at this stage.

❖ Objective criteria to Analyze:

- Price
- Easy maintenance
- Geographic Location
- Reliability

- Terms and conditions
- Delivery time respect
- Easy operation
- Product quality
- Technical specifications

❖ *Subject criteria to Analyze*

- Already existing relationship
- The reputation of the supplier
- Competence
- Interlocutors' personality

Step 4: Proposal Requests

The purchase orders that get budget approval are made to return to the procurement team. They make a Request for Proposal (RFP).

The items are dispatched for soliciting bids to the vendors for fulfilling the order of the products or services. The supplier submits their bidding and reviews based on the compliance records, reputation, price, performance history.

Step 5: Agreement of Negotiation and approval

The appropriate vendor who wins the winning bid gets the contract. The agreement has to be mutually satisfactory for both parties. After the contract is signed, the Purchase order gets a legally binding contract between the seller and the buyer.

Step 6: Shipping and receiving the products

Within the agreed timeframe, the suppliers supply the goods or services. In case of issues, the consumer notifies the vendor.

Step 7: Matching in a 3 Way System

There is a 3-way matching system that revolves around the comparison of three things. It ensures that the transaction is perfect and correct. Those are:

- Shipping documents
- The packing slips along with the actual purchase order
- A supplier invoice

Step 8: Approval of Invoice and Payment

The order that matches, get approval for payment. If any additional charges or other modifications are there, then it needs another step of approval. Once it gets approved, the payment gets issued to that vendor. These payments capture early discounts or any incentive to avoid late amounts.

Step 9: Securing Record Updates

The completed orders get recorded in the books of the organization. The documents of the transaction are stored securely in a location.

3.2 Data source and challenges

3.2.1. Data source

There are 2 databases provided by Microsoft for Adventure Works, which are AdventureWorks and AdventureWorks Data Warehouse (DW). Researcher uses the updated version of Adventure Works which is for AdventureWorks 2014. Adventure Works 2014 database is an Online Transaction Processing (OLTP) database, which is rich in structure, content, and variety. While Adventure Works DW 2014 is a data warehouse, which is targeted for Online Analytical Processing (OLAP) and data mining.

The OLTP database consists of 71 tables that are grouped into different classification such as Sales, Purchasing, Production, Human Resources, and Person. The database (in its raw state) contains data of almost 20,000 people (employees,

customers, store contacts, vendor contacts, and general contacts). It also contains data of over 31,000 sales transactions to customers and over 4000 purchasing transactions from suppliers.

3.2.2. Challenges

The data source used to develop BI system is AdventureWorks DW 2014. This is an OLAP database. However, this database still needs to be organized by using data warehousing because this OLAP database still need to be configured in order to match and answer the project scope.

AdventureWorks 2014 is a rather large and complex dataset. Despite the plethora of resources and documentation, it's still quite complicated to get started.

3.3. Business Requirements Analysis for Purchasing

3.3.1. Stock control to support purchasing strategy

Stock (or inventory) control is concerned with how much stock you have at any given point in time, and how to keep track of it. The purpose of stock control is to reduce the costs of holding stock while ensuring you can meet the customer's demand and making sure that there's enough material for production. Businesses should always have a 'safety' amount of stock so that they're able to react and cover any unforeseen issues.

Low inventory level can lead to:

- Ineffective Decision Making
- Increased Lead Times and Stock-Outs
- Delays in Shipping and Delivery
- Increase Costs and Decrease Warehouse Organization
- Decrease in Customer Satisfaction

According to the specification, a minimum stock level should be identified and tracked continuously to re-order when stock reaches that level.

It is necessary to compare the existing quantity of product in inventory (Quantity.ProductInventory) with the SafetyStockLevel.Product to check the need for product replenishment for making purchasing decisions in real-time.

3.3.2. Improving Product Quality Management

Quality control (QC) is a process through which a business seeks to ensure that product quality is maintained or improved. Quality control creates safe measures that can be implemented to make sure deficient or damaged products do not end up with customers. Quality control protocols may help you lower your inspection costs and use your resources in a more cost-effective manner. By analyzing the attribute RejectedQty of the FactProductOrder table, we can determine the number of defective imports, thereby making solutions to solve the problems. The rejected quantity of product can have the following reasons:

- The products are not meet the quality of the organization
- The vendor sends the wrong kind of products
- Shipping mistakes

For instance, with the historical data of RejectedQty, the managers could define the product has the highest defect rate and so on they would decide to buy that kind of product from the vendors again or not. In addition, we can refer to the PreferredVendorStatus (Description: 0 = Do not use if another vendor is available. 1= Preferred over other vendors submitting the same product. Default: 1) attribute of the FactProductVendor table to get more information about the supplier with the corresponding priority to make a purchasing decision.

3.3.3. Criteria evaluation for vendors selection

The vendor selection process is one of the final steps in strategic sourcing. The goal of every procurement organization is to utilize limited resources most efficiently. This makes evaluating suppliers necessary to ensure the best contracts in terms of quality, costs, flexibility, and reliability. The supplier assessment process might be challenging, but the benefits of finding low-risk sources of high-quality goods and services plus mutually beneficial, long-term business relationships outweigh the efforts needed. Supplier evaluation criteria should align with the company's mission, vision, and business goals. With the historical data provided by the AdventureWork database, we could select many attributes to compare with the company's criteria for deciding to select the needed vendor. The manager could use single or combination of attributes for vendor selection decision-making. By analyzing the MinOrderQty and MaxOrderQty attributes of the FactProductVendor table from each vendor, the manager can identify whether that vendor is reliable enough or not, and can control the number of products that have been ordered to that vendor. The ActiveFlag attribute of the DimVendor table will show the vendor availability. Or to save on shipping costs, the manager could base on the DimVendorAddresses table to identify the vendor with a close distance. Or to compare the cost of the same product from different vendors, the manager could count on the StandardPrice attribute of the FactProductVendor table to find out which supplier has the most affordable price suited the purchasing budget. Furthermore, the CreditRating attribute of the DimVendor table (Description: 1 = Superior, 2 = Excellent, 3 = Above average, 4 = Average, 5 = Below average) could be one of the criteria to select vendor based on their reliable. The manager could also use the AverageLeadTime attribute to track the earliest time of the completed order for selection decision.

3.3.4. Price list comparison to support monthly report

Historically recorded data has always played an essential role in supporting analysis and decision-making. With standard price comparison tables contributed

by suppliers and collected through transaction history, the organization will generate monthly comparison reports and update prices regularly to reinforce smart purchasing strategies. By analyzing the StandardPrice attribute from FactProductVendor, the manager can track prices continuously and make purchasing decisions with preferential prices, bringing more profit to the organization. For instance, through the ups and downs of prices provided in the report, the manager will have an overview of product prices and consequently, with the support of others analytical data, a purchasing strategy will be implemented to meet the need of purchasing team

3.3.5. Ship Method comparison to support decision making

One of the key requirements in the purchasing department is choosing the most efficient and effective shipping method, to ensure the company can have the cost as low as possible. The ShipBase (Minimum Shipping Cost) attribute and Name attribute from the table FactPurchaseOrder (shipping method type) will help managers compare costs from different shipping methods. Based on the data history of recently completed orders through the Status attribute of the FactPurchaseOrder table (Status = 4 means the order is completed) to determine the aggregate of transactions made with different shipping methods attached. In summary, the manager can measure, and evaluate the shipping method which has the lowest cost or which one has the most transactions. Consequently, the manager will make decision to choose the appropriate shipping method to suit the budget of the strategy

3.4. IT requirements Analysis (IT & Infrastructure)

Request analysis is the process of clearly defining what to do and the objectives of the project. This is a necessary process to have a successful information system project.

3.4.1. The IT requirements for this project are:

- Identify the problem the company is facing and come up with a solution.

- Understand the project and take advantage of new functions, technologies and methods to solve problems.

Implement the project in accordance with requirements and schedule.

3.4.2. The infrastructure requirements for this project are:

- ***High availability and scalability:*** A system with a database that is always available and can be expanded quickly can help businesses minimize damage when something goes wrong.
- ***Server security:*** The organization data is important, so it is necessary to control and secure the server to avoid the attack of hackers.

3.5 Comparative Analysis of BI and Data Visualization Tools

3.5.1 Surveying and evaluation

Software	Price	Features	Time	User	Cloud
SQL Server	\$13,748	<p>Transform raw data, complex data into actionable information more easily.</p> <p>Allow users to quickly build business intelligence programs and test them.</p> <p>Allow to perform extract, transform and load</p>	Year	1	Supported

		operations (ETL) on data from data warehouses.			
Power BI	<p>Free: Power BI Desktop</p> <p>\$9,99: Power BI Pro</p> <p>\$20: Power BI Premium</p>	<p>Collaboration and analytics</p> <p>Build your business on secure data analytics</p> <p>Unify self-service and enterprise analytics</p> <p>Accelerate big data prep with Azure</p> <p>Find answers fast with industry-leading AI</p> <p>Improve publishing efficiency and accuracy of BI content</p> <p>Get unparalleled Excel integration</p> <p>Stream analytics in real-time</p>	Month	1	Supported

MS Excel	\$139,99 \$6,99 (per month with Microsoft 365)	Inserting a pivot table Sorting of tabulated data Adding formulas to the sheet Calculating large data	Lifetime Month	1	Supported
Microsoft Project Professional	\$10	Communication & Collaboration: Teams can work together on projects. Coauthoring: Stakeholders and team members work together to edit and update task lists and schedules. Reporting: Pre-built reports that can track progress, resources, programs, and portfolios. Roadmap: Track programs and project portfolios.	Month	1	Supported

		<p>Timesheets: Collect project and non-project time for payroll and invoicing.</p> <p>Resource Management: Manage resources by requesting and assigning tasks.</p>			
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Table 4. Surveying and evaluation tools

3.5.2 Proposing BI solution for the project

To meet the demand of the project, the project team will apply some tools including SQL Server, Power BI, Excel and Microsoft Project Professional to support the technical implementation through analyzing the AdventureWork database also visualizing the appropriate outcome results based on our expected requirements for the project. The tools discussed above are all popular software to serve users to use features to meet their work needs. The final results of the project are the precious information we achieved to support the decision-making of the Purchasing department with the assistance of the technical tools

CHAPTER 4: BUILDING DATA WAREHOUSE AND INTEGRATING DATA

In this chapter, we will present detail about the building data warehouse process for the purchasing module as well as integrate data from the Adventureworks2014 data sample into our data warehouse

4.1. Designing Data Warehouse

4.1.1. Bus Matrix

a) Business Process of Purchasing

- Receive Purchase Requisition (demand quantity)
- Send Purchase Order (choose vendor)
- Receive Goods Receipt (receive goods from vendor)
- Receive invoice
- Return Faulty Goods (inspection procedure to identify faulty product)
- Send payment

b) Common Dimensions

- PurchaseOrderDetail
- ShipMethod
- VendorAddress
- Time
- Vendor
- Product
- ProductInventory

- PurchaseOrderHeader

Business Process \ Common Dimension	Time	ShipMethod	Vendor	Product	ProductLocation
Receive Purchase Requisition	X			X	X
Send Purchase Order	X	X	X	X	
Receive Goods Receipt	X	X		X	
Receive invoice	X				
Return Faulty Goods	X		X	X	X
Send payment	X	X	X		

Table 5. Bus Matrix

By analyzing the Bus Matrix table above, we learn that the purchase module interacts with 5 common Dimensions tables such as time, product, vendor, ship method, product location. We will detail the data source to build these Dimension tables further in this chapter

4.1.2 Master Data

Master data is data used to build Dimension tables in the Data Warehouse including table:

No.	Objects	Description
1	Product	Product information.
2	ShipMethod	Information about shipment methods.
3	Vendor	Supplier's information.
4	ProductLocation	Inventory's location of information

Table 6. Master Data

4.1.3 Transaction Data

Transaction data is data used to build Fact tables in the Data Warehouse, including tables:

No.	Object	Description
1	ProductVendor	Information about supplier's products such as name, price, quantity, cost, etc.
2	UnitMeasure	Information about the unit measure.
3	ProductInventory	Information about the inventory such as quantity, shelf, bin, etc.
4	PurchaseOrder	A detailed description of each purchase order, it contains the purchase order detail and purchase order header relating to data such as: rejected quantity, received quantity, ship base, etc,

Table 7. Transaction Data

4.1.4. Fact and dimension tables

With the business requirements covered in chapter 3, information is collected to help users maintain and compare products from different suppliers, saving costs and increasing profits. Easily capture the flow of critical elements in several Dimensions required to build a Data Warehouse schema.

AdventureWorks2014		Purchase Otto		Data Type
Table	Column	Table	Column	
		DimProduct	ProductKey	Int
Product	ProductID		ProductID	Int
	ProductName		ProductName	nvarchar (50)
	ProductNumber		ProductNumber	nvarchar (25)

	SafetyStockLevel		SafetyStockLevel	smallint
	ReorderPoint		ReorderPoint	smallint
Product Inventory	ProductID	DimProductLocation	ProductID	Int
	LocationID		LocationKey LocationID	int
	Name		LocationName	nvarchar (50)
	Availability		Availability	decimal(8, 2)
		DimVendor	VendorKey	int
	BusinessEntityID		VendorID	int
Vendor	AccountNumber		AccountNumber	nvarchar (15)
	Name		VendorName	nvarchar (50)
	CreditRating		CreditRating	tinyint
	PreferredVendorStatus		PreferredVendorStatus	bit
	ActiveFlag		ActiveFlag	bit
Purchasing.vVendorWithContacts	ContactPerson		ContactPerson	nvarchar (50)
	PhoneNumber		PhoneNumber	nvarchar (50)
	EmailAddress		EmailAddress	nvarchar (50)

	City		City	nvarchar (30)
	Title		Title	nvarchar (8)
		DimShipMethod	ShipMethodKey	int
ShipMethod	ShipMethodID		ShipMethodID	int
	Name		ShipMethodName	nvarchar (50)
	ShipBase		ShipBase	money
	ShipRate		ShipRate	money
	ModifiedDate		ModifiedDate	datetime
		FactProductVendor	ProductVendorKey	int
ProductVendor	BusinessEntityID		VendorKey	int
	ProductID		ProductKey	int
	AverageLeadTime		AverageLeadTime	int
	StandardPrice		StandardPrice	money
	LastReceiptCost		LastReceiptCost	money
	LastReceiptDate		LastReceiptDate	datetime
	MinOrderQty		MinOrderQty	int
	MaxOrderQty		MaxOrderQty	int

	OnOrderQty		OnOrderQty	int
	UnitMeasureCode		UnitMeasureCode	nchar(3)
	ModifiedDate		ModifiedDate	datetime
Product	Name		ProductName	nvarchar(50)
Vendor	Name		VendorName	nvarchar(50)
	CreditRating		CreditRating	tinyint
	PreferredVendorStatus		PreferredVendorStatus	bit
	ActiveFlag		ActiveFlag	bit
UnitMeasure	Name		Name	nvarchar(50)
		FactProductInventory	ProductInventoryKey	int
	LocationID		LocationKey	int
	ProductID		ProductKey	int
ProductInventory	Shelf		Shelf	nvarchar(10)
	Bin		Bin	tinyint
	Quantity		Quantity	smallint
	ModifiedDate		ModifiedDate	datetime
Product	SafetyStockLevel		SafetyStockLevel	smallint

	ReorderPoint		ReorderPoint	smallint
Location	Name		LocationName	nvarchar(50)
		FactPurchaseOrder	PurchaseOrderKey	int
	BusinessEntityID		VendorKey	int
	ShipMethodID		ShipMethodKey	int
	ProductID		ProductKey	int
	Status		Status	tinyint
	ShipDate		ShipDate	datetime
	TaxAmt		TaxAmt	money
	Freight		Freight	money
	TotalDue		TotalDue	money
	OrderDate		OrderDate	datetime
PurchaseOrderDetail	DueDate		DueDate	datetime
	UnitPrice		UnitPrice	money
	LineTotal		LineTotal	money
	ReceivedQty		ReceivedQty	decimal(8, 2)
	RejectedQty		RejectedQty	decimal(8, 2)

	StockedQty		StockedQty	decimal(9, 2)
ShipMethod	ShipBase		ShipBase	money

Table 8. Fact and dimension tables

4.1.5. Data Warehouse model

By analyzing and describing the vital data source to build dimensions and morals for Data Warehouse. The recommended Data Warehouse model is the Galaxy model, Fact and Dim tables are clear and easy to understand.

The Fact tables analyze the important factor to help the manager's decision. The FactProductVendor table will help the manager to compare and evaluate the vendors. The FactPurchaseOrder will support the purchasing strategy of the purchasing department. The FactProductInventory will let the manager know the suitable time for purchasing product when compare the quantity in the inventory to the safety stock level. The Dimension tables offer the manager specific information in the purchasing process such as DimVendor, DimProduct, DimProductLocation, DimTime, and DimShipMethod. All the Dimension and Fact tables will be described in the diagram below

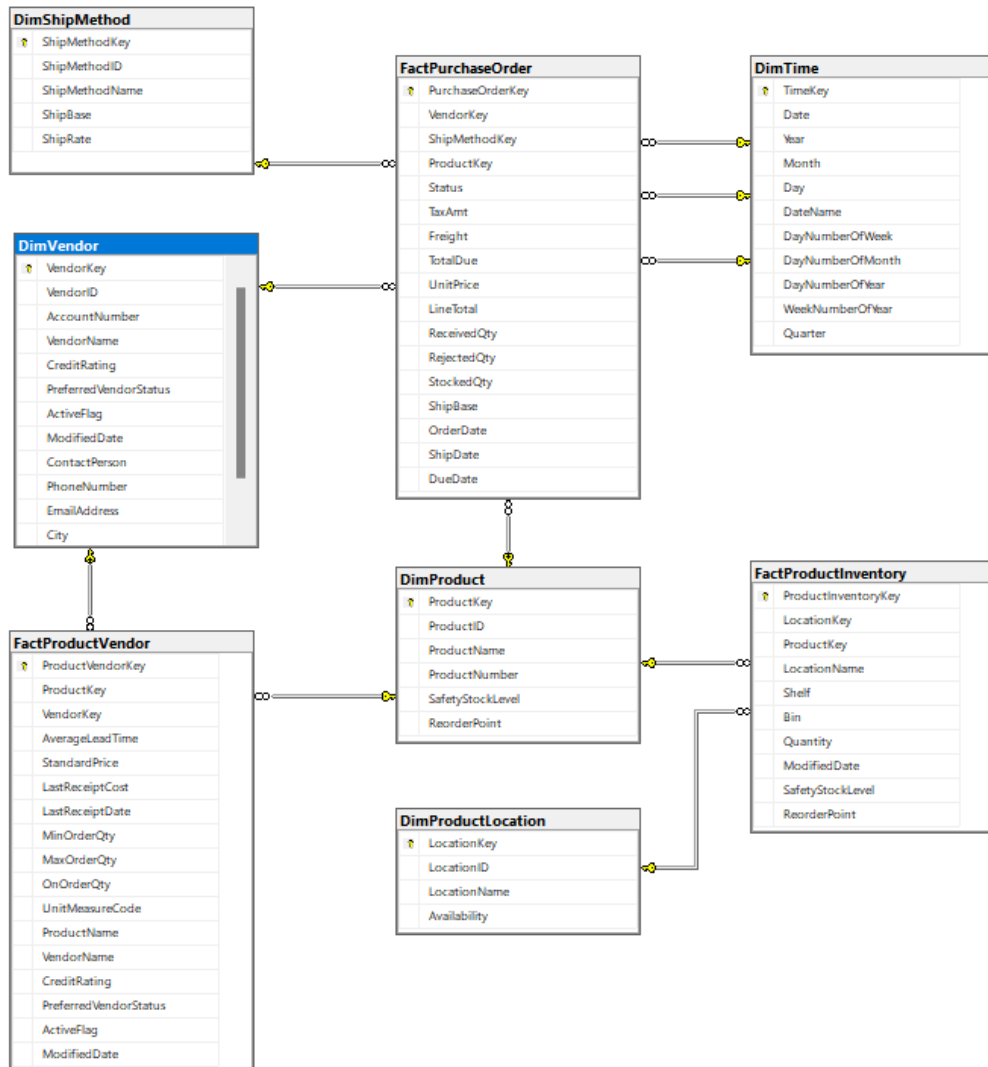


Table 9. Data Warehouse

The description of Dimension and Fact tables in the Data warehouse:

No.	Tables	Description
1	DimProduct	Specific information about the product.
2	DimProductLocation	Specific information about the inventory location
3	DimVendor	Specific vendor information.

4	DimShipMethod	Specific information about shipment method.
5	DimTime	Information about time.
6	FactProductInventory	Detailed information about the product inventory
7	FactPurchaseOrder	Detailed information about each purchase order.
8	FactProductVendor	Detailed information about each vendor's product.

Table 10. Description of tables in Data Warehouse

Using the described Dimension and Fact tables in the Data Warehouse, the manager can analyze necessary information about the current state of the procurement process to make a better decision to maximize the revenue for the company.

The relationships in Data Warehouse schema:

No.	Relationship	Relation type	Description
1	DimProduct – Fact ProductVendor	1-m	One product can have one or multiple rows in the Fact ProductVendor table, and each row in the Fact ProductVendor table only has one product.
2	DimVendor – Fact ProductVendor	1-m	One vendor can have one or multiple rows in the Fact ProductVendor table, and each row in the Fact ProductVendor table only has one vendor.

3	DimProduct – Fact ProductInventory	1-m	One inventory can have one or multiple rows in the Fact ProductVendor table, and each row in the ProductInventory table only has one product.
4	DimProductLocation – Fact ProductInventory	1-m	One location can have one or multiple rows in the Fact ProductVendor table, and each row in the FactProductInventory table only has one location.
5	DimProduct– FactPurchaseOrder	1-m	One product can have one or multiple rows in the Fact ProductVendor table, and each row in the FactPurchaseOrder table only has one product.
6	DimShipMethod– FactPurchaseOrder	1-m	One shipping method can have one or multiple rows in the Fact FactPurchaseOrder table, and each row in the FactPurchaseOrder table only has one shipping method.
7	DimVendor– FactPurchaseOrder	1-1	One vendor can have one or multiple rows in the Fact FactPurchaseOrder table, and each row in the FactPurchaseOrder table only has one vendor.

Table 11. Relationship in Data Warehouse

4.2. ETL processes

After building the Data Warehouse, the next step is using the SSIS (SQL Server Integration Service) tool to transfer data from the data source into the Data Warehouse. Later in this section, ETL processes will be presented to filter data in the Dim table and Fact table

4.2.1. Dimension table's ETL process

In this section, we will present the specific ETL process for Dimension tables by using the DimProduct table as an example:

- Step 1: Create a new SSIS package and name as DimProduct.dtsx

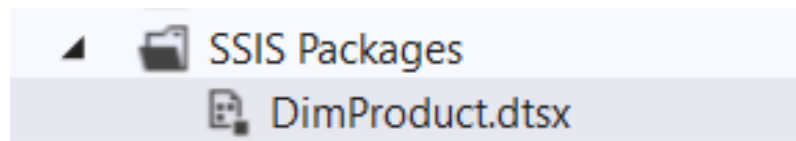


Figure 4. SSIS Packages

- Step 2: Drag and drop the Data Flow Task from the SSIS Toolbox into the Control Flow

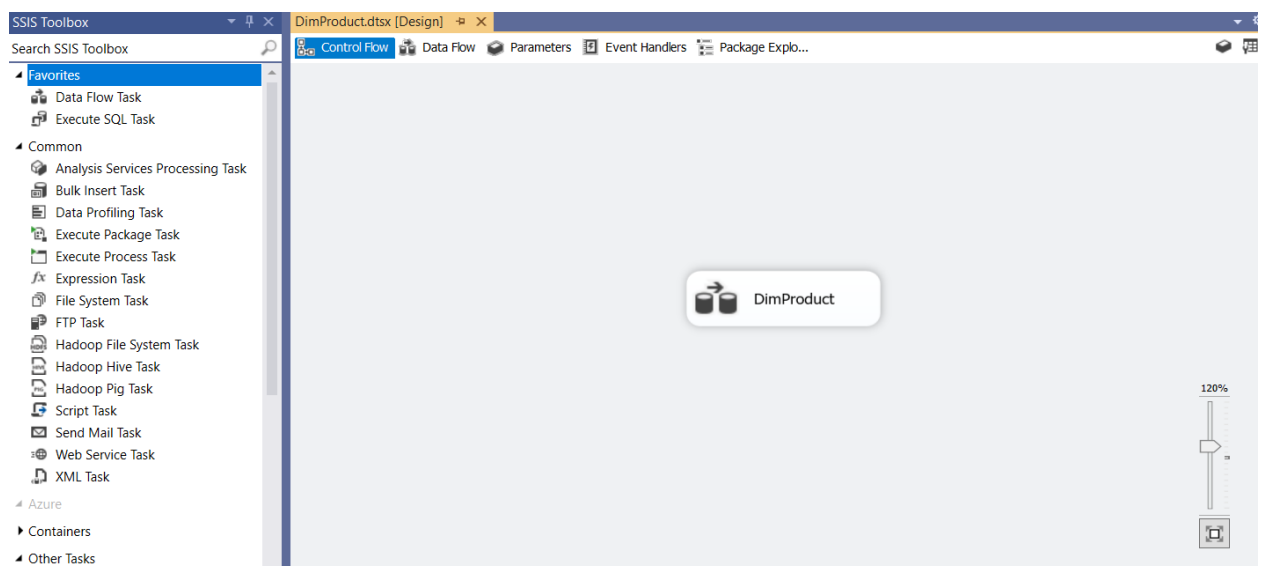


Figure 5. Data Flow Task

- Step 3: Double click on the Data flow Task to setup OLE DB Source. Drag and drop the OLE DB Source from the SSIS Toolbox into the Data Flow
 - Double click on the OLE DB Source to setup

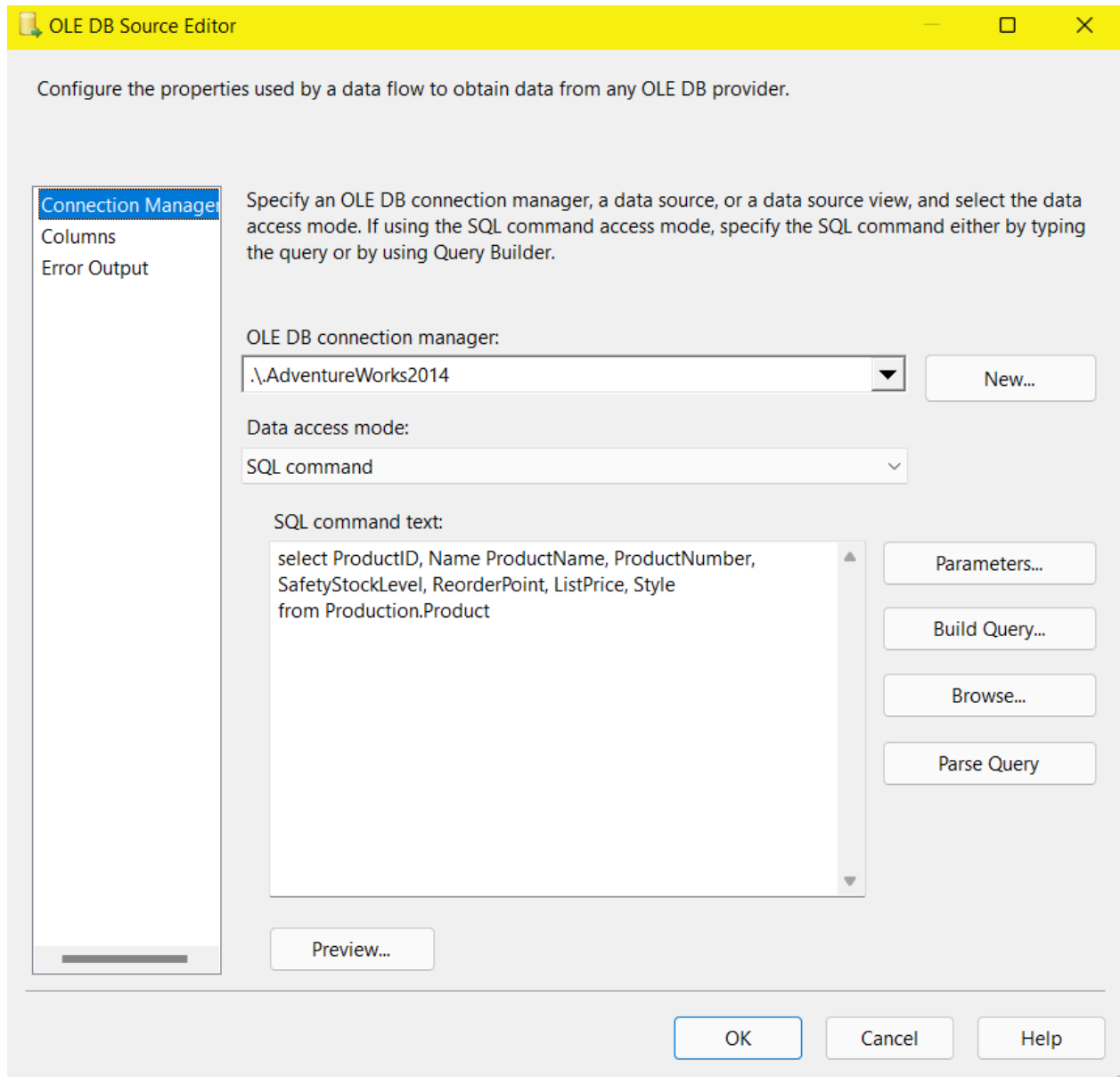


Figure 6. OLE DB Source Editor

- Step 4: Drag and drop the Slowly Changing Dimension and pull the blue arrow from the OLE DB Source to the Dimension
 - Double click on the Dimension to select the Data Warehouse connection that used for Dim Table.
 - Select compatible columns and choose business key

Select a Dimension Table and Keys
Select a dimension table to load and map columns in the

Connection manager: .\PurchaseOtto New...

Table or view: [dbo].[DimProduct]

Input Columns	Dimension Columns	Key Type
ListPrice	ListPrice	Not a key column
ProductID	ProductID	Business key
ProductName	ProductName	Not a key column
ProductNum...	ProductNumber	Not a key column
ReorderPoint	ReorderPoint	Not a key column
SafetyStock...	SafetyStockLevel	Not a key column
Style	Style	Not a key column

Help < Back Next > Finish >>| Cancel

Figure 7. Slowly Changing Dimension Wizard

- Click Next and choose then connection manager then select the Dimension columns and change its Change type into Changing a attribute
- Step 5: Click start to run the DimProduct table to see the result

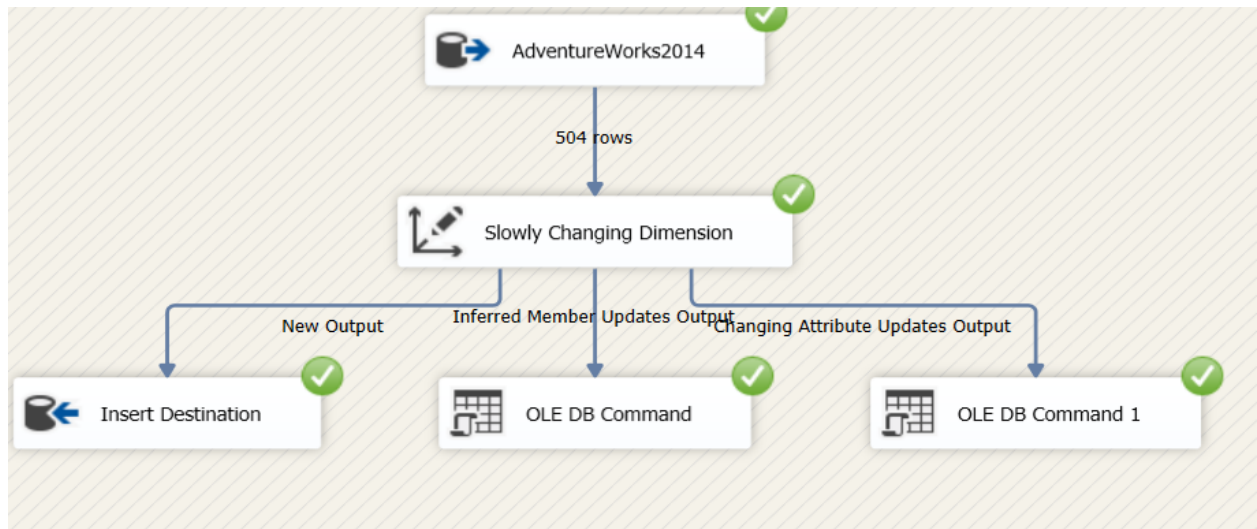


Figure 8. Execute Packages Successfully

- The DimProduct table will be dumped data successfully if it shows the result like in the picture

4.2.2. Fact table's ETL process

- Step 1: Create a new SSIS package and name as FactProductVendor.dtsx

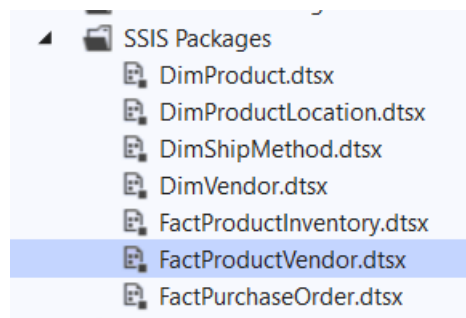


Figure 9. SSIS package of FactProductVendor.dtsx

- Step 2: Drag and drop the Data Flow Task from the SSIS Toolbox into the Control Flow

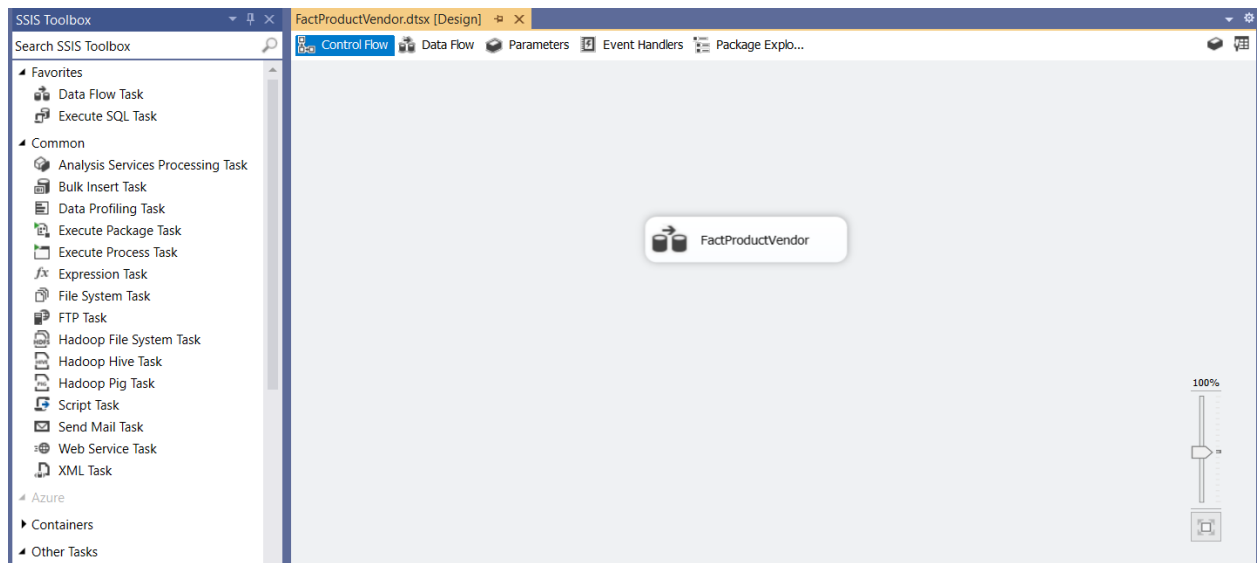


Figure 10. Data Flow Task of Fact table

- Step 3: Double click on the Data flow Task to setup OLE DB Source. Drag and drop 2 OLE DB Source from the SSIS Toolbox into the Data Flow
 - Double click on the OLE DB Source to setup. One connects to the Adventure Works database and the other connects to the Purchasing data warehouse

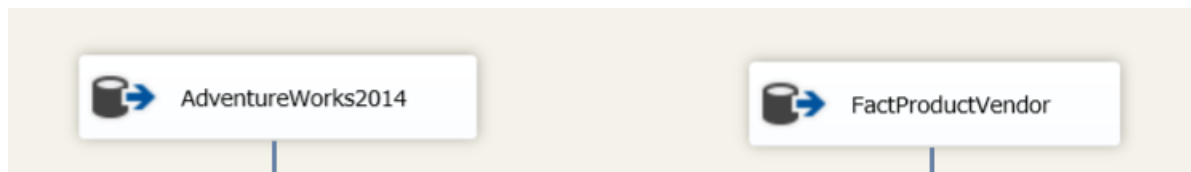


Figure 11. OLE DB Source of Fact table

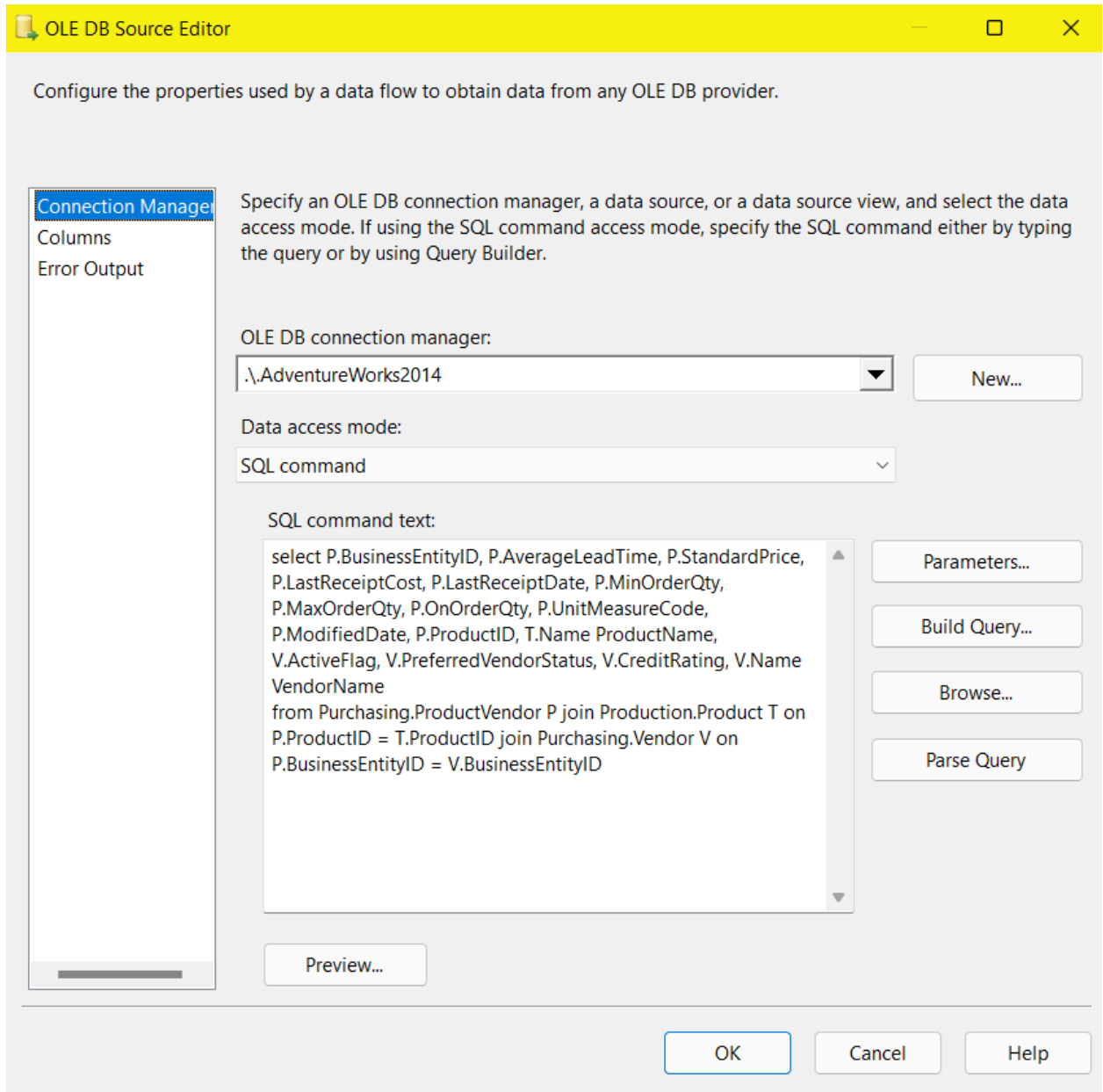


Figure 12. OLE DB Source Editor for Adventure Works 2014 database

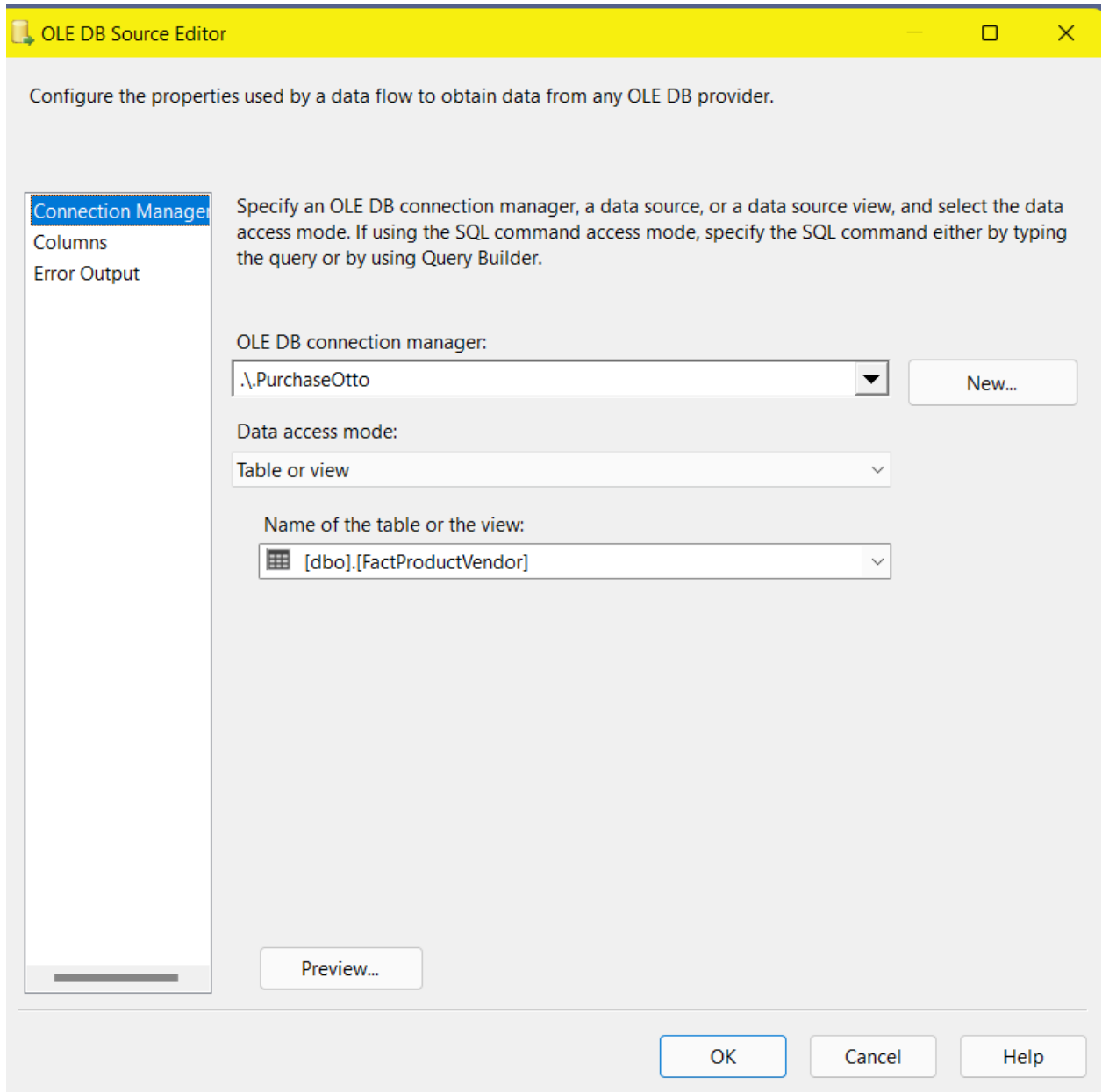


Figure 13. OLE DB Source Editor for data warehouse

- Step 4: Drag and drop the Lookup and pull the blue arrow from the OLE DB Source to the Dimension
 - Double click on the Lookup to setup. Connect to the data warehouse and pick the compatible Dim table in the tab Connection

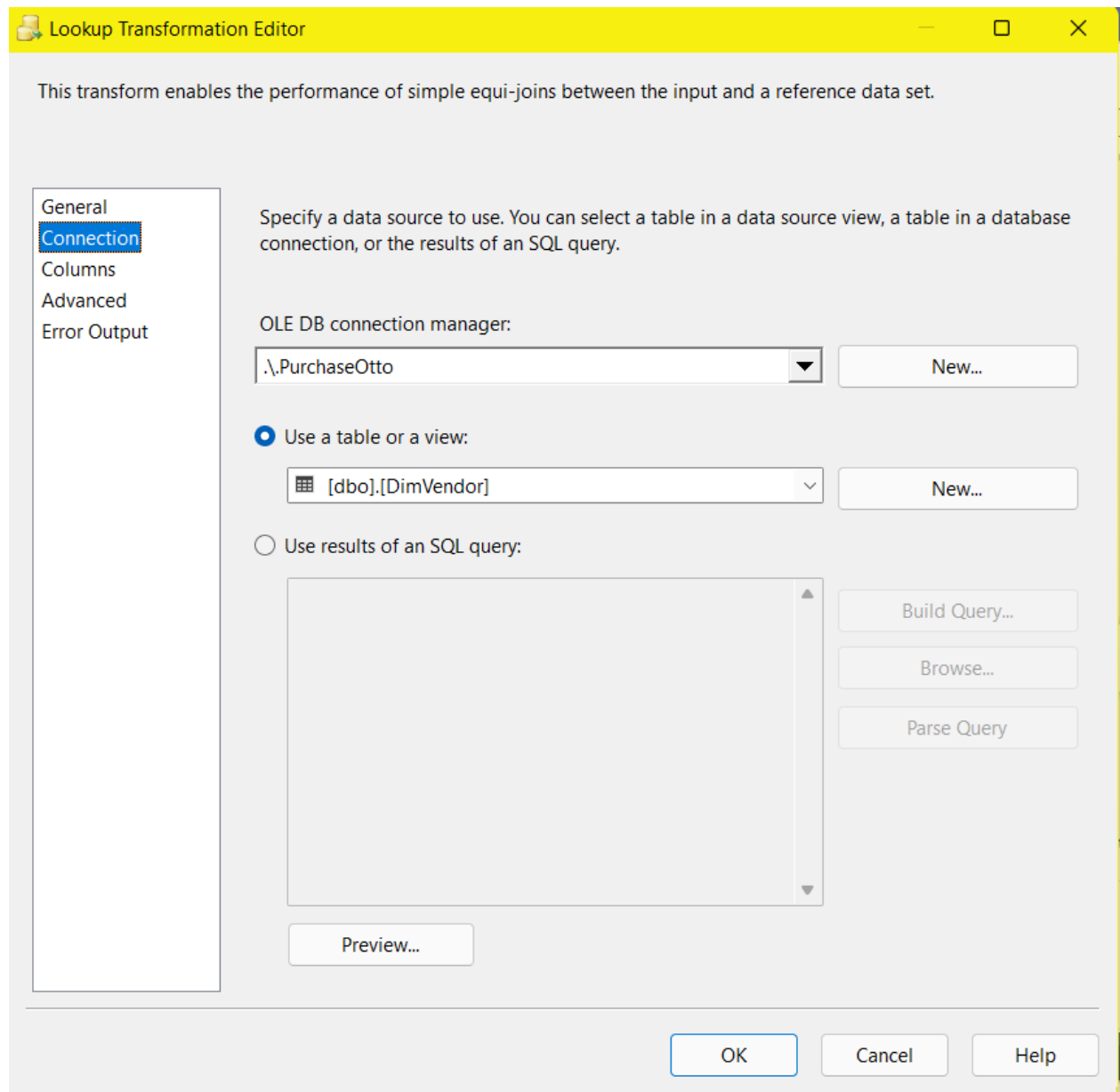


Figure 14. Lookup Transformation Editor 1

- In the tab columns, link the attribute ID to the other and tick on the Key attribute

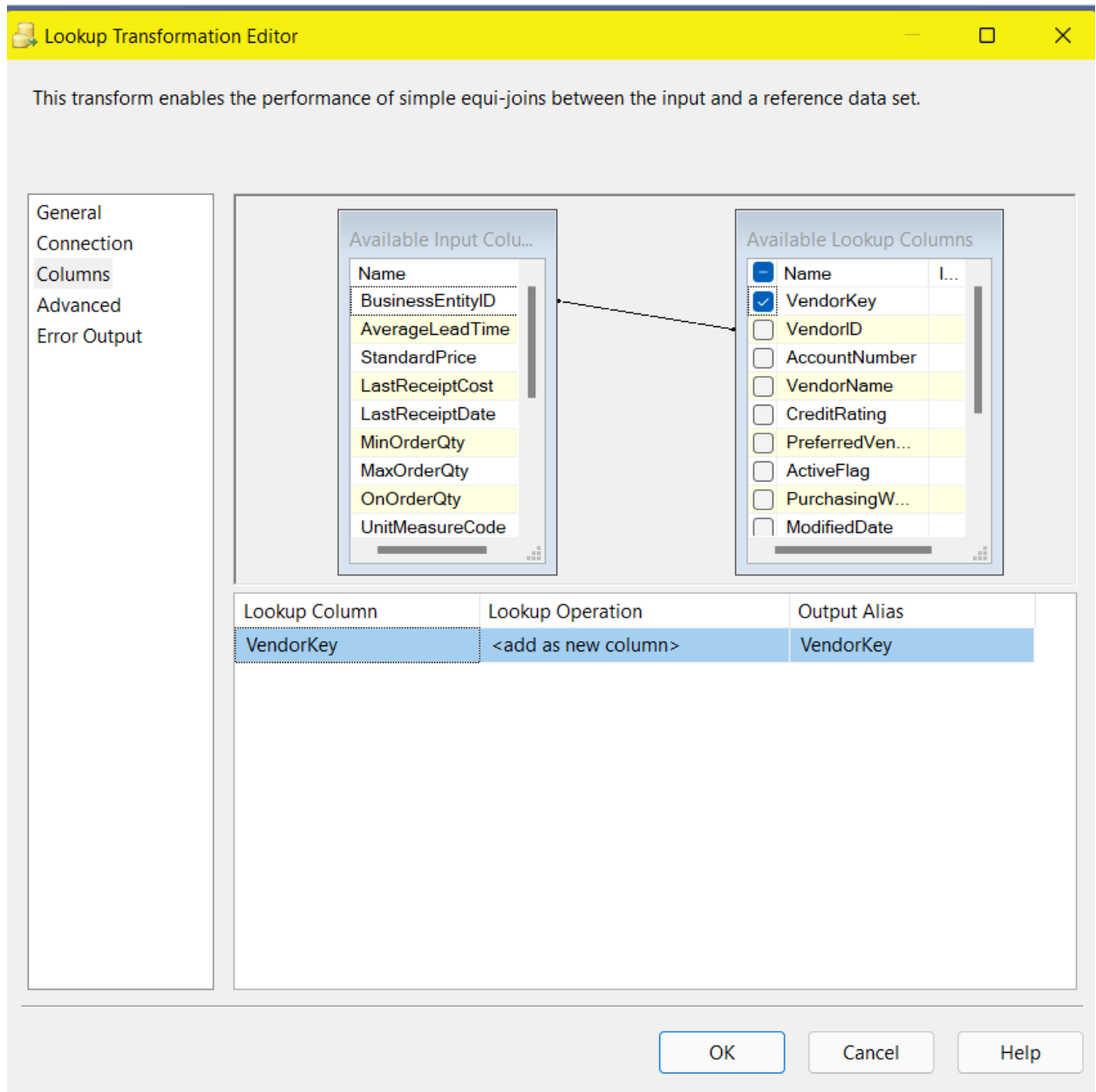


Figure 15. Lookup Transformation Editor 2

- ❖ Remember to drag and drop the Lookup compatible to the number of relationships between the Dim tables and Fact table
- Step 5: Drag and drop the Sort to setup based on the lookup key
 - Pull the arrow from the lookup to the sort and choose the lookup key

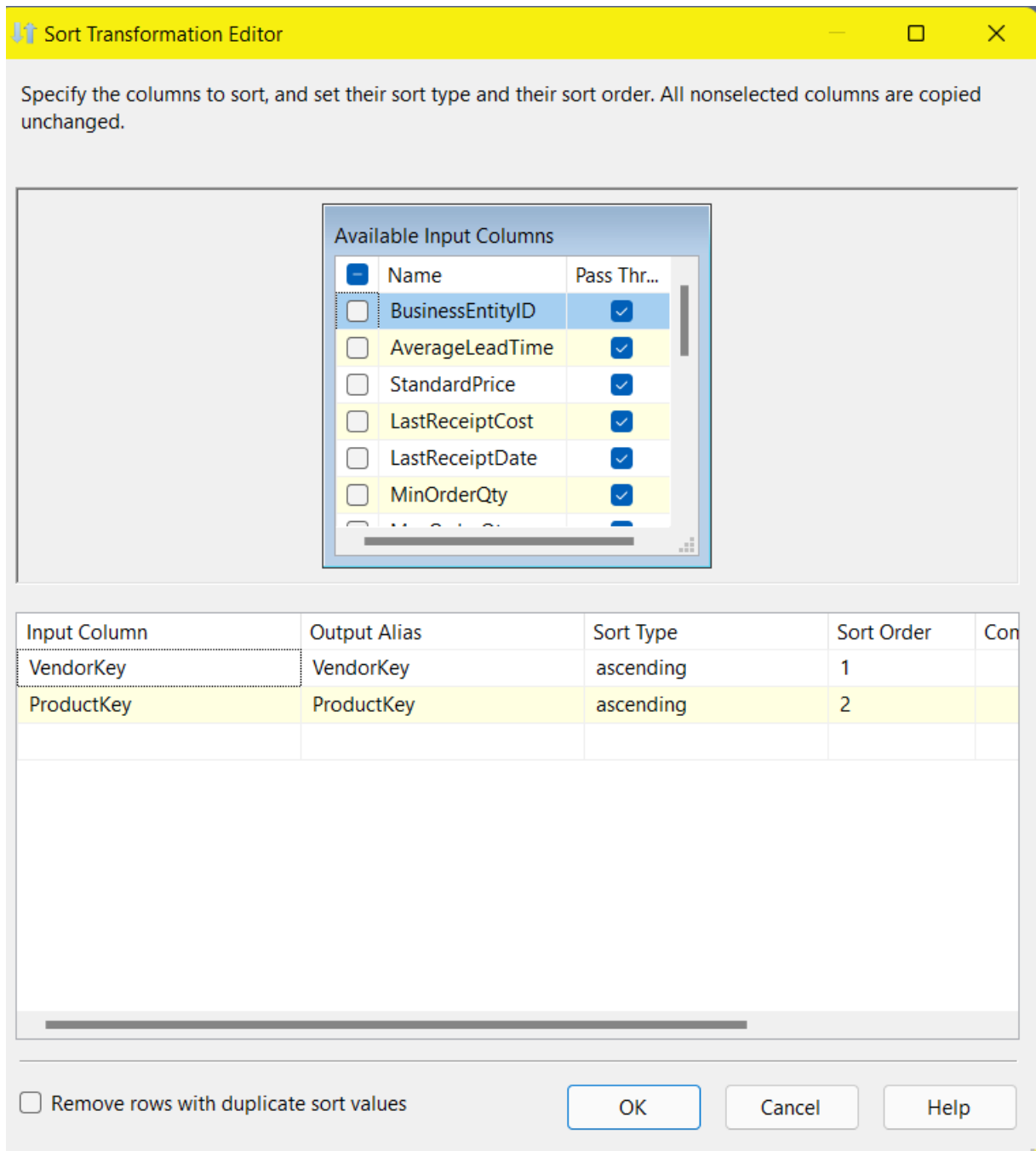


Figure 16. Sort Transformation Editor 1

- Drag and drop another sort and pull the arrow from the OLE DB Source (Purchasing data warehouse) to it and tick the compatible lookup key

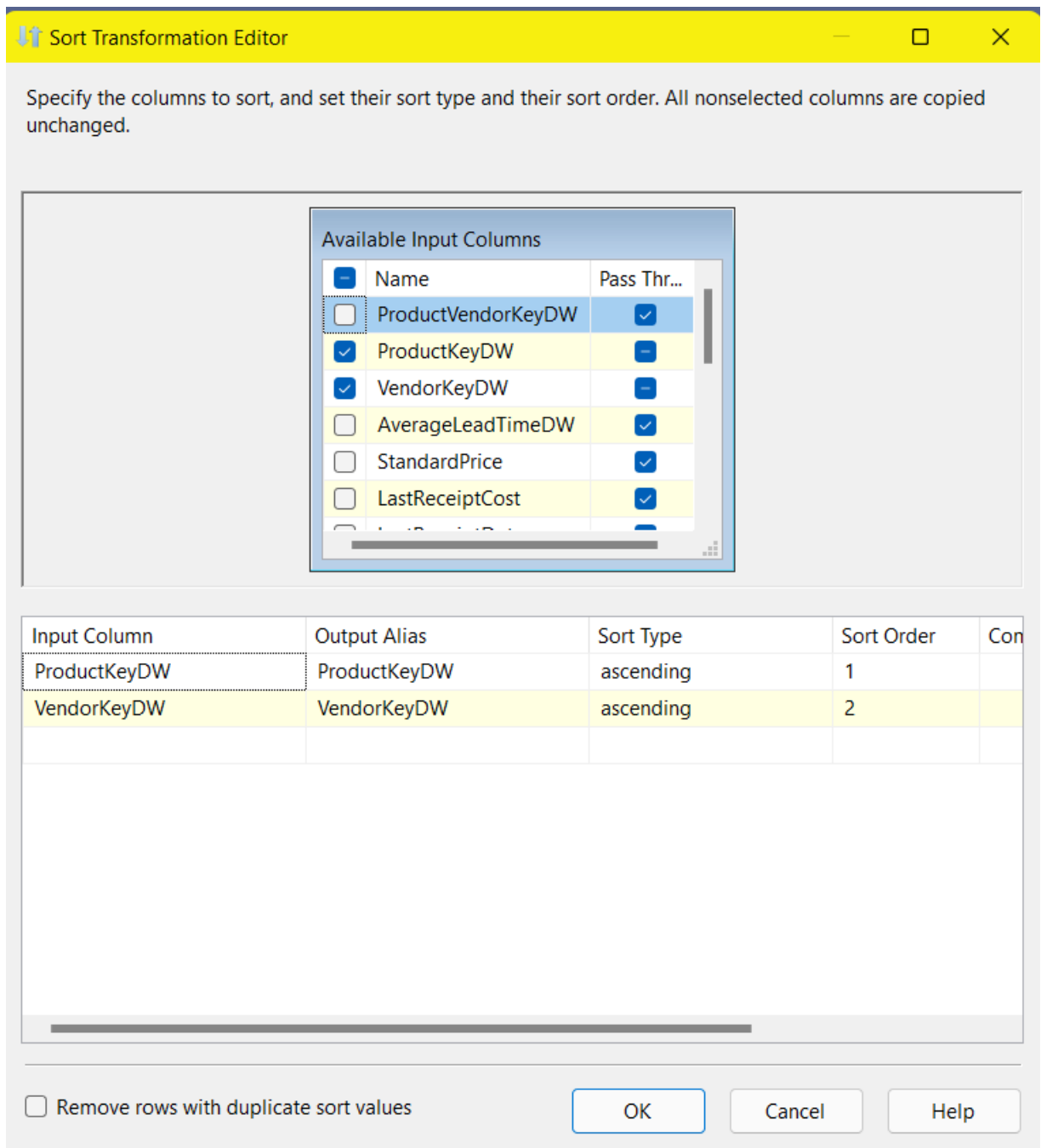


Figure 17. Sort Transformation Editor 2

- ❖ Remember to check the Sort Order from the 2 Sort to ensure the values are the same
- Step 6: Drag and drop the Merge join to synchronize data

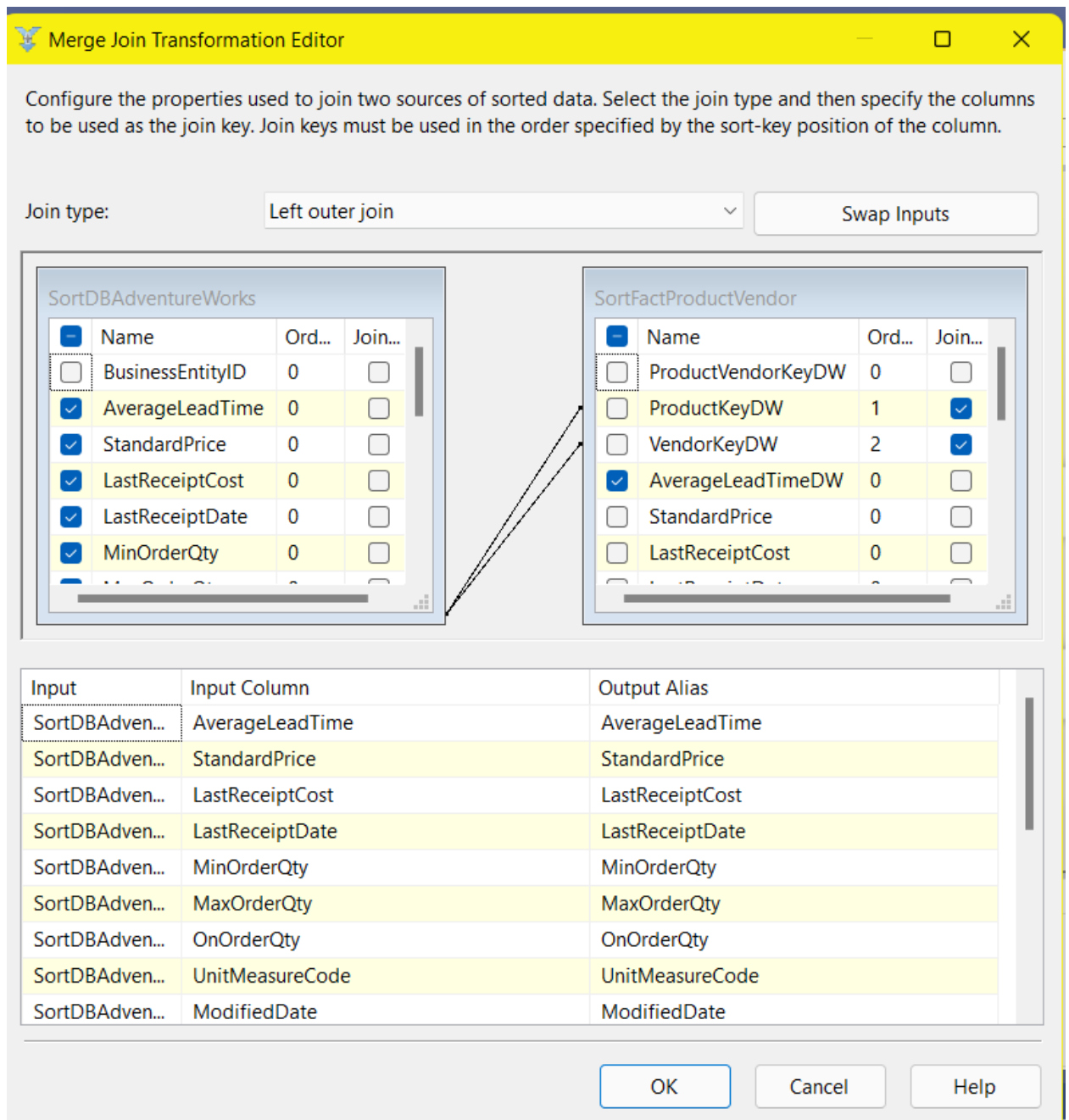


Figure 18. Merge Join Transformation Editor

- Step 7: Drag and drop the Conditional Split to setup
 - Pull the arrow from the Merge join to the Conditional Split
 - In the Output Name, there are 2 rows and the attached conditions

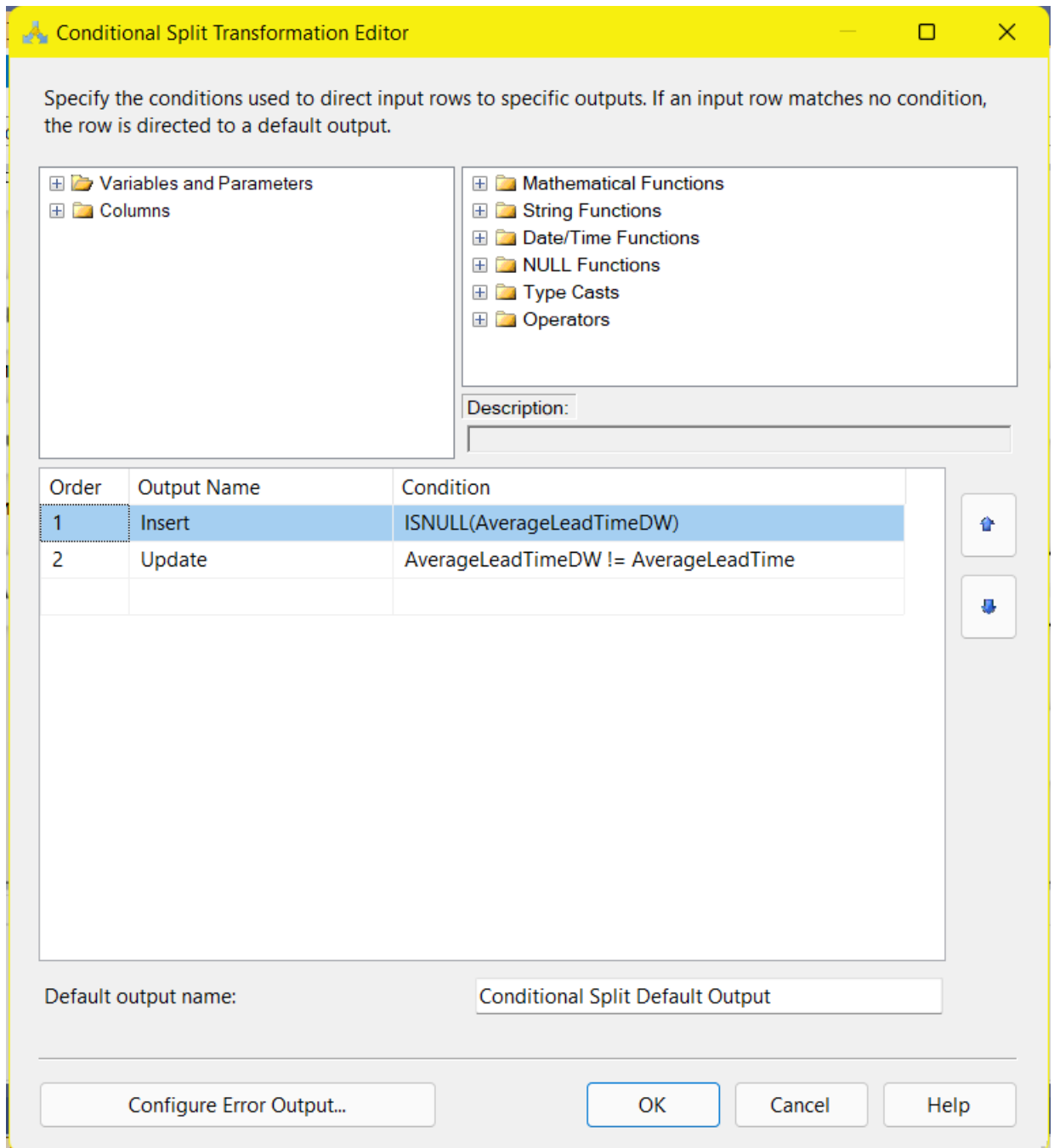


Figure 19. Conditional Split Transformation Editor

- Step 8: Drag and drop the OLE DB Destination to conduct inserting data
 - Connect to the data warehouse and check columns in the tab Mappings

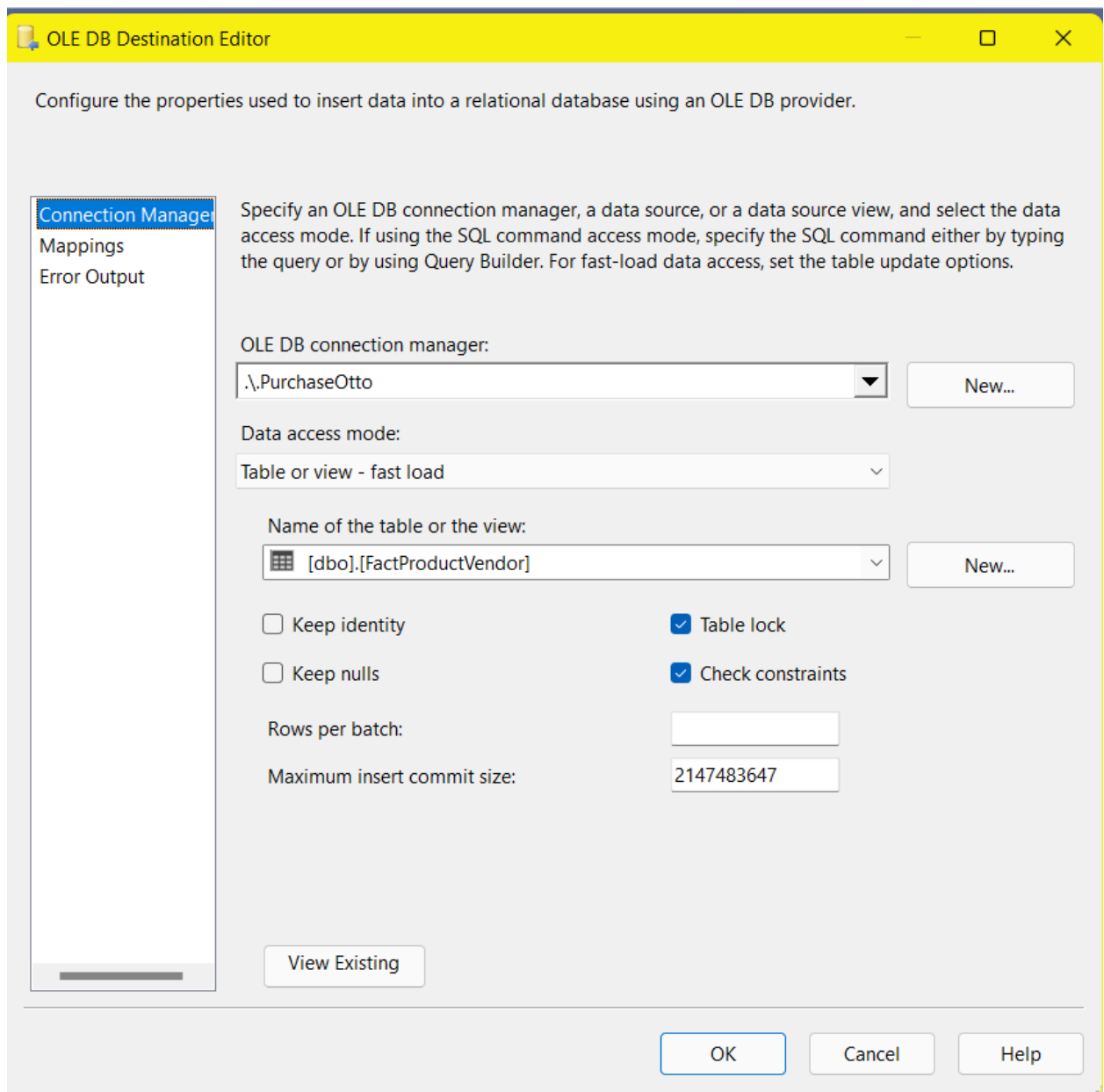


Figure 20. OLE DB Destination Editor of Connection Manager

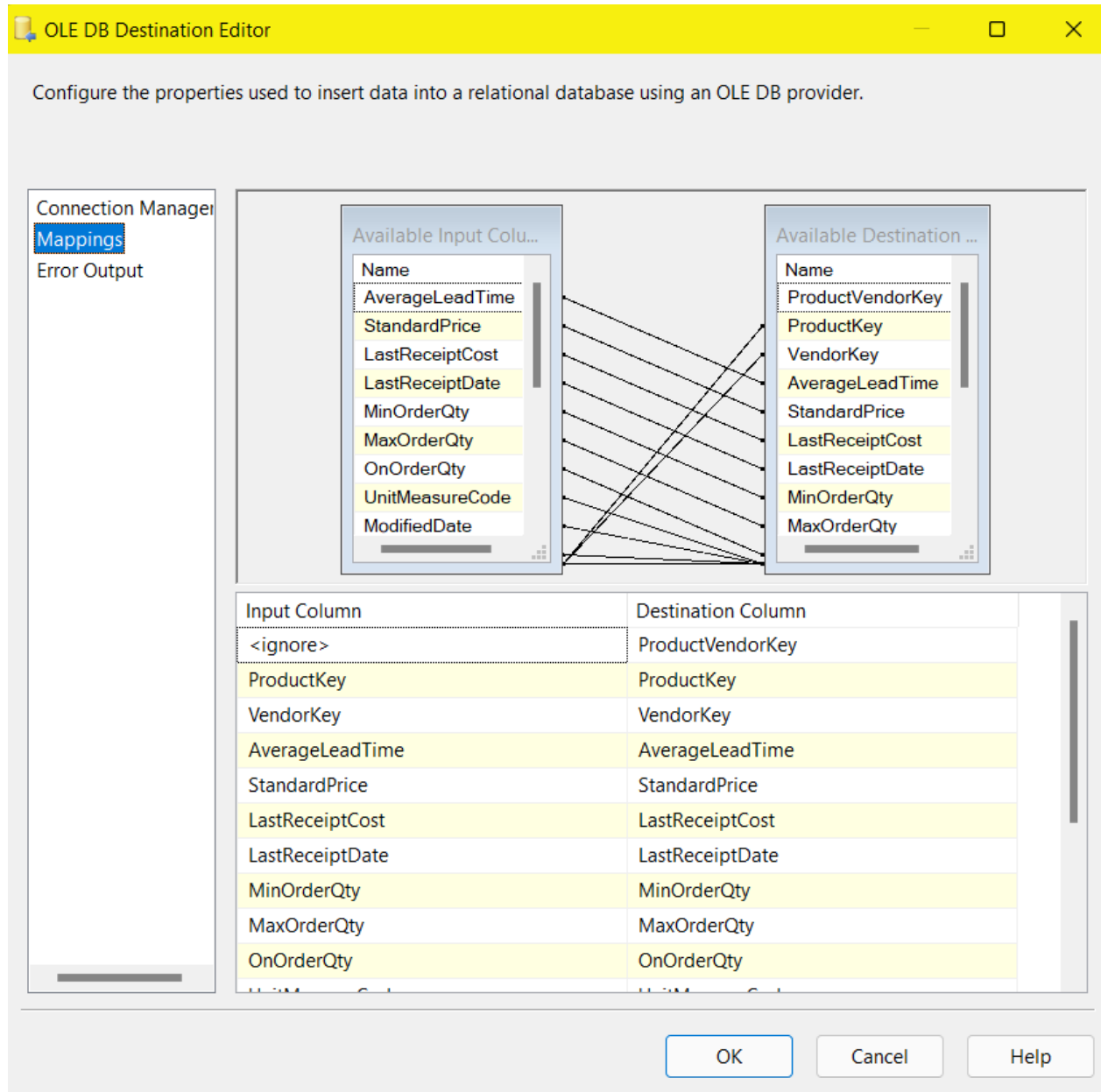


Figure 21. OLE DB Destination Editor of Mappings

- Step 9: Drag and drop the OLE DB Command to conduct updating data
 - In the tab Connection Managers, connect to the data warehouse

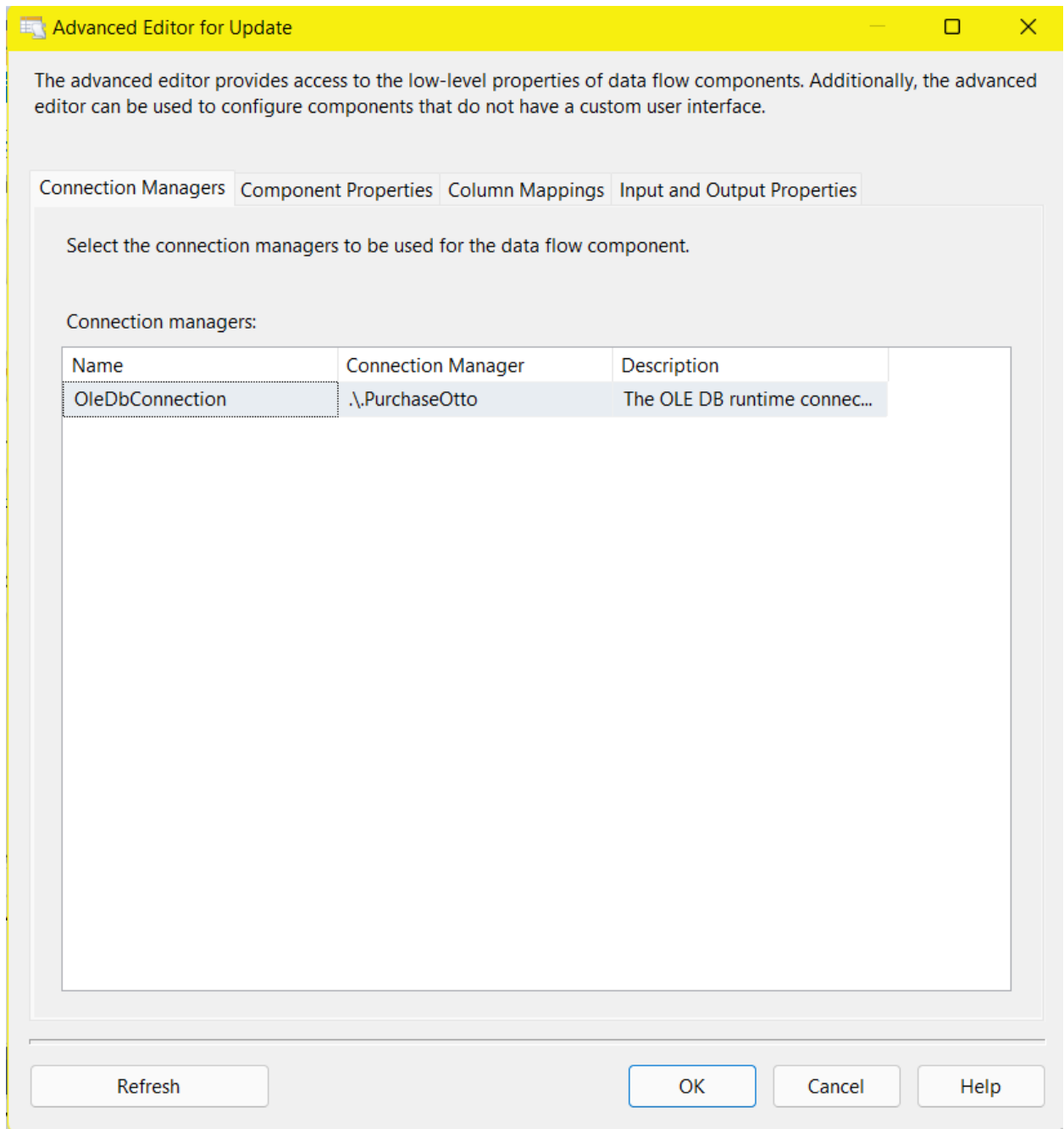


Figure 22. Advanced Edit for Update of Connection Managers

- In the tab Component Properties, setup syntax update function

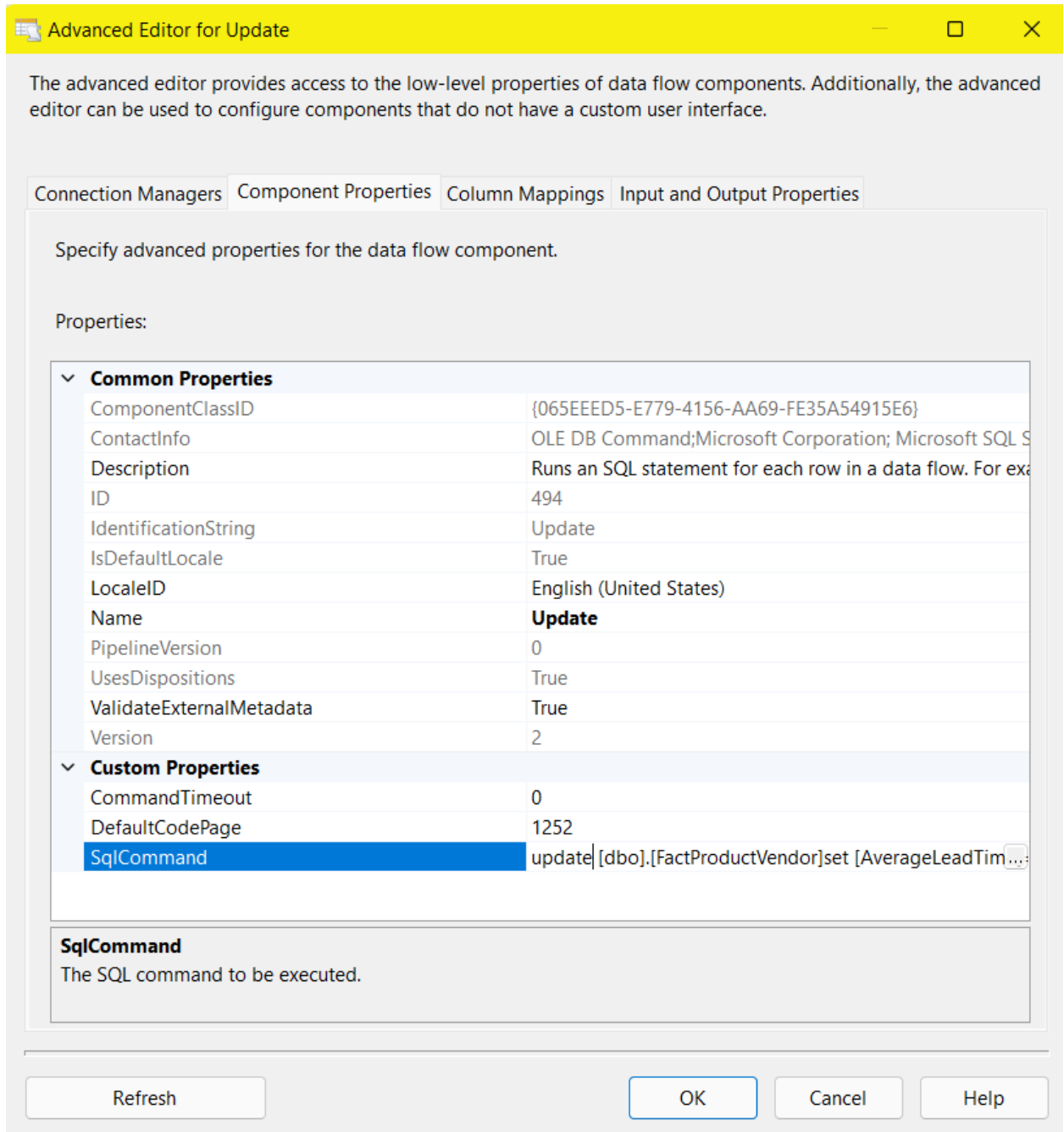


Figure 23. Advanced Editor for Update of Component Properties

- In the tab Column Mappings, pick the compatible attributes in the Input column

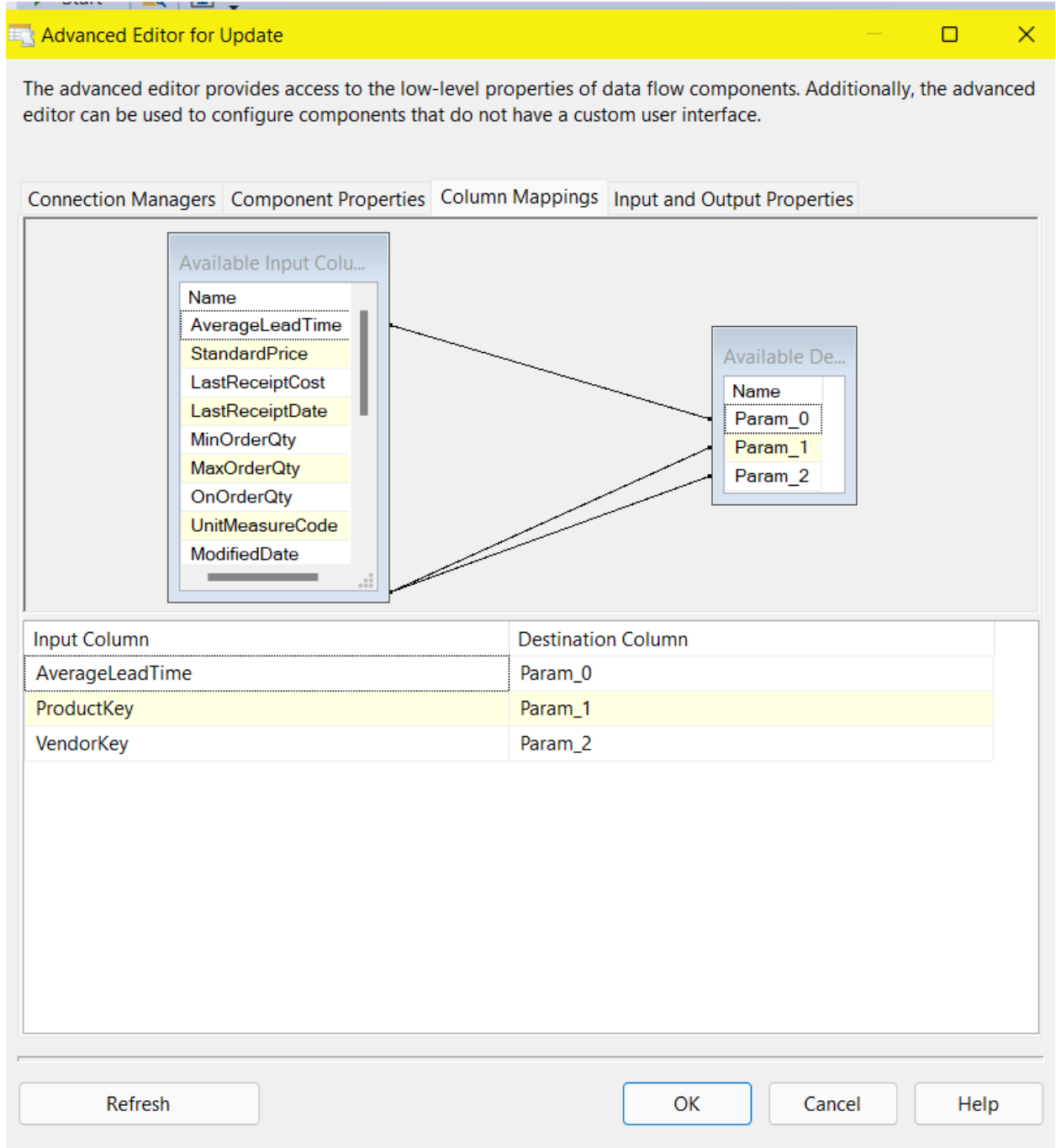


Figure 24. Advanced Editor for Update of Column Mappings

- Step 9: Run the Fact table to see the result

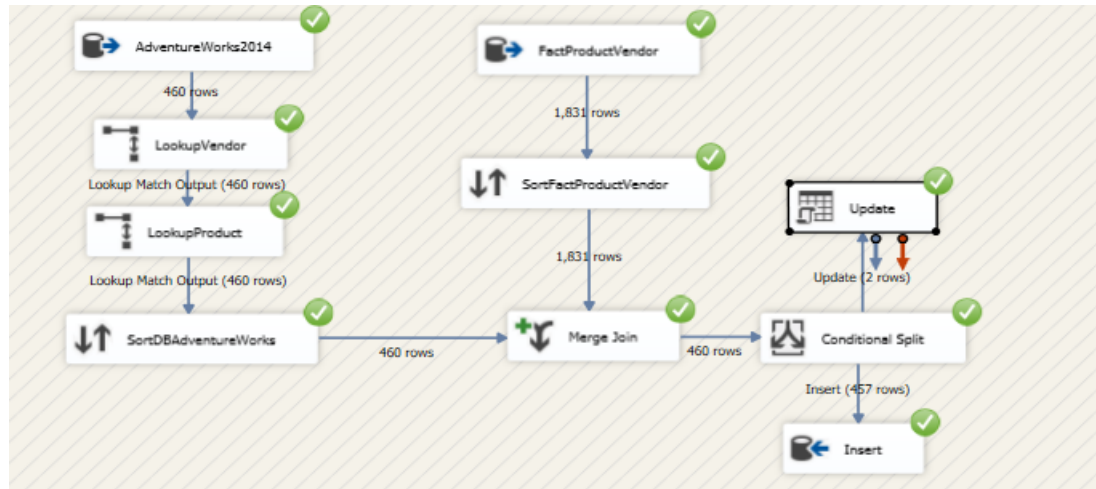


Figure 25. Execute Package Successfully

- The Fact table will be filtered data successfully if it shows the result like in the picture

CHAPTER 5: DATA ANALYTICS

In this chapter, we will use the SSAS technology and the MDX and OLAP technique to make a presentation for the information from the Data Warehouse and visualizing them to help the manager make a better decision

5.1. Data analytics with SSAS technology

5.1.1. Building the cube

- **Step 1: Create data source**
- In this step, we have to create a data source in order to connect to the data

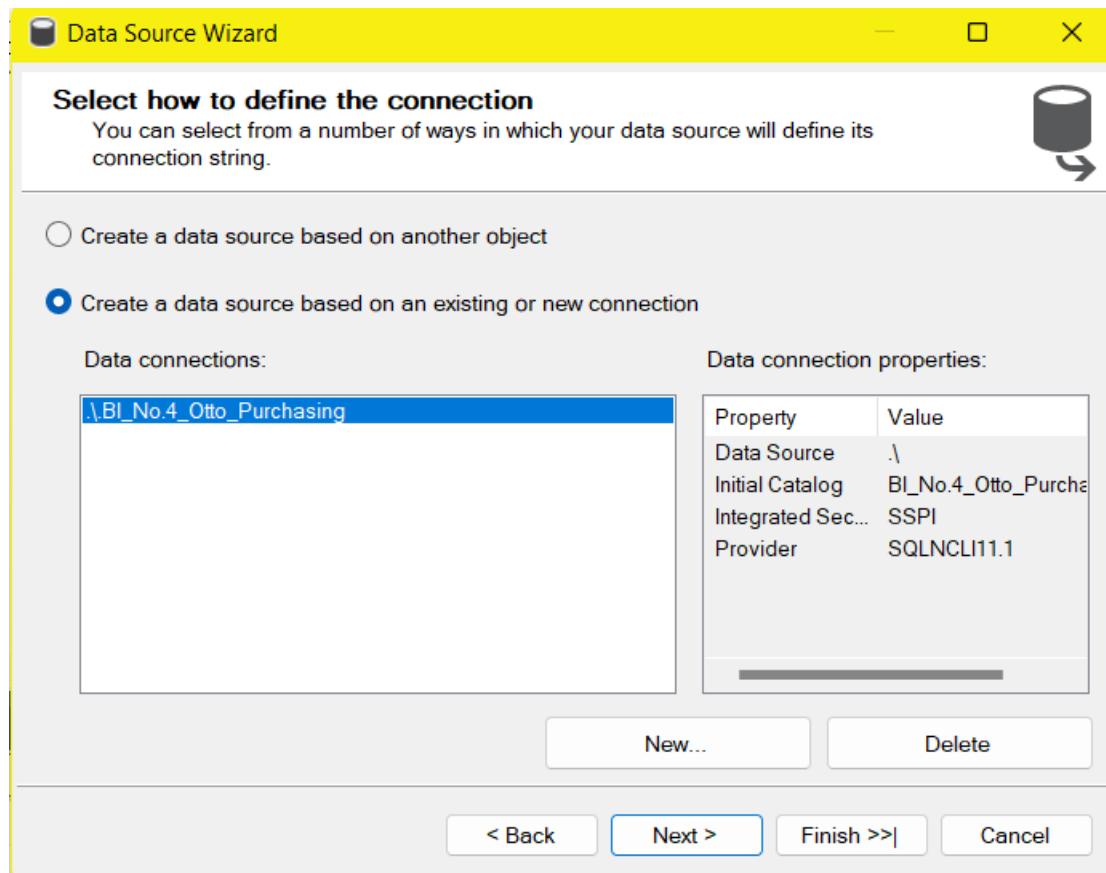


Figure 26. Data Source connection

- Use the service account

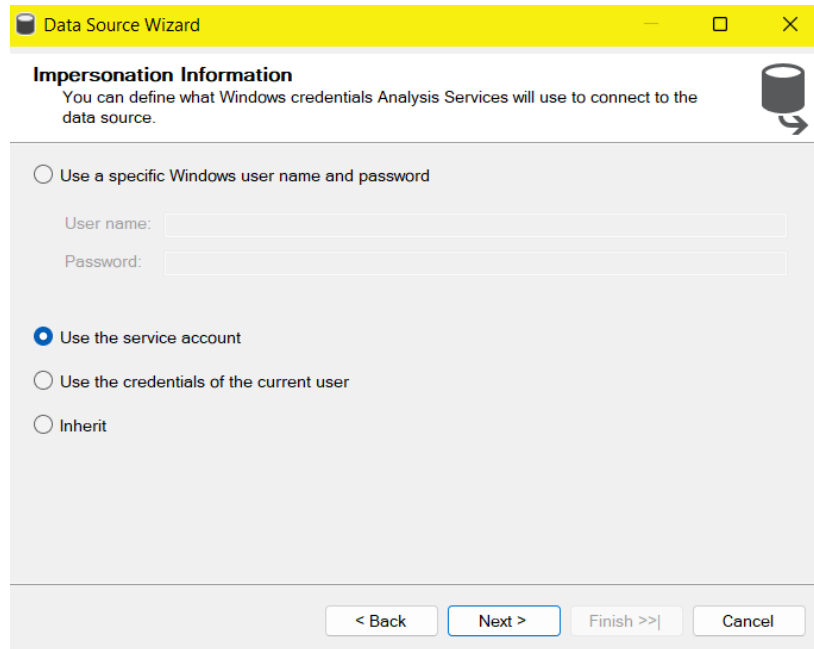


Figure 27. Data source account

- Name the Data source optionally

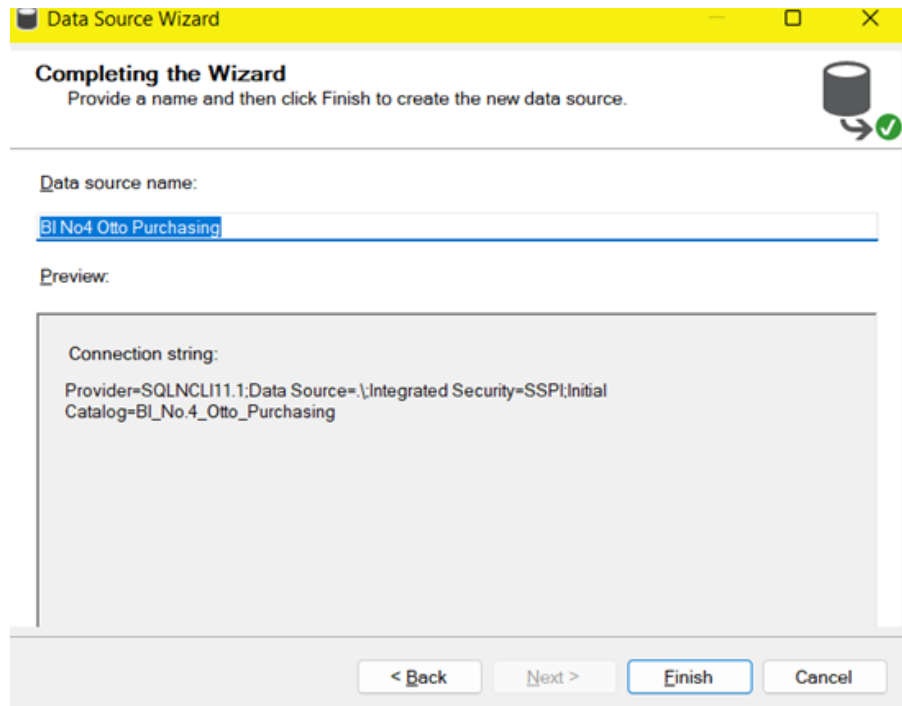


Figure 28. Data source name

- **Step 2:** Create Data source view
- Choose the relational data source created in the previous step

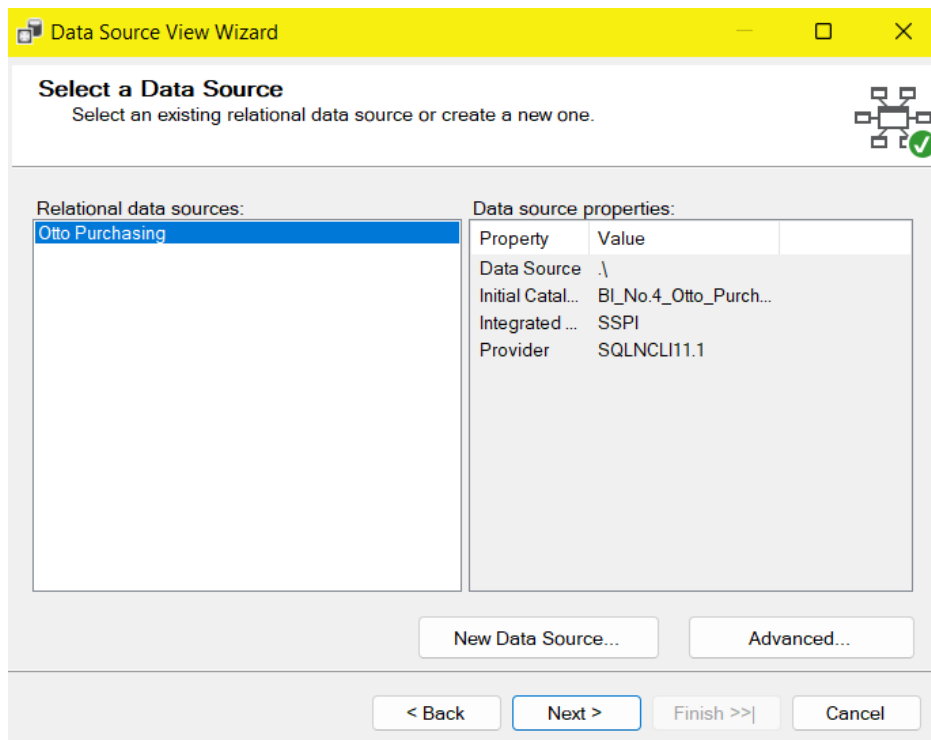


Figure 29. Select Data source

- Use arrows to move the related tables from the data warehouse to the Included objects except the sysdiagrams table and click next to name data source view optionally

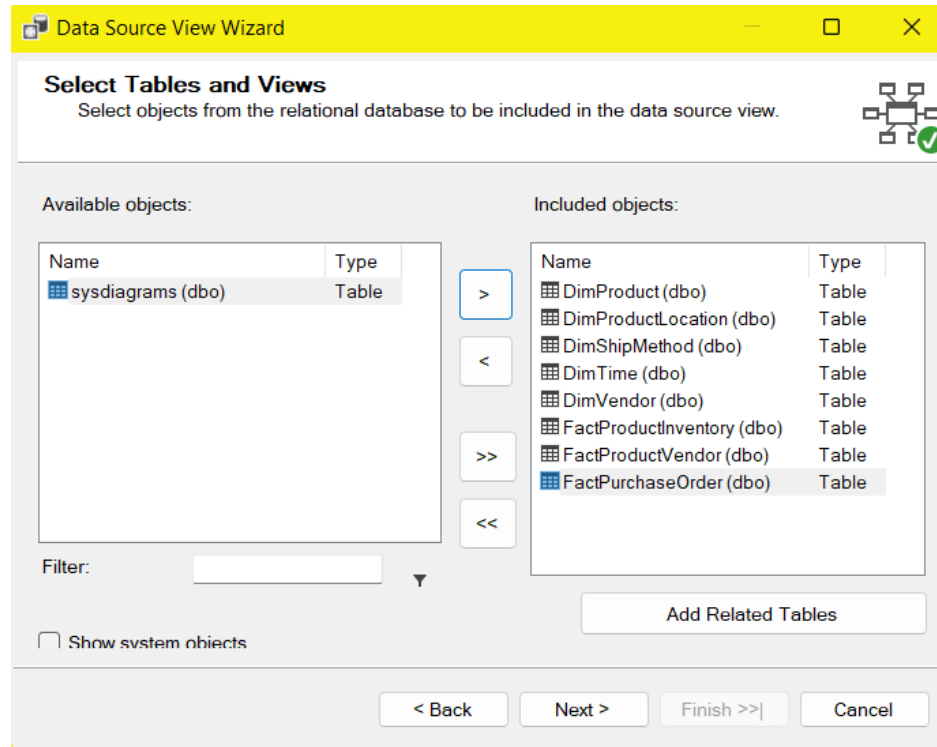


Figure 30. Select tables and views

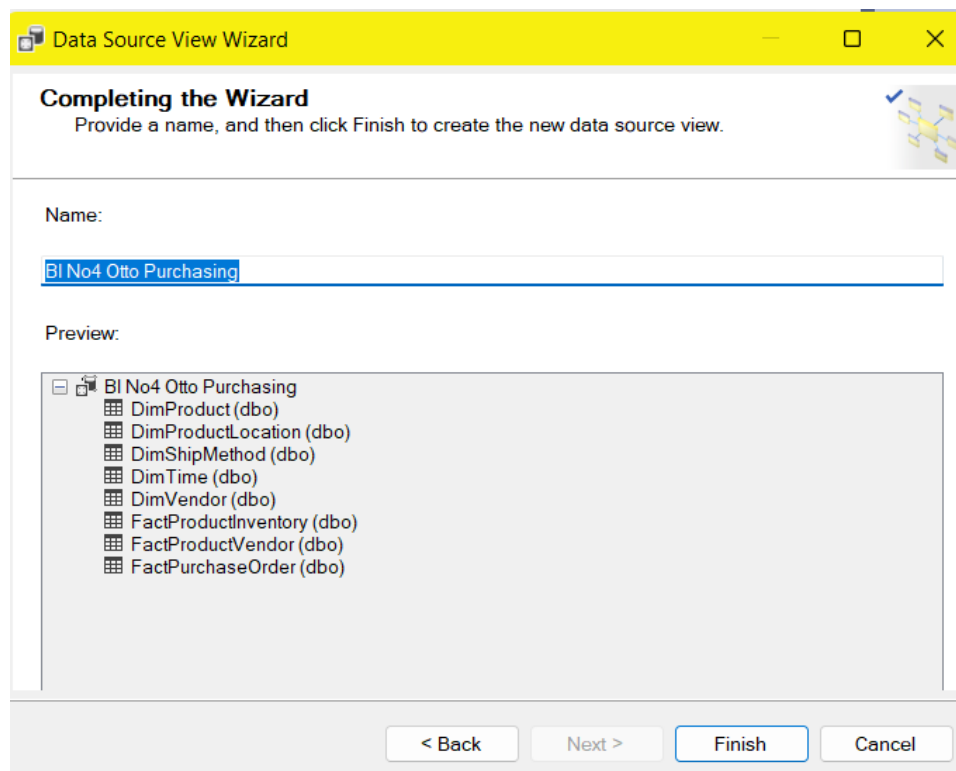


Figure 31. Completing the Wizard

- **Step 3: Create Cube**

- In this step, choosing the option Use existing tables

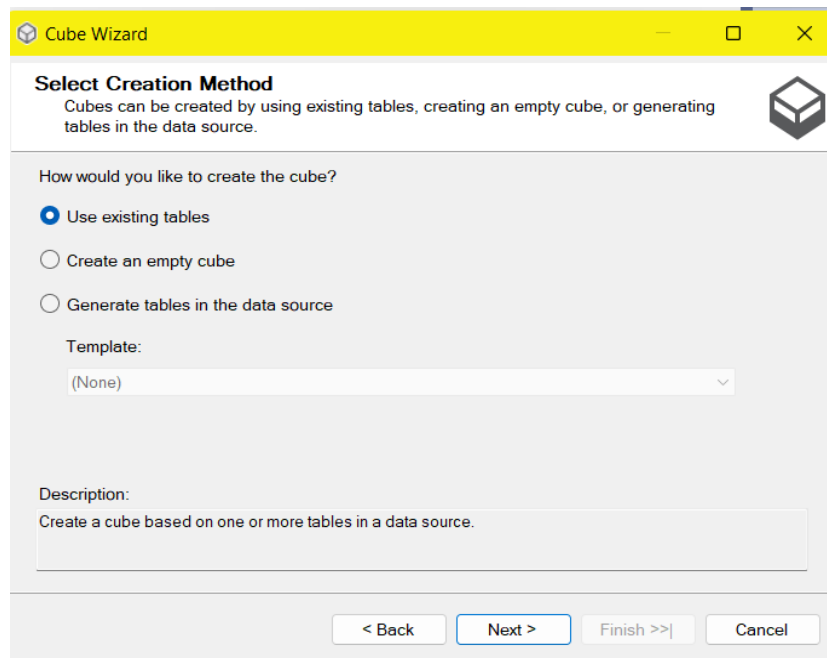


Figure 32. Cube Select Creation Method

- In the next step, we only choose the Fact tables

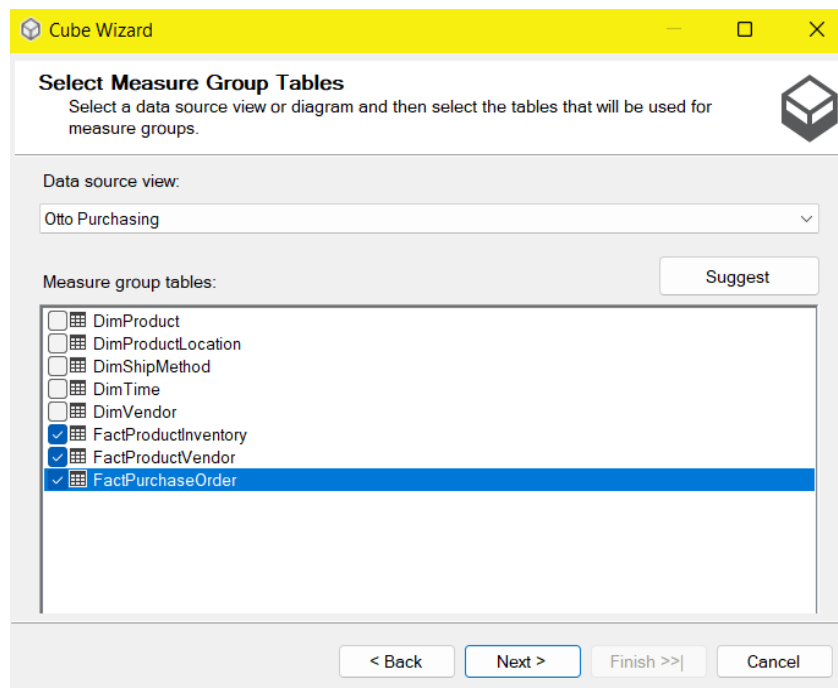


Figure 33. Select Measure Group Tables

- Confirm the data in the Next step

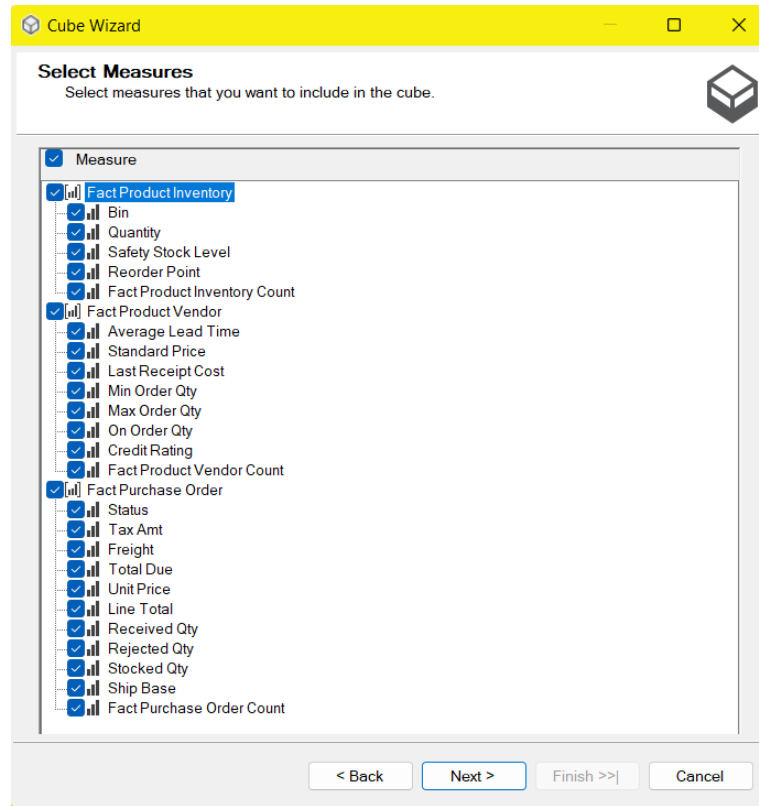


Figure 34. Select Measure

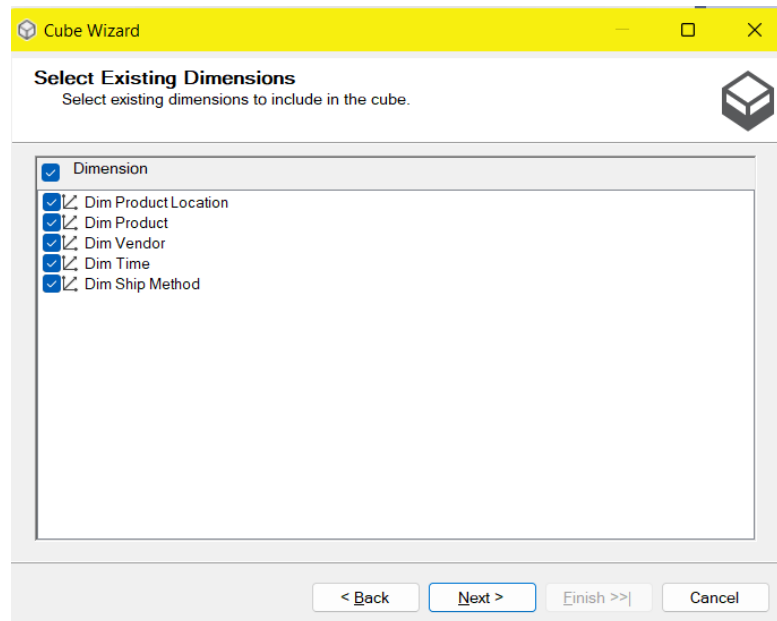


Figure 35. Selecting Existing Dimensions

- To complete building the cube, name the cube and click to finish

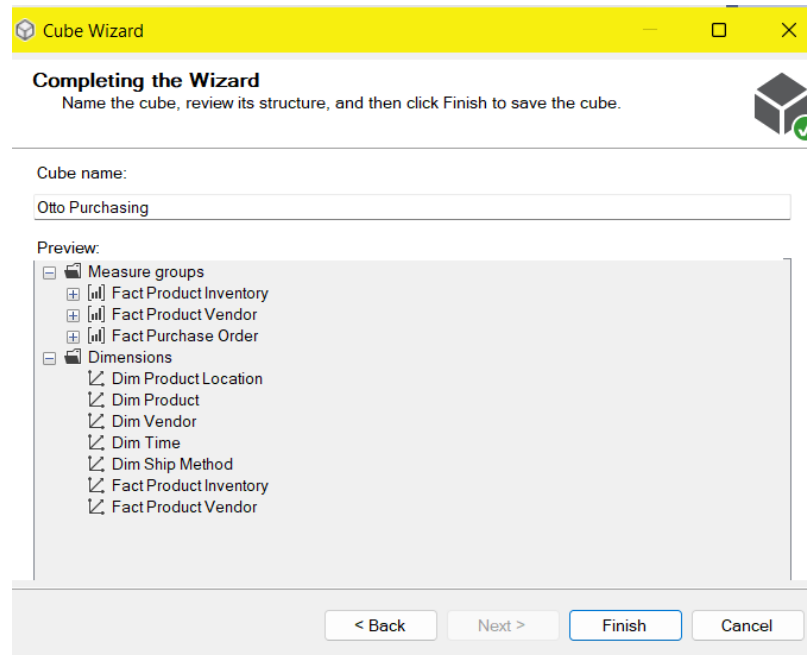


Figure 36. Cube completing the wizard

- Completing all the steps above and is the menu you receive in the SSAS tool

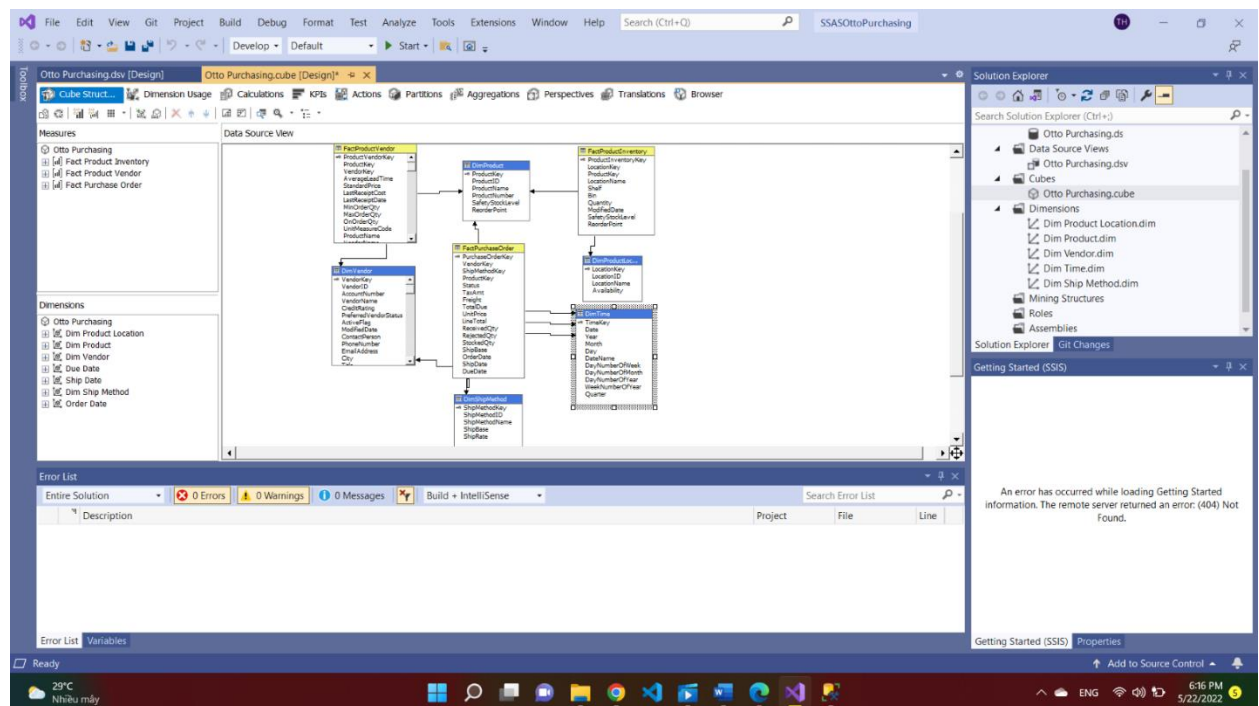


Figure 37. Complete SSAS building

5.1.2. Analysis with SSAS

5.1.2.1. Check the quantity of product compared with safety stock level and re-order point

Product Name	Quantity	Safety Stock Level	Reorder Point
Adjustable Race	1085	3000	2250
All-Purpose Bike Stand	144	4	3
AWC Logo Cap	288	4	3
BB Ball Bearing	1352	2400	1800
Bearing Ball	1109	3000	2250
Bike Wash - Dissolver	36	4	3
Blade	1361	2400	1800
Cable Lock	252	4	3
Chain	589	1500	1125
Chain Stays	1629	3000	2250
Chainring	1684	3000	2250
Chainring Bolts	1136	3000	2250
Chainring Nut	1750	3000	2250
Classic Vest, L	252	4	3
Classic Vest, M	216	4	3
Classic Vest, S	180	4	3
Cone-Shaped Race	970	3000	2250

Figure 38. Quantity check with SSAS

As we can see from the above list, some products like Adjustable Race and Blade have the quantity in stock when compared to the safety stock level and the reorder point is at an alarming level because the quantity is below the safe level. From observation, this will help managers make more reasonable purchasing decisions and ensure the quantity of goods in stock served for both sales and production

5.1.2.2. Check the quality of product

Product Name	PercentageofRejectedQty
Adjustable Race	0.0196078431372549
All-Purpose Bl...	0
AWC Logo Cap	0
Bearing Ball	0.02
Bike Wash - ...	0
Cable Lock	0
Chain	0.0323886639676113
Chainring	0.00161485668146952
Chainring Bolts	0.008
Chainring Nut	0.008
Classic Vest, L	0
Classic Vest, M	0
Classic Vest, S	0
Cone-Shaped...	0.02
Crown Race	0.0196078431372549
Cup-Shaped ...	0.0196078431372549
Decal 1	0.0527572484366117

Figure 39. Quality check with SSAS

To check the product quality, we use the formula to divide the rejected quantity by the received quantity to determine the percentage of defective goods. As a result, with the defective rate statistic, the manager can compare with the allowable defective rate and decide to buy the same product or not, or look for an alternative product

5.1.2.3. Vendor selection based on comparison

Product Name	Vendor Name	Average Lead Time	Standard Price	Credit Rating
Adjustable Race	Litware, Inc.	17	47.87	1
All-Purpose Bi...	Green Lake Bike Company	45	49	1
AWC Logo Cap	Integrated Sport Products	45	6.55	1
Bearing Ball	Wood Fitness	19	39.92	1
Bike Wash - ...	Green Lake Bike Company	45	3	1
Cable Lock	International Trek Center	10	8.5	1
Chain	Varsity Sport Co.	19	14.99	1
Chainring	Beaumont Bikes	17	24.21	1
Chainring	Bike Satellite Inc.	17	25.11	1
Chainring	Training Systems	19	27.33	1
Chainring Bolts	Beaumont Bikes	17	45.21	1
Chainring Bolts	Bike Satellite Inc.	17	43.21	1
Chainring Bolts	Training Systems	19	47.28	1
Chainring Nut	Beaumont Bikes	17	40.76	1
Chainring Nut	Bike Satellite Inc.	17	38.56	1
Chainring Nut	Training Systems	19	42.21	1

Figure 40. Vendor selection with SSAS

Based on the data of the list above, we can see that a product can have many different suppliers. For example, compared with the same credit crating, the product Chaining is provided by the three vendors, the Beaumont Bikes, Bike Satellite Inc., and Training Systems. If based on the fastest Average Lead Time, the manager will have two options of selecting suppliers that provide the same product Chaining such as Beaumont Bikes and Bike Satellite Inc. And we also easily identify the standard price from Beaumont Bikes is 24.21 has 0.9 lower than Bike Satellite Inc. which is 25.11, so the manager can easily choose Beaumont Bikes due to the lower price for the order about “Chainring” in the future.

5.1.2.4. Ship Method selection based on ship base

Ship Method Name	Ship Base	TotalNumberOfPurchaseOrder
CARGO TRANSPORT 5	8.99	3225
OVERNIGHT J-FAST	21.95	2985
OVERSEAS - DELUXE	29.95	344
XRQ - TRUCK GROUND	3.95	1017
ZY - EXPRESS	9.95	1274

Figure 41. Ship method selection with SSAS

One of the key requirements in the purchasing department is choosing the most efficient and effective ship method, to ensure the company can have the cost as lowest as possible. In the

figure above, cargo transport 5 has an 8.99 ship base the second lowest in the list, but it has the highest number of the purchase order using it, meanwhile overseas – deluxe has the highest ship base (29.95) and the lowest number of purchase order which mean the manager may try to limit the use of this method.

5.1.3. Building KPIs system

With increasing demands for efficiency and productivity, facility managers are looking for creative ways to extend the value of their systems. Key performance indicators, or KPIs, are critical for teams to track the performance of their commercial building's operational systems. In our analysis, we have contributed the two KPIs to track to meet these demands by providing ongoing insight into how well a facility is currently achieving its operational objectives, and how achievement is progressing over time. The first KPI is about quality management which helps the manager identify the defective rate of each product and then decide to buy that product again or not or search for an alternative one. The second KPI is about the cost of each shipping method which helps the manager select the appropriate ship method for the product transportation within an allowable budget

5.1.3.1. Quality Check KPI

This indicator is applied to all products which means that if a product has an excess of defective items, it will have to decide to buy a replacement product or change suppliers to ensure the quantity purchased meet the required quality for trading and production

Calculation:

$$[\text{Measures}].[\text{Rejected Qty}]/[\text{Measures}].[\text{Received Qty}]$$

Value Expression:

[Measures].[PercentageofRejectedQty]

Goal Expression: 0.01

Status Expression:

```
case when KPIVALUE("KPIQualityCheck")/ KPIGOAL(
"KPIQualityCheck") >0.9 then -1
when KPIVALUE("KPIQualityCheck")/ KPIGOAL(
"KPIQualityCheck") <= 0.9
and KPIVALUE("KPIQualityCheck")/ KPIGOAL( "KPIQualityCheck")
> 0.8 then 0
else 1
end
```

Trend expression:

```
case when [Measures].[PercentageofRejectedQty] >
(PARALLELPERIOD([Due Date].[Year].[Year],1, [Due
Date].[Year] ),[Measures].[PercentageofRejectedQty]) then -1
when [Measures].[PercentageofRejectedQty] =
(PARALLELPERIOD([Due Date].[Year].[Year],1, [Due
Date].[Year] ),[Measures].[PercentageofRejectedQty]) then 0
else 1 end
```

Result:

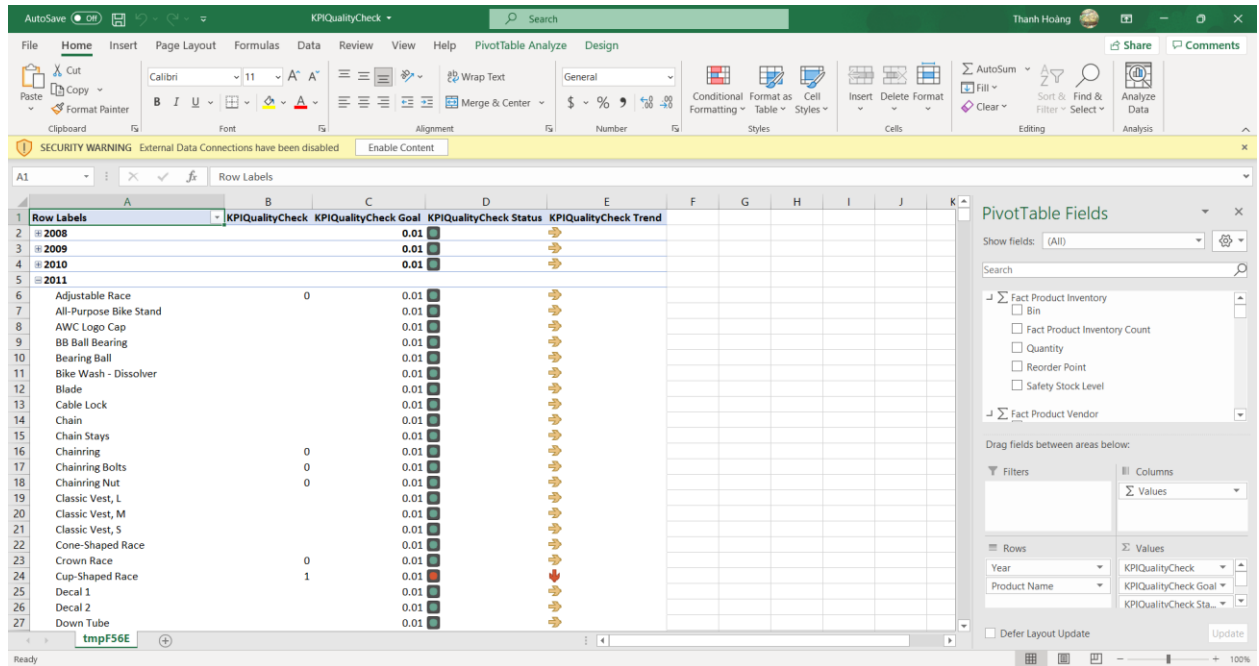


Figure 42. Quality Check KPI

5.1.3.2. Ship Method KPI

This metric is used to assess whether your fees are working against the KPIs defined in your to ensure that you can really make some benefit

Value Expression:

[Measures].[Ship Base]

Goal Expression: 17500

Status Expression:

```
case when KPIVALUE("KPIShipMethod")/KPIGOAL("KPIShipMethod")
>0.9 then -1
when KPIVALUE("KPIShipMethod")/KPIGOAL("KPIShipMethod")
<=0.9
and KPIVALUE("KPIShipMethod")/KPIGOAL("KPIShipMethod") >0.8
then 0 else 1 end
```

Trend expression:

```

case when ISEMPTY(PARALLELPERIOD([Due Date].[Year].[Year],1,
[Due Date].[Year] )) THEN 0
when [Measures].[Ship Base] > (PARALLELPERIOD([Due
Date].[Year].[Year],1, [Due Date].[Year] ),[Measures].[Ship
Base]) then 1 when [Measures].[Ship Base] =
(PARALLELPERIOD([Due Date].[Year].[Year],1, [Due
Date].[Year] ),[Measures].[Ship Base]) then 0 else -1 end

```

Result:

Row Labels	KPIShipMethod	KPIShipMethod Goal	KPIShipMethod Status	KPIShipMethod Trend
2008		17500	On Track	
2009		17500	On Track	
2010				
2010	CARGO TRANSPORT 5	17500	On Track	
2010	OVERNIGHT J-FAST	17500	On Track	
2010	OVERSEAS - DELUXE	17500	On Track	
2010	XRQ - TRUCK GROUND	17500	On Track	
2010	ZY - EXPRESS	17500	On Track	
2011				
2011	CARGO TRANSPORT 5	260.71	On Track	
2011	OVERNIGHT J-FAST	307.3	On Track	
2011	OVERSEAS - DELUXE	149.75	On Track	
2011	XRQ - TRUCK GROUND	35.55	On Track	
2011	ZY - EXPRESS	109.45	On Track	
2012				
2012	CARGO TRANSPORT 5	1896.89	On Track	
2012	OVERNIGHT J-FAST	4477.8	On Track	
2012	OVERSEAS - DELUXE	509.15	On Track	
2012	XRQ - TRUCK GROUND	248.85	On Track	
2012	ZY - EXPRESS	805.95	On Track	
2013				
2013	CARGO TRANSPORT 5	8864.14	On Track	
2013	OVERNIGHT J-FAST	21620.75	On Track	
2013	OVERSEAS - DELUXE	2755.4	On Track	
2013	XRQ - TRUCK GROUND	1228.45	On Track	
2013	ZY - EXPRESS	3711.35	On Track	
2014				
2014	CARGO TRANSPORT 5	17071.01	On Track	

Figure 43. Ship Method KPI

CHAPTER 6: VISUALIZATION AND FORECASTING

In this chapter, we will visualize the requirements and significations of the report according to data in the data warehouse we built and using some BI tools to conclude statistical reports.

6.1. Report and dashboard systems

At the beginning of the project and after the data warehouse was completely created, we decided to choose PowerBI as a tool for visualization. Down here is the visualization report structure.

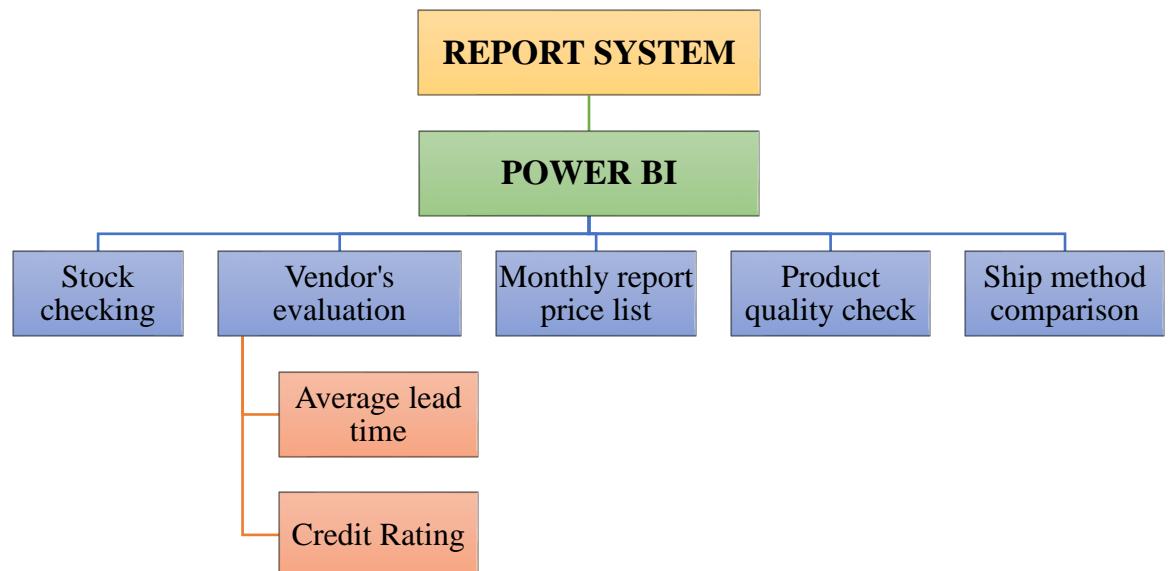


Table 12. The report system

6.2. Data analysis with Power BI

6.2.1. Stock checking

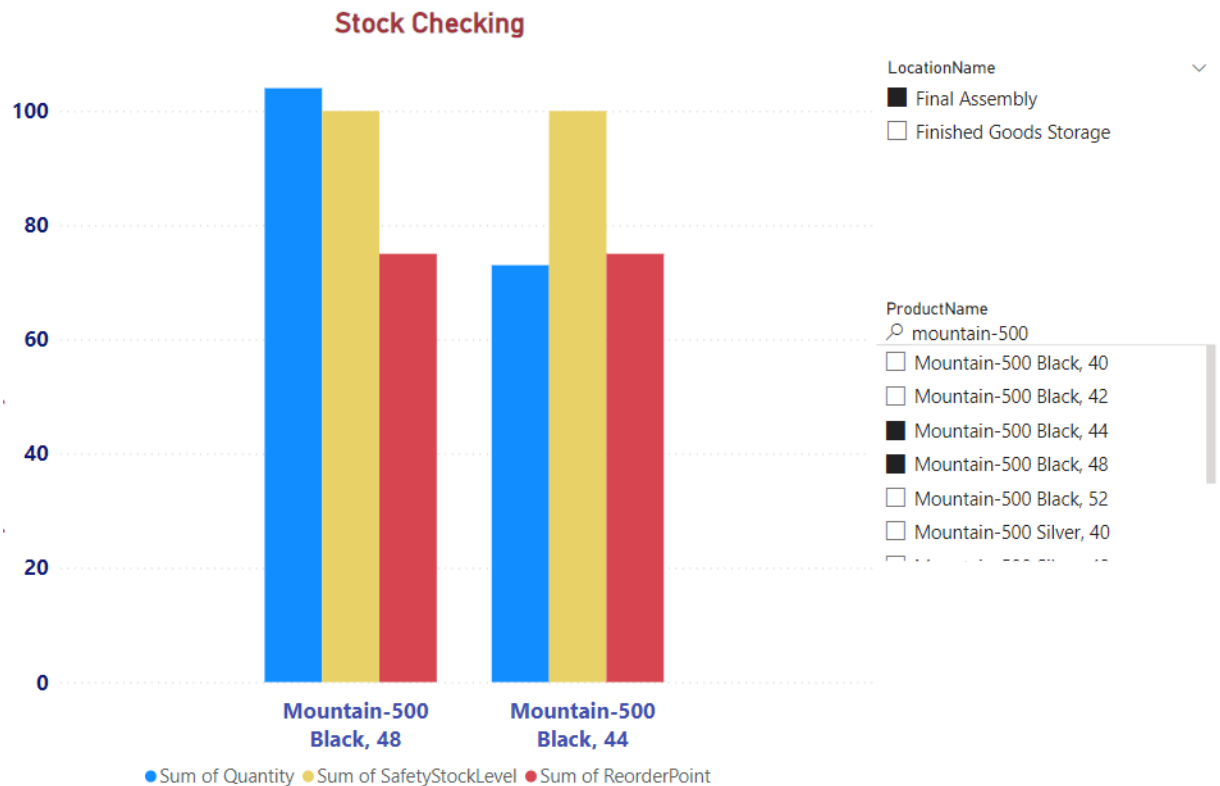


Figure 44. Stock checking chart

The chart above compares stock quantity, safety stock level, and re-order point to trigger a reorder. PowerBI allows active users in selecting the products and product locations to review the above metrics. According to the chart, the figures for the "Mountain-500 Black, 44" product and the "Mountain-500 Black, 48" one at the Final Assembly warehouse. From the observation that the Quantity of "Mountain-500 Black, 48" is higher than the safety stock level which means that this product also has a stable inventory, no need to make a purchase. However, for the "Mountain-500 Black product, 44" is less than the safety stock level and even less than the minimum to activate new stock. In general, through the analysis of the value of the product inventory, the manager can check the entire amount of goods in the warehouse at any point, the minimum inventory must be determined and continuously monitored to set up the row when the quality is up to that. Inventory control will help reduce inventory costs and ensure that customer needs can be met quickly and ensure that there are enough materials for production and sales.

Tracking and having an entire project in place allows managers to respond to and solve unforeseen problems.

6.2.2. Vendor's evaluation

a. Average Leader Time



Figure 45. Average Leader Time chart

The chart above illustrates a comparison of the average lead time between placing an order with a supplier and receiving a product purchased from a supplier for each product. This chart provides information about the average delivery time of 1 Chainring product for three vendors: Training Systems, Beaumont Bikes, Bike Satellite Inc. It can be seen that there is not too much difference between the delivery times of all three vendors for Chainring products. Beaumont Bikes and Bike Satellite Inc have the same delivery time of 17, the difference from the supplier Training Systems is 19. It shows that for this Chainring product both Beaumont Bikes and Bike Satellite should be considered for selection because of the fastest average delivery time. Comparing the average delivery time of each supplier will

let the administrator know that a potential supplier can meet the fastest quantity of goods so that he can plan to ship products according to the requirements. properly planned and timely response. This will save time and managers can accurately measure time according to the plan.

b. Credit Rating

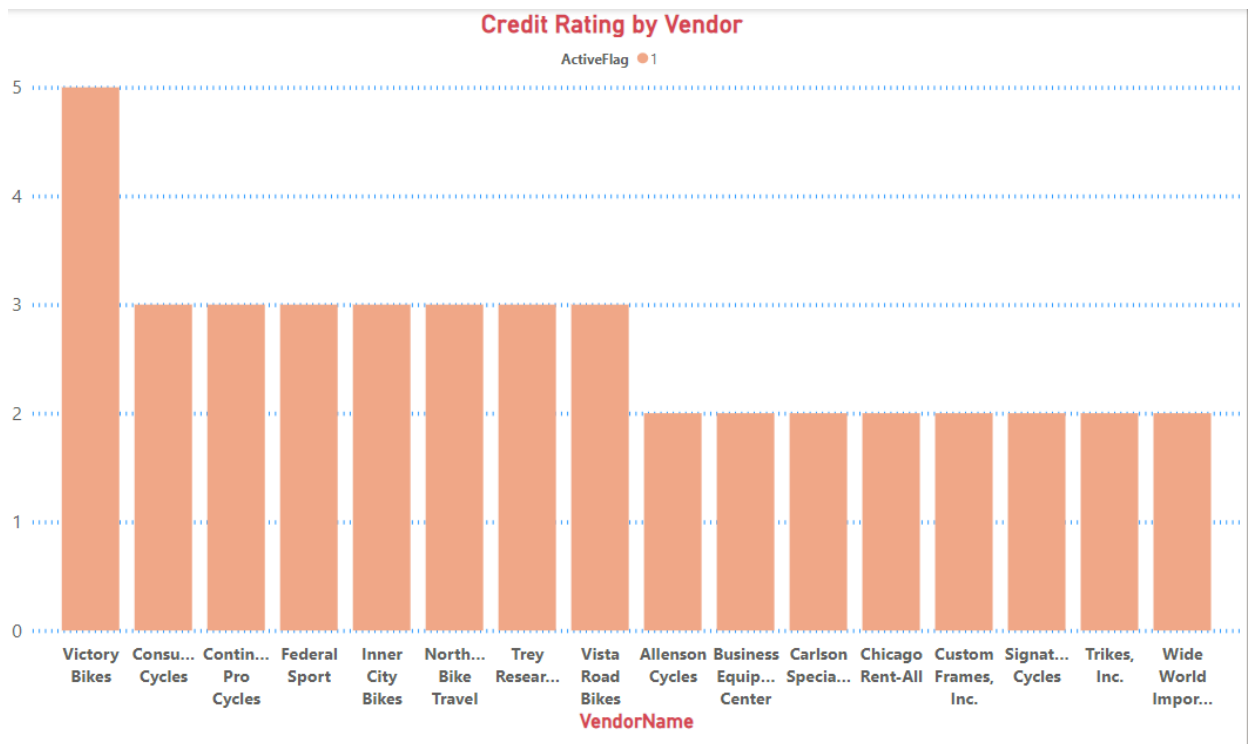


Figure 46. Credit Rating chart

The chart above provides a comparison of the quality ratings for active suppliers. Corresponds to 1= Superior, 2= Excellent, 3=Above Average, 4=Average, 5=Below Average. From the chart, it can be seen that almost all active suppliers are rated at level 1 of high quality and make up the majority. The vendor rated at 5 (below average) has only one supplier, Victory Bikes; no providers at level 4; at the above average rating (level 3) there are 7 suppliers; the remaining suppliers are all from level 2: Excellent to level 1: Superior. It can be seen that most of the quality suppliers provide products with an excellent level of reliability. However, it is necessary to consider continuing to cooperate with

suppliers at levels 4, and 5 to avoid bringing a quality risk affecting revenue, reputation, and image of the business. Supplier evaluation becomes essential to secure the best contracts in terms of quality, cost, flexibility, and high reliability.

6.2.3. Monthly report price list

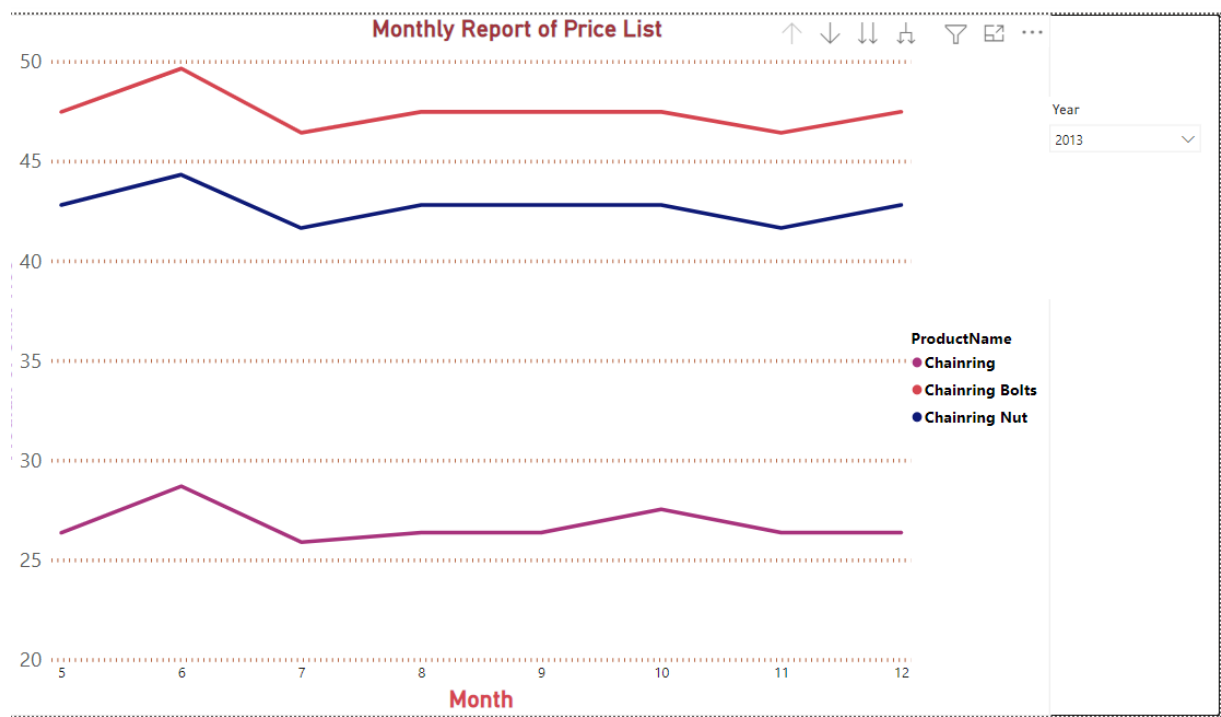


Figure 47. Monthly report price list chart

The chart above illustrates the monthly selling price of each supplier's product. There are 256 products in total with the monthly selling price in the year selected by the user. For instance, there are three products on the chart: Chainring, Chainring Bolts, and Chainring Nut with their unit prices over the months in 2013. In general, both products have many price fluctuations during the year. The prices of three products tend to increase to the highest in June, Chainring Bolts has the highest selling price from the supplier. However, in December 2013, when Chainring Bolts, Chainring Nut increased, the price of Chainring products showed signs of slight decrease.

In conclusion, with this dashboard, the manager can have an overview of the price changing of each product in each month which could help the manger make an apporiate purchasing strategy within an allowable budget. With standard price comparison tables contributed by suppliers and collected through transaction history, managers will generate monthly comparison reports to reinforce a smart purchasing strategy and catch the market trend

6.2.4. Product quality check

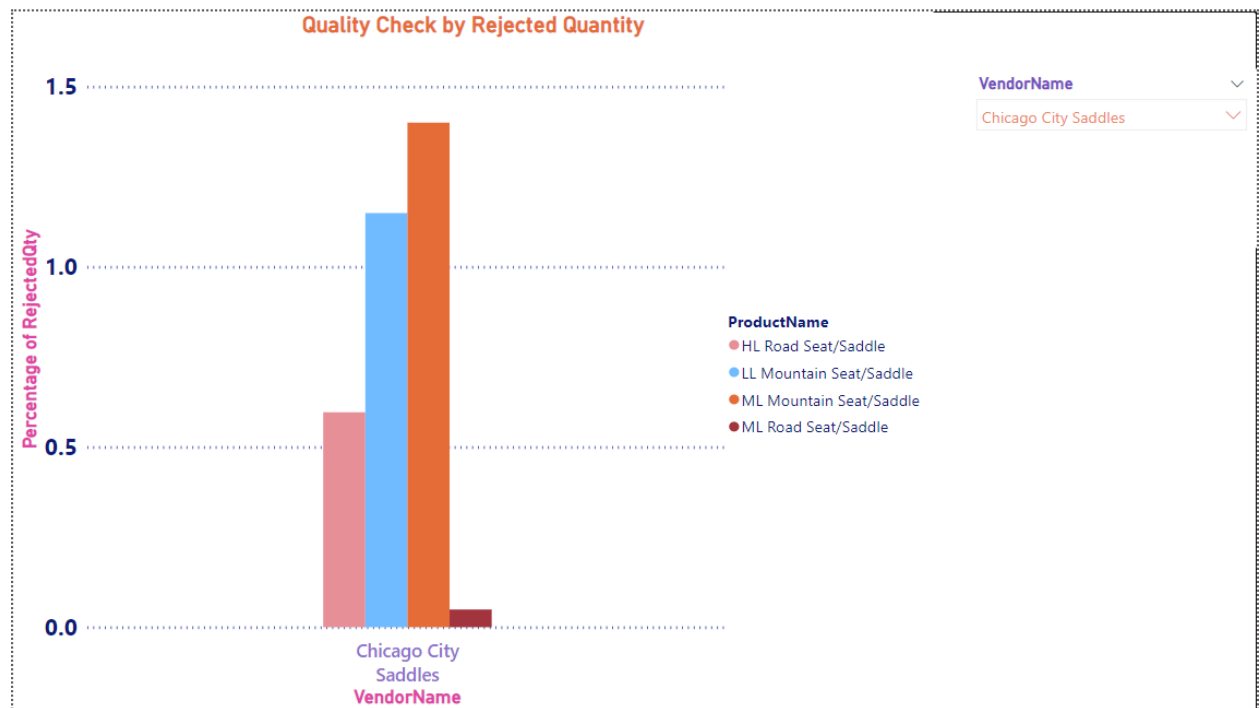


Figure 48. Product quality check chart

The chart above illustrates the defect rate of products by each vendor. The chart will provide comparison information on replacement orders from Chicago City Saddles supplier, this supplier will supply four main products: HL Road Seat / Saddle, LL Road Seat / Saddle, ML Road Saddle / Saddle, and Seat / Road Saddle ML. In general, the proportional order quantity is changed by products with high variance and unequal additions. The defective rate is highest for the product ML Mountain Seat / Saddle at 1.4%, the defective rate from the lowest is ML Road Seat / Saddle with 0.05%, these 2 products are slightly different about 1.35% high,

showing managers that it is necessary to review the item and choose a better supplier to avoid a rapid increase in order volume, affecting the performance of external product suppliers, and ensuring product quality maintained or improved. By analyzing the number of orders, managers can identify faulty goods, thereby offering solutions to overcome the problem. In addition, product quality checks will also help reduce inspection costs and cost-effectively use resources, creating safety measures that can be taken to ensure missing or damaged products.

6.2.5. Ship method comparison

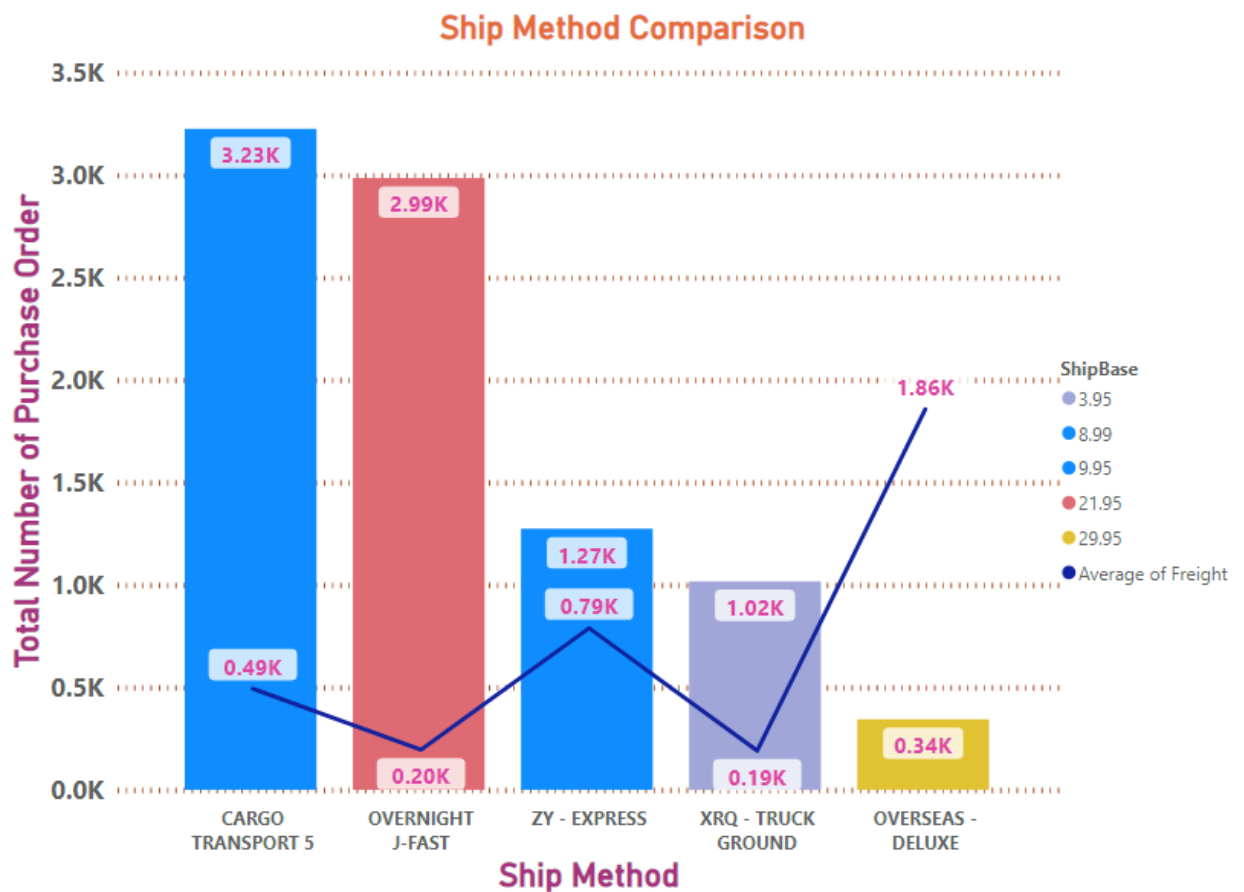


Figure 49. Ship method comparison chart

The chart above illustrates a comparison of the minimum shipping costs, the average delivery costs of each purchase order, as well as the number of orders for each different shipping method. For each mode of transport, there will be different prices, according to the chart, we see that the Overseas - Deluxe shipping method has the highest shipping cost at 29.95, followed by Overnight J-Fast at 21.95, and XRQ - Truck Ground has the lowest shipping cost 3.95. However, when looking at the number of orders (Purchase Order), it can be seen that the XRQ - Truck ground shipping method has the lowest cost of 3.95 but has a very low number of POs of 1017 compared to other expensive shipping methods. high value like Overnight J-Fast 21.95 is 2985 Purchase Order and Cargo Transport 5 8.99 is 3225 Purchase Order. However, although Overnight J-Fast's ShipBase is fairly high, the average shipping cost of this carrier is low.

6.3. Evaluation and Discussion

Last but not least, we hope that those deliverables such as data warehouse and visualization could help the manager make better decision-making, especially in the procurement to increase the benefit for the whole company in an efficient and effective way Last but not least, we hope that those deliverables such as data warehouse and visualization could help the manager make better decision-making, especially in the procurement to increase the benefit for the whole company in an efficient and effective way

CHAPTER 7. CONCLUSION AND FUTURE WORKS

7.1. Results

Building a data warehouse to help Adventure Works Cycle improves the speed and efficiency of accessing different data sets and makes it easier for corporate decision-makers to derive insights that will guide the business and marketing strategies that set them apart from their competitors. The support solution for decision-making comprises three main elements: source data, data store, and data mining.

The project will include the use of tools such as Power BI, SSAS, and SSIS which help analyze and visualize data to support better decision-making in making purchasing strategies.

Proposing to build a system of KPIs is a crucial way to ensure the teams are supporting the overall goals of the organization

7.2. Limitations

This is a new approach for the team, so the team took more time to apply new theories and tools for the project. Due to limited time of implementation, the team has not been able to intervene deeply in data analysis of purchases related transactions as well as use other popular data visualization tools to improve the quality of their data.

7.3. Future works

Investigating in Adventure Works' database to design a data warehouse related to different departments in the company to better increase departmental data access

Applying other popular visualization tools such as Tableau, Qlik, etc. to increase data quality

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