

Business Intelligence Project

Sales Use Case

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I Introduction

This Business Intelligence Project is about medical products sales intelligence. We will be working on two fact tables and four dimensions using Python for data exploration, Microsoft Azure as a cloud provider to host our solution, and Microsoft Power BI as a reporting tool.

II Methodology

To manage our BI project, we will adopt the following methodology:

1. **Identification:** Identify the problem and understand the data at hand.
2. **Design:** Design the functional and the technological architecture of the solution.
3. **Development:** Implement the technological architecture.
4. **Deployment:** Correctly deploy and administer the solution.

III Identification

In this initial phase, we will identify the problem. Thereafter, we will analyze and interpret the data.

III.1 Business Understanding

The business case is about medical products sales. By the end of this project, the solution should answer the following questions:

- How are the sales' performance and evolution?
- How are we performing compared to the target?
- Where do sales make low margins?

III.2 Data Understanding

To answer the aforementioned questions, we will need to understand the semantics of our data.

III.2.1 Sales

This table contains information about sales (date, customer, product, and costs).

Column	Description
Cal Date	Sale's date
Cust Sold To Nbr	Customer's number
Product 5-digit Code	Product's code
QTY Pieces	Products' quantity
VBR	Value-based rebate
ISV excl Log Sur	Invoiced sales value excluding logistic surcharge
Logistic Surcharge	Logistic surcharge due to delays in ports or such
COS	Cost of the product
Dist Costs	Distribution expenses

Table 1: Sales table

	QTY Pieces	VBR	ISV excl Log Sur	Logistic Surcharge	COS	Dist Costs
count	6.054870e+05	605487.000000	6.054870e+05	605487.000000	605487.000000	605487.000000
mean	1.395991e+03	-8.010553	4.442257e+02	1.798414	237.549062	24.964773
std	2.653016e+04	181.386871	3.433859e+03	36.888962	1275.116648	101.417216
min	-7.200000e+05	-25562.741873	-1.299681e+06	-4396.726150	-104438.440000	-5245.000000
25%	0.000000e+00	-1.270000	0.000000e+00	0.000000	0.000000	0.000000
50%	2.000000e+01	0.000000	9.294000e+01	0.000000	44.550000	5.830000
75%	2.160000e+02	0.000000	3.078000e+02	0.000000	155.960000	20.790000
max	8.000000e+06	32539.411602	1.299681e+06	10209.122676	224682.740000	12178.800000

Figure 1: Sales table numeric features

Modalities	
Product 5-digit Code	4395
Cust Sold To Nbr	4804

Figure 2: Sales table categorical features

III.2.2 Target

This table contains the target to be reached by sales representatives.

Column	Description
Month	Month in “Month Year” format
Region Sales Rep	Sales representative full name
Region Geography	Sales representative’s region
Target	Target to reach in terms of invoiced sales value

Table 2: Target table

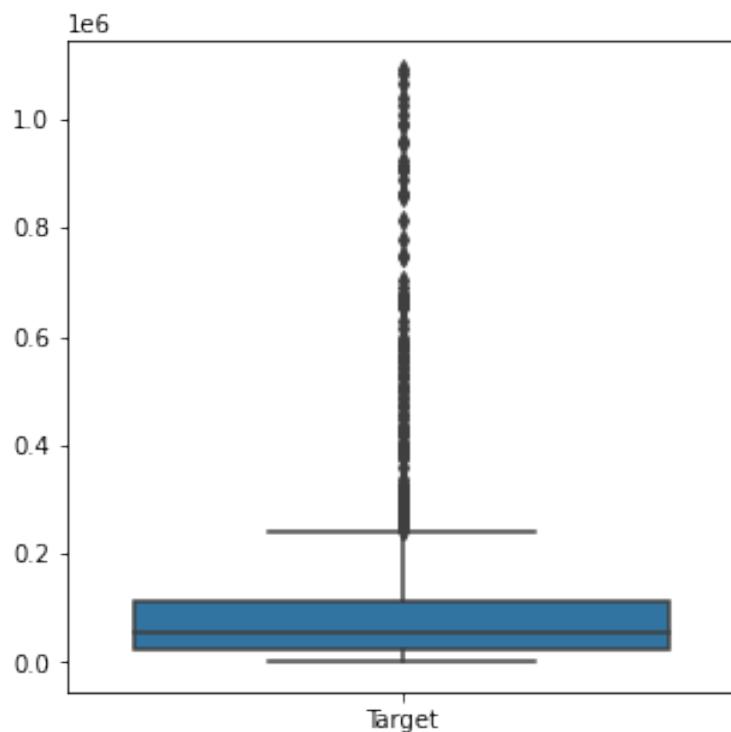


Figure 3: Target table numeric feature box plot

Modalities	
Month	12
Region Geography	31
Region Sales Rep	91

Figure 4: Target table categorical features

III.2.3 Customers

This table contains information about customers (identification and categorization).

Column	Description
Cust Sold To Nbr	Customer's number
Cust Sold To Name	Customer's name
Cust Sold To Country	Country where the customer is located
C-07	Customer's seventh category
C-06	Customer's sixth category
C-05	Customer's fifth category
C-04	Customer's fourth category
C-03	Customer's third category
C-02	Customer's second category
C-01	Customer's first category

Table 3: Customers table

Modalities	
C-01	2
C-02	7
C-03	10
C-04	22
Cust Sold To Country	66
C-05	1176
C-06	1423
C-07	2645
Cust Sold To Name	4358
Cust Sold To Nbr	4830

Figure 5: Customers table categorical features

III.2.4 Products

This table contains information about products (identification and categorization).

Column	Description
Product 5-digit Code	Product's code
P-08	Product's eighth category
P-07	Product's seventh category
P-06	Product's sixth category
P-05	Product's fifth category
P-04	Product's fourth category
P-03	Product's third category
P-02	Product's second category
P-01	Product's first category

Table 4: Products table

Modalities	
P-02	2
P-01	2
P-03	9
P-04	20
P-05	42
P-06	111
P-07	255
P-08	575
Product 5-digit Code	4445

Figure 6: Products table categorical features

III.2.5 Sales Managers

This table represents relationships between sales representatives and their managers.

Column	Description
Region Sales Rep	Sales representative full name
Region Sales Manager	Sales manager full name

Table 5: Sales Managers table

Modalities	
Region Sales Manager	26
Region Sales Rep	93

Figure 7: Sales Managers table categorical features

III.2.6 Sales Reps and Geographies

This table contains sales representatives' information (customers, products, name, and location).

Column	Description
Cust Sold To Nbr	Customer's number affiliated to the sales representatives
P-08	eighth category of product affiliated to the sales representative
Region Sales Rep	Sales representative full name
Region Geography	Sales representative region

Table 6: Sales Reps and Geographies table

Modalities	
Region Geography	32
Region Sales Rep	93
P-08	606
Cust Sold To Nbr	6080

Figure 8: Sales Reps and Geographies table categorical features

IV Design

In this phase, we will design the Business Intelligence solution. The design should demonstrate the following characteristics:

- **Feasible:** The design should be feasible with present technologies.
- **Stable:** The design should ensure the stability of the solution.
- **Flexible:** The design should be flexible. For instance, it should allow table schema modification.
- **Scalable:** The design should be scalable and answer the Business Intelligence workload.

IV.1 Functional Architecture

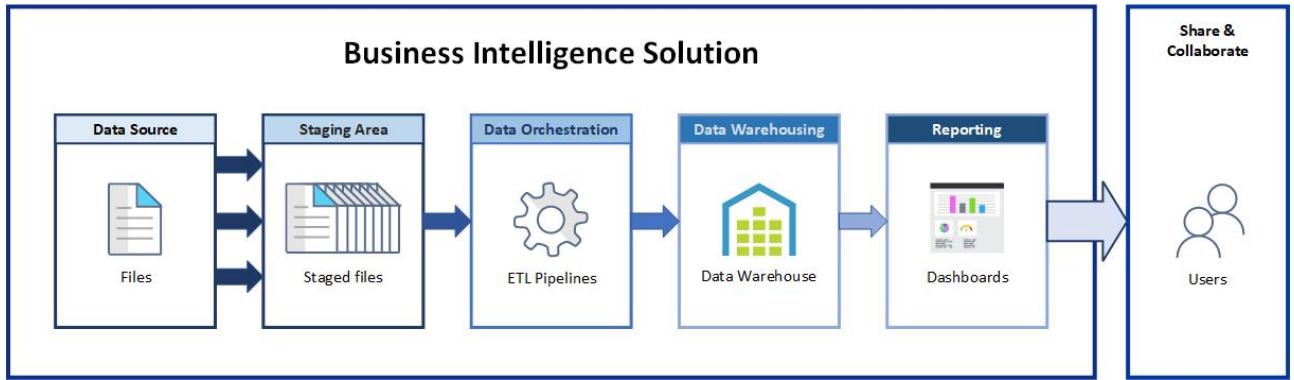


Figure 9: Functional Architecture

Data from the data source will be stored in a staging area before loading to the data warehouse. Next, it will be extracted, transformed, and loaded in the data warehouse using a data orchestration tool. Finally, the data insights will be shared with users using a reporting tool and through different collaboration channels.

IV.2 Technological Architecture

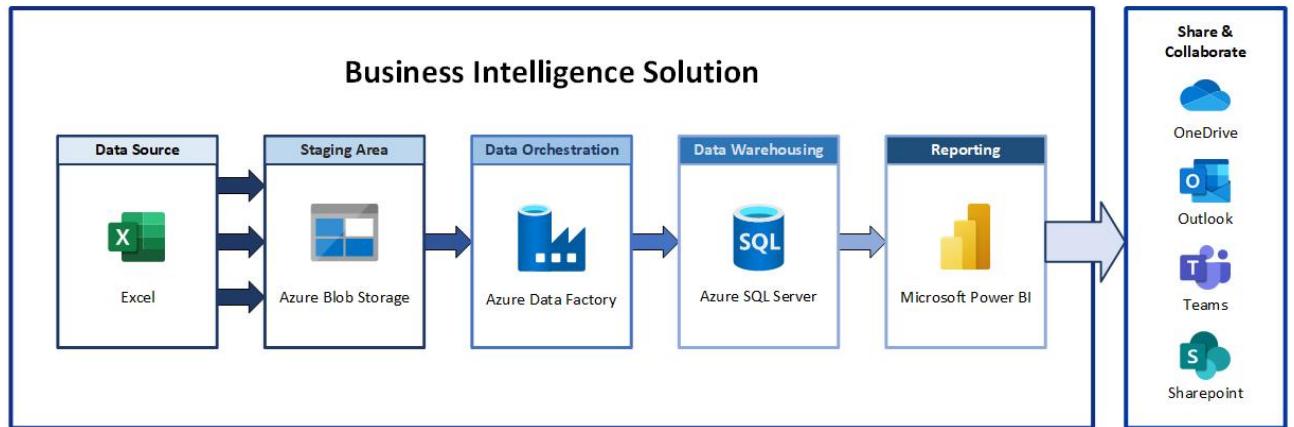


Figure 10: Technological Architecture

Excel files will be staged first in Azure Blob Storage. Then, Azure Data Factory will connect and extract data from the blob storage. After, it will transform it and load it to Azure SQL Server, the data warehouse. Finally, the Business Intelligence application will be developed using Microsoft Power BI that offers omnichannel sharing.

V Development

In this phase, we will explore the building bricks of the Business Intelligence solution.

V.1 Cloud resources provisioning

First, we organized the project resources in a resource group.

The screenshot shows the Azure Resource Group overview for the 'Salesxtest' resource group. At the top, there are navigation links like 'Home >' and a search bar. Below that is a toolbar with actions such as '+ Create', 'Edit columns', 'Delete resource group', 'Refresh', 'Export to CSV', 'Open query', 'Assign tags', 'Move', 'Delete', 'Export template', 'Feedback', and 'Open in mobile'. A 'JSON View' link is also present. The main area is divided into sections: 'Essentials' (Subscription: Visual Studio Enterprise Subscription – MPN, Deployment status: 3 Succeeded, Location: West Europe), 'Resources' (a table listing resources like Data factory, Storage account, SQL database, and SQL server), and 'Recommendations'. The 'Resources' table has columns for Name, Type, and Location. The table data is as follows:

Name	Type	Location
adfxsalesxtest	Data factory (V2)	West Europe
blobxsalesxtest	Storage account	West Europe
sales (sqxsalesxtest/sales)	SQL database	West Europe
sqlxsalesxtest	SQL server	West Europe

At the bottom, there are pagination controls: '< Previous', 'Page 1 of 1', and 'Next >'.

Figure 11: Azure Resource Group overview

Then, we provisioned an Azure Blob Storage resource to temporarily stage data.

The screenshot shows the Azure Blob Storage overview for the 'blobxsalesxtest' storage account. The left sidebar includes navigation links for Home, Overview, Activity log, Tags, Diagnose and solve problems, Access Control (IAM), Data migration, Events, Storage Explorer (preview), Data storage (Containers, File shares, Queues, Tables), Security + networking (Networking, Azure CDN, Access keys), and Help + feedback. The main content area displays the storage account details under the 'Essentials' section, including Resource group: Salesxtest, Location: West Europe, Subscription: Visual Studio Enterprise Subscription – MPN, Disk state: Available, and Tags: Layer : Staging. Below this, there are tabs for Properties, Monitoring, Capabilities (7), Recommendations, Tutorials, and Developer Tools. The 'Properties' tab is active, showing settings for Blob service (Hierarchical namespace: Disabled, Default access tier: Hot, Blob public access: Enabled, Blob soft delete: Enabled (7 days), Container soft delete: Enabled (7 days), Versioning: Disabled, Change feed: Disabled) and Security (Require secure transfer for REST API operations: Enabled, Storage account key access: Enabled, Minimum TLS version: Version 1.2, Infrastructure encryption: Disabled). There are also sections for Networking (Allow access from: All networks) and a summary table with metrics like Requests, Throughput, and Latency.

Figure 12: Azure Blob Storage overview

We provisioned an Azure Data Factory resource to orchestrate data between the staging area and the data warehouse.

adfxsalesxtest Data factory (V2)

Essentials

- Resource group (change) : Salesxtest
- Status : Succeeded
- Location : West Europe
- Subscription (change) : Visual Studio Enterprise Subscription – MPN
- Subscription ID :

Type : Data factory (V2)

Getting started : Quick start

Getting started

- Open Azure Data Factory Studio Start authoring and monitoring your data pipelines and data flows. [Open](#)
- Read documentation Learn how to be productive quickly. Explore concepts, tutorials, and samples. [Learn more](#)

Monitoring

PipelineRuns	ActivityRuns
100	100
80	80
60	60

Figure 13: Azure Data Factory overview

Finally, we provisioned an Azure SQL Database to store the high-quality data.

sales (sqlxsalesxtest/sales) SQL database

Overview

Essentials

- Resource group (change) : Salesxtest
- Status : Online
- Location : West Europe
- Subscription (change) : Visual Studio Enterprise Subscription – MPN
- Subscription ID :
- Tags (change) : Layer: Data Warehouse

Server name : sqlxsalesxtest.database.windows.net

Elastic pool : No elastic pool

Connection strings : Show database connection strings

Pricing tier : Basic

Earliest restore point : 2021-10-20 18:44 UTC

Show data for last: 1 hour 24 hours 7 days

Aggregation type: Max

Compute utilization

Database data storage

5.86% USED SPACE

Used space 120 MB Allocated space 224 MB

Figure 14: Azure SQL Database overview

V.2 Staging

Initially, we placed the flat files into the blob storage.

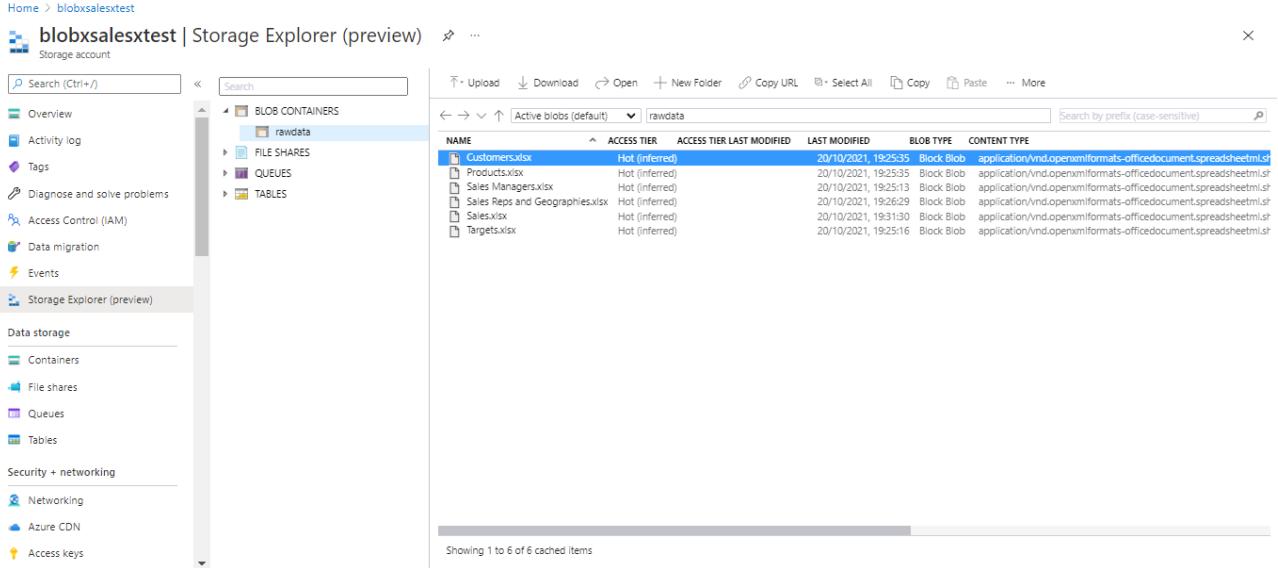


Figure 15: Staging area in Azure Blob Storage's Storage Explorer

V.3 Data Warehousing

Then, we designed the data warehouse.

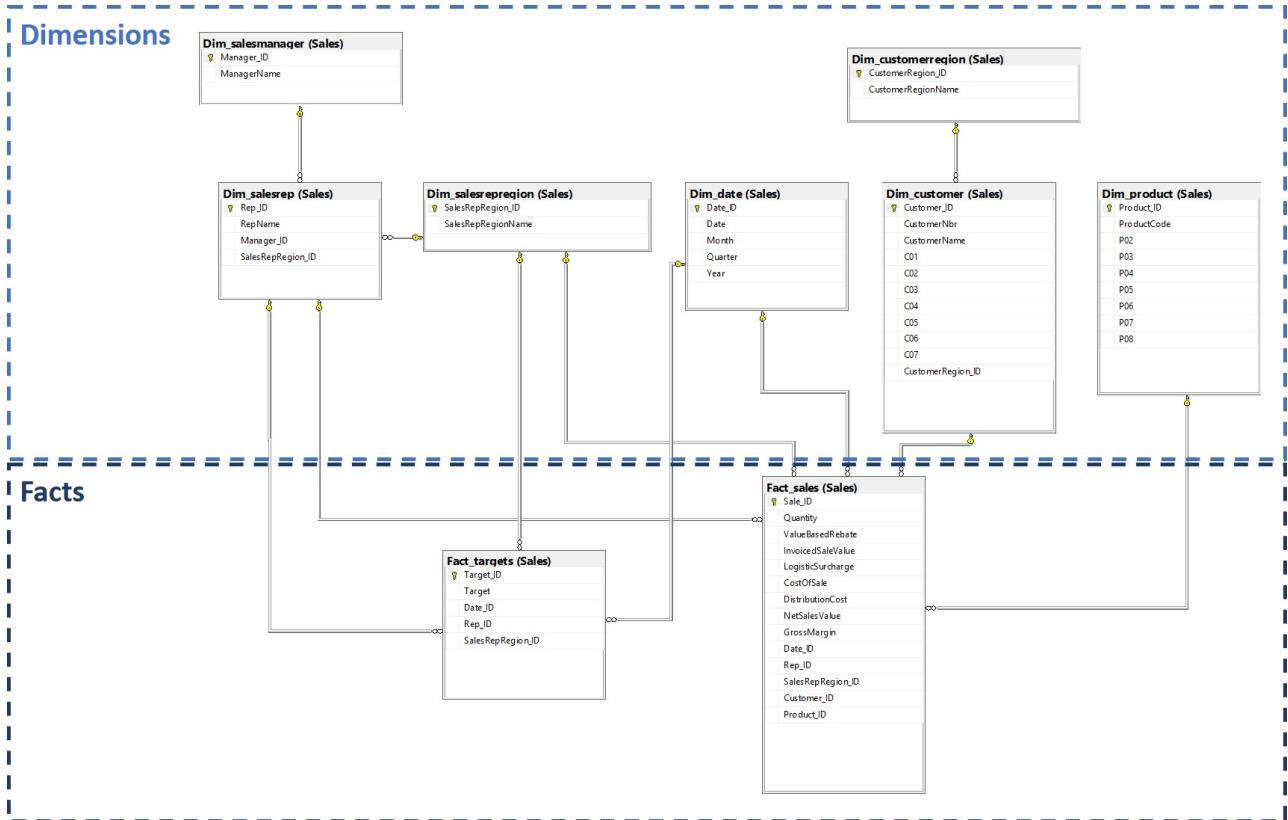


Figure 16: Data Warehouse Diagram in SQL Server Management Service

The data warehouse contains two fact tables and seven dimensions:

V.3.1 Fact tables

Column	Description	Type
Sale_ID	Sale unique identifier	Integer
Quantity	Product's quantity	Decimal (30, 20)
ValueBasedRebate	Value based rebate	Decimal (30, 20)
InvoicedSaleValue	Invoiced sale value excluding logistic surcharge	Decimal (30, 20)
LogisticSurcharge	Logistic surcharge	Decimal (30, 20)
CostOfSale	Cost of sale	Decimal (30, 20)
DistributionCost	Distribution charge	Decimal (30, 20)
NetSalesValue	Invoiced sale value + Value based rebate + Logistic surcharge	Decimal (30, 20)
GrossMargin	Net sales value - Cost of sale - Distribution cost	Decimal (30, 20)
Date_ID	Date unique identifier	Integer
Rep_ID	Sales representative unique identifier	Integer
SalesRepRegion_ID	Sales representative region unique identifier	Integer
Customer_ID	Customer unique identifier	Integer
Product_ID	Product unique identifier	Integer

Table 7: Fact_sales table

Column	Description	Type
Target_ID	Target unique identifier	Integer
Target	Target value	Decimal (30, 20)
Date_ID	Date unique identifier	Integer
Rep_ID	Sales representative unique identifier	Integer
SalesRepRegion_ID	Sales representative region unique identifier	Integer

Table 8: Fact_targets table

V.3.2 Dimensions

Column	Description	Type
Date_ID	Date unique identifier	Integer
Date	Date	Date
Month	Month number	Integer
Quarter	Quarter number	Integer
Year	Year	Integer

Table 9: Dim_date table

Column	Description	Type
Rep_ID	Sales representative unique identifier	Integer
RepName	Sales representative name	Varchar (25)
Manager_ID	Sales manager unique identifier	Integer
SalesRepRegion_ID	Sales representative region unique identifier	Integer

Table 10: Dim_salesrep table

Column	Description	Type
Customer_ID	Customer unique identifier	Integer
CustomerNbr	Customer number	Char (10)
CustomerName	Customer name	Varchar (40)
C01	Customer's first category	Varchar (17)
C02	Customer's second category	Varchar (14)
C03	Customer's third category	Varchar (16)
C04	Customer's fourth category	Varchar (31)
C05	Customer's fifth category	Varchar (35)
C06	Customer's sixth category	Varchar (35)
C07	Customer's seventh category	Varchar (35)
CustomerRegion_ID	Customer region unique identifier	Integer

Table 11: Dim_customer table

Column	Description	Type
Product_ID	Product unique identifier	Integer
ProductCode	Product code	Varchar (17)
P02	Product's second category	Varchar (31)
P03	Product's third category	Varchar (31)
P04	Product's fourth category	Varchar (33)
P05	Product's fifth category	Varchar (40)
P06	Product's sixth category	Varchar (40)
P07	Product's seventh category	Varchar (40)
P08	Product's eighth category	Varchar (40)

Table 12: Dim_product table

Column	Description	Type
SalesRepRegion_ID	Sales representative region unique identifier	Integer
SalesRepRegionName	Region where sales representatives are responsible	Varchar (25)

Table 13: Dim_salesrepregion table

Column	Description	Type
Manager_ID	Manager unique identifier	Integer
ManagerName	Sales manager name	Varchar (25)

Table 14: Dim_salesmanager table

Column	Description	Type
CustomerRegion_ID	Customer region unique identifier	Integer
CustomerRegionName	Region where customers are located	Varchar (25)

Table 15: Dim_customerregion table

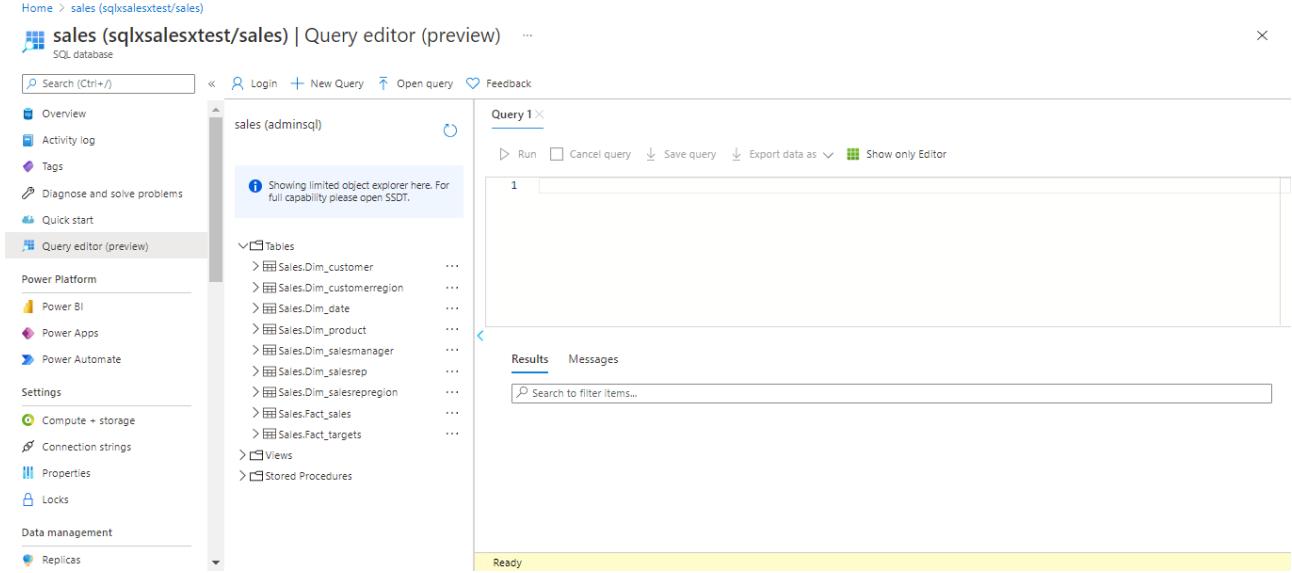


Figure 17: Data Warehouse in Azure SQL Database Query Editor

V.4 Data Orchestration

Afterward, we developed an ETL pipeline that will extract and transform data from flat files to load it in the corresponding tables in the data warehouse. This ETL includes eight data flows, where each populates a table in the data warehouse.

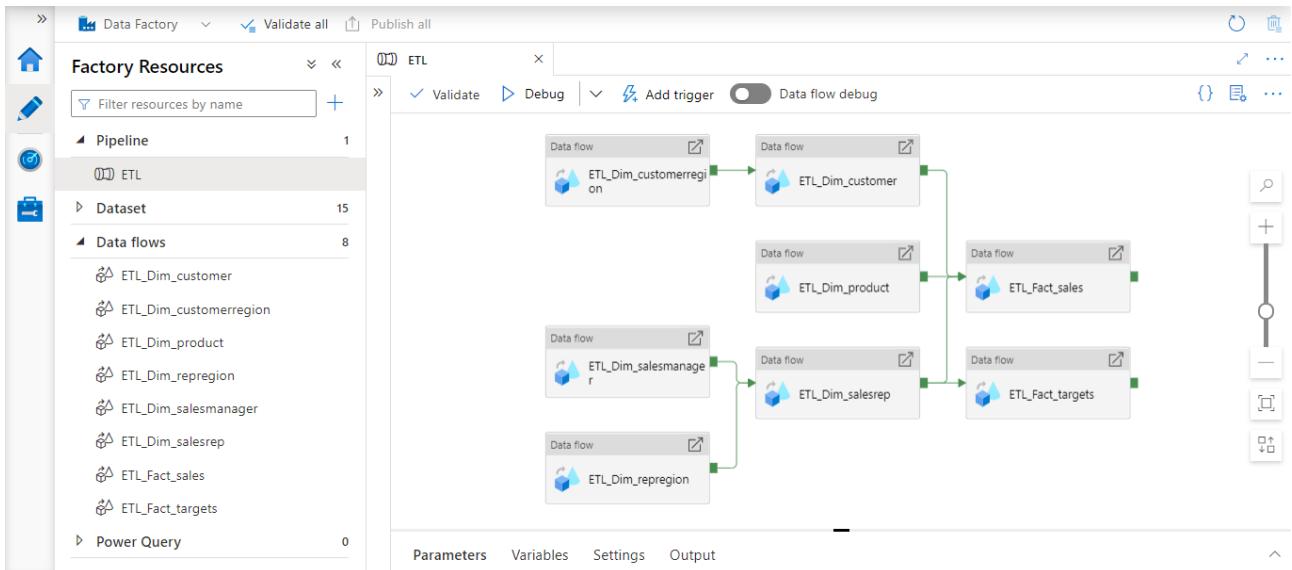


Figure 18: ETL Pipeline in Azure Data Factory authoring window

We will explore, as an example, the data flow ETL_Dim_customerregion. First, we filter “Sales.xlsx” to keep only rows with actual sale (quantity different from zero). Then we join the result set with “Customers.xlsx” on “Cust Sold To Nbr”. Afterward, we aggregate on

“Cust Sold To Country” using count to drop duplicated countries. We rename the column “Cust Sold To Country” to “CustomerRegionName” using Select transformation. We sort the result set alphabetically. We create a unique identifier. Finally, we insert the result in the “Dim_customerregion” table.

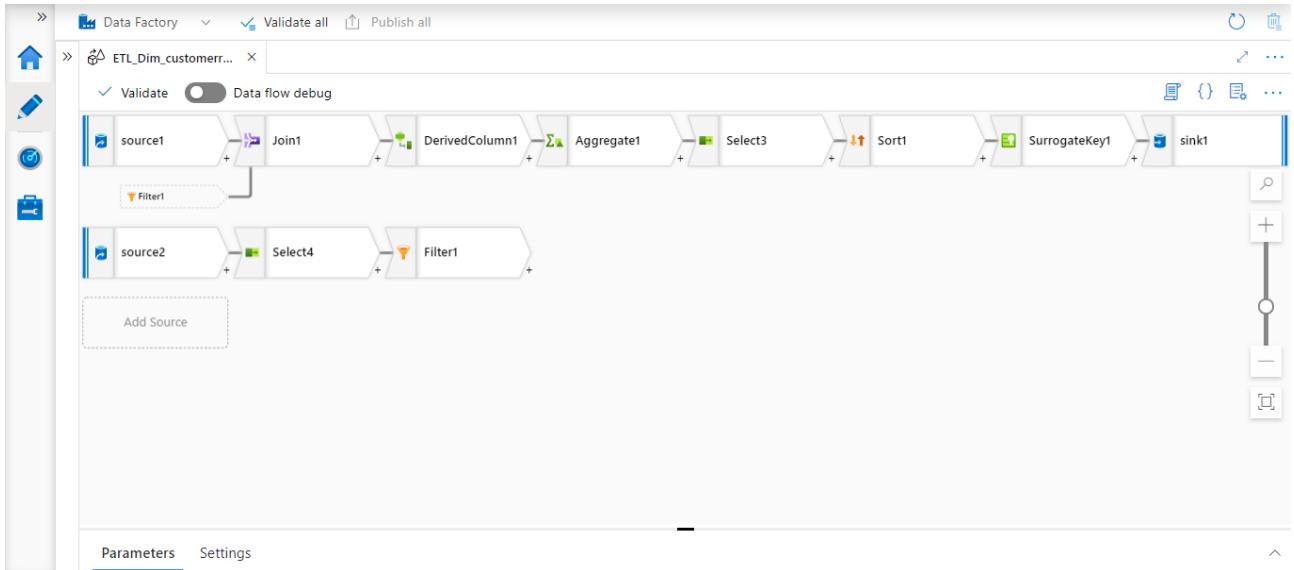


Figure 19: Data Flow in Azure Data Factory authoring window

N.B: Dim_date is populated during the creation of the data warehouse with create_data_warehouse.sql .

V.5 Reporting

We connected Microsoft Power BI desktop to the data warehouse, and we generated an eight pages report.

The “Business Growth by Product” page analyzes growth by products and categories, the gross margin percentage evolution, the year-over-year change in gross margin percentage, and the quantity and net sales value evolution.

Business Growth by Product

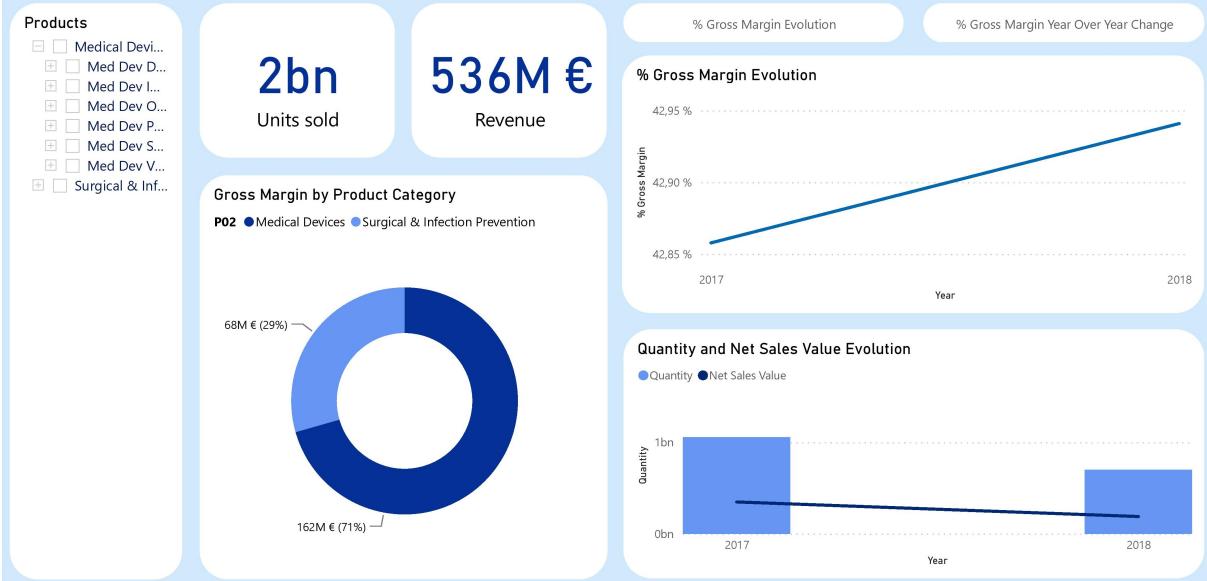


Figure 20: Business Growth by Product

The “Business Growth by Customer” page analyzes growth by customers and categories, the gross margin percentage evolution, the year-over-year change in gross margin percentage, and the quantity and net sales value evolution.

Business Growth by Customer

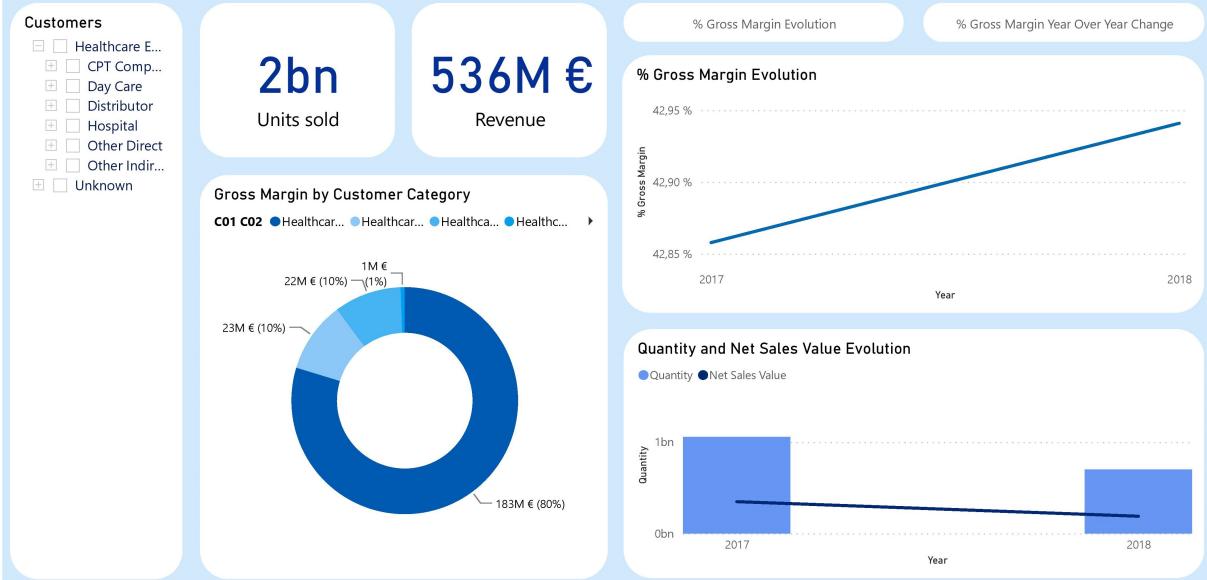


Figure 21: Business Growth by Customer

The “Business Growth by Region” page analyzes growth by customer region and sales representative region, the gross margin percentage evolution, the year-over-year change in gross margin percentage, and the quantity and net sales value evolution.

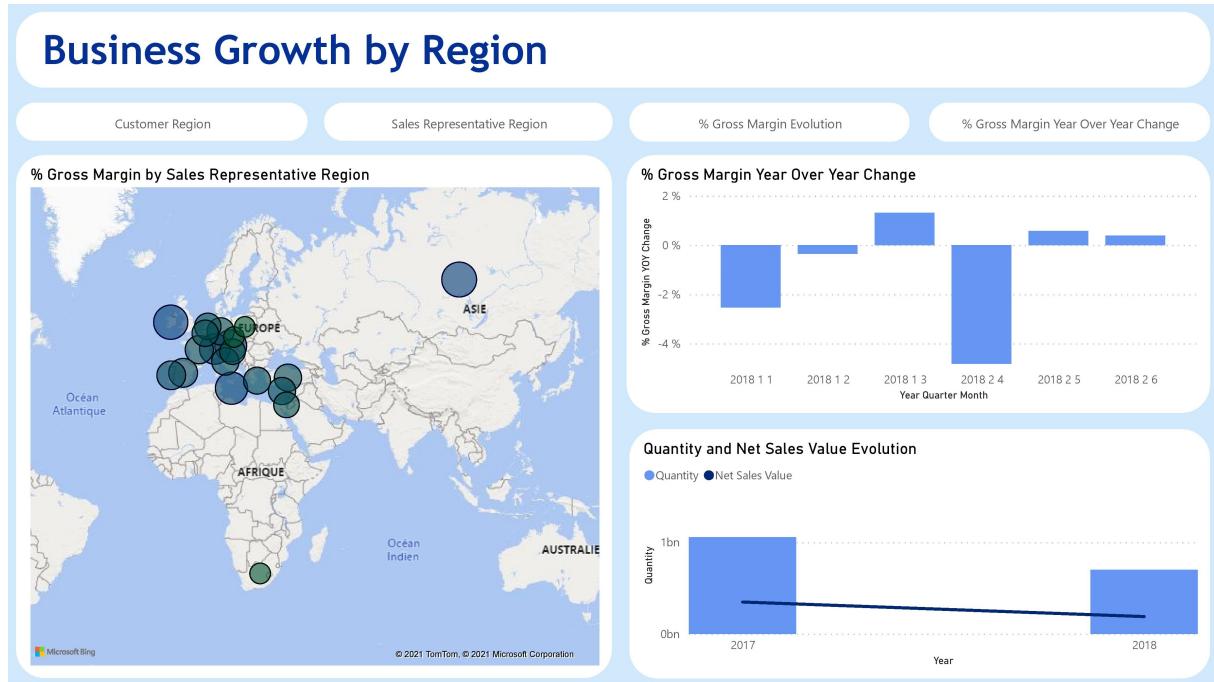


Figure 22: Business Growth by Region

The “Business Performance 2018” page contrasts sales and targets during the first semester of 2018, and shows business performance compared to the target by sales representative region, by the sales representative, and by the sales manager.

Business Performance 2018

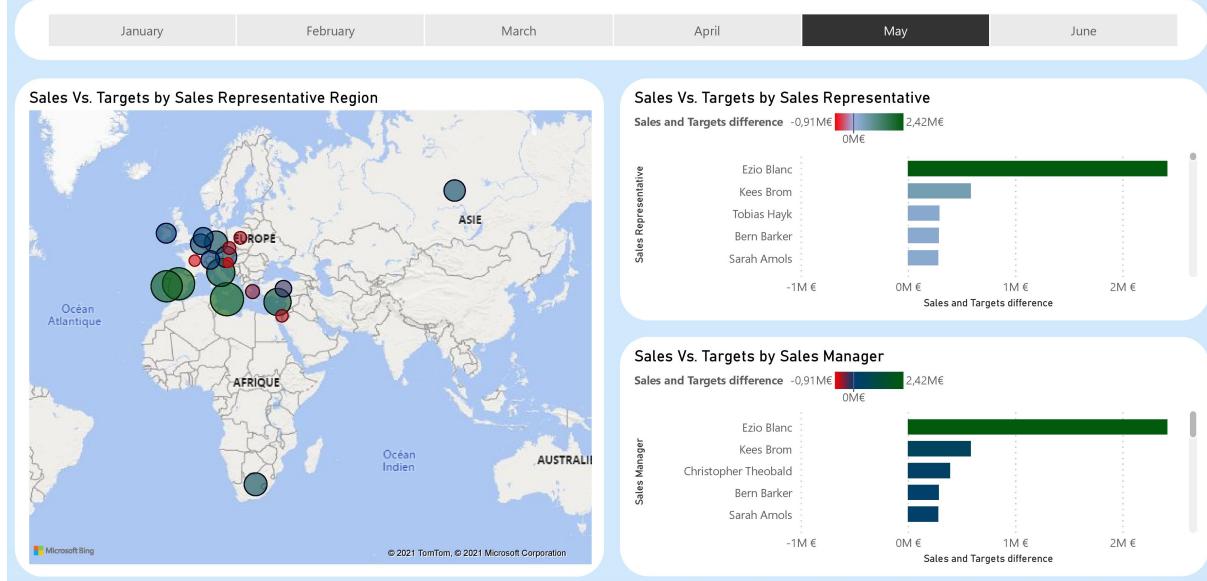


Figure 23: Business Performance in 2018

The “Business Growth Opportunities” page provides growth opportunities by the sales manager and sales representative. In other words, it shows gross margin percentage value during a certain period by the sales manager and by the sales representative.

Business Growth Opportunities

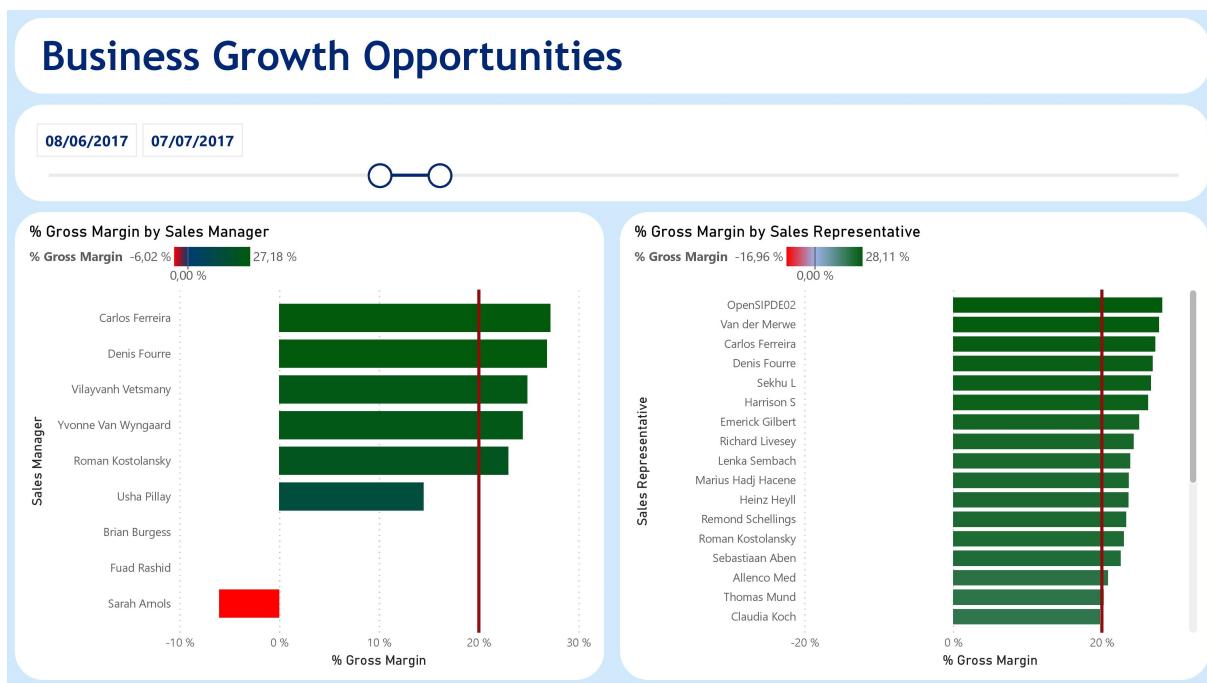


Figure 24: Business Growth Opportunities

The “Business Evolution” page displays the wholesale business evolution.

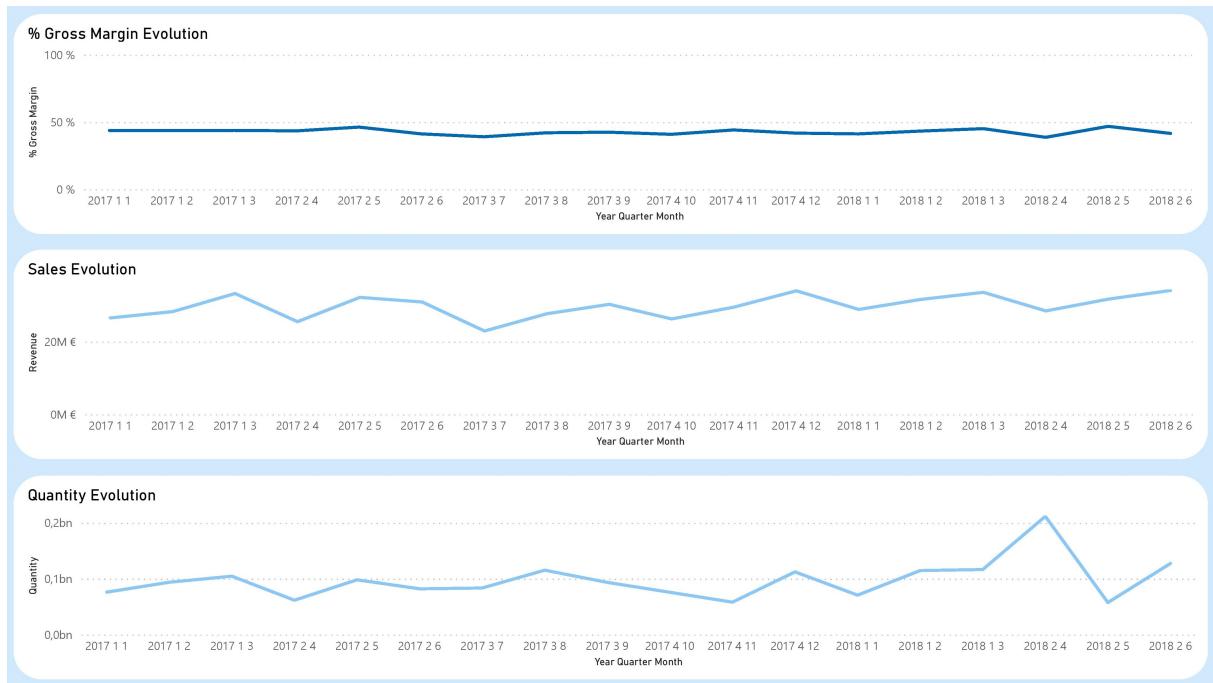


Figure 25: Business Evolution

The “Customer Details Matrix” page gives all sales details about customers and highlights customers with whom the business is having a low gross margin.

C01	Quantity	Value Based Rebate	Distribution Cost	Cost Of Sale	Logistic Surcharge	Invoiced Sale Value	Gross Margin	Net Sales Value
Healthcare Europe	1 756M	-7,35M€	22,07M€	284,17M€	2,18M€	541,37M€	229,96M€	536,20M€
CPT Company	47M	-0,16M€	1,58M€	35,57M€	0,01M€	59,35M€	22,05M€	59,20M€
CPT Company	47M	-0,16M€	1,58M€	35,57M€	0,01M€	59,35M€	22,05M€	59,20M€
CPT Company	47M	-0,16M€	1,58M€	35,57M€	0,01M€	59,35M€	22,05M€	59,20M€
AB Medica s.p.a.	1M	0,00M€	0,07M€	0,88M€	0,01M€	1,25M€	0,30M€	1,26M€
AB Medica s.p.a.	1M	0,00M€	0,07M€	0,88M€	0,01M€	1,25M€	0,30M€	1,26M€
AB Medica s.p.a.	1M	0,00M€	0,07M€	0,88M€	0,01M€	1,25M€	0,30M€	1,26M€
Alcon	11M	0,00M€	0,24M€	7,49M€	0,00M€	11,77M€	4,04M€	11,77M€
Angiokard Medizintechnik GmbH	0M	0,00M€	0,03M€	0,35M€	0,00M€	0,52M€	0,14M€	0,52M€
ArcRoyal Ltd	2M	0,03M€	0,11M€	2,08M€	0,01M€	3,10M€	0,94M€	3,13M€
B Braun Medical	5M	-0,01M€	0,49M€	17,94M€	0,00M€	30,01M€	11,56M€	29,99M€
Banta RR Donnelley	0M	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€
Beaver Visitec International	1M	0,00M€	0,02M€	0,17M€	0,00M€	0,27M€	0,08M€	0,27M€
Biometrix s.r.o.	0M	0,00M€	0,01M€	0,45M€	0,00M€	0,55M€	0,08M€	0,55M€
Blink Medical	0M	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€
Cemed / JR herzchir. OP Sets	0M	0,00M€	0,04M€	0,39M€	0,00M€	0,85M€	0,42M€	0,85M€
Clonallion Laboratories Limited	0M	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€
Total	1 756M	-7,35M€	22,07M€	284,17M€	2,18M€	541,37M€	229,96M€	536,20M€

Figure 26: Customer Details Matrix

The “Product Details Matrix” page gives all sales details about products and highlights products that generate low gross margin.

P02	Quantity	Value Based Rebate	Distribution Cost	Cost Of Sale	Logistic Surcharge	Invoiced Sale Value	Gross Margin	Net Sales Value
Medical Devices	141M	-4,45M€	7,25M€	127,46M€	1,24M€	300,22M€	162,30M€	297,01M€
Med Dev Digestive Health	46M	-2,59M€	2,24M€	41,30M€	0,75M€	124,61M€	79,23M€	122,77M€
Digestive Health Diagnostics	0M	-0,02M€	0,07M€	0,23M€	0,06M€	0,59M€	0,33M€	0,63M€
Digestive Health Diagnostics	0M	-0,02M€	0,07M€	0,23M€	0,06M€	0,59M€	0,33M€	0,63M€
Digest Health Diagnostics Clotest	0M	-0,02M€	0,07M€	0,23M€	0,06M€	0,59M€	0,33M€	0,63M€
Clotest Rapid Urease Tests	0M	-0,02M€	0,07M€	0,23M€	0,05M€	0,59M€	0,33M€	0,63M€
Clotest Rapid Urease Tests	0M	-0,02M€	0,07M€	0,23M€	0,05M€	0,59M€	0,33M€	0,63M€
Jack Bean Urease Control Tablets	0M	0,00M€	0,00M€	0,00M€	0,00M€	0,00M€	-0,00M€	0,00M€
Digestive Health Endoscopy	0M	-0,00M€	0,04M€	0,10M€	0,03M€	0,15M€	0,04M€	0,18M€
Digestive Health Enteral Feeding	45M	-2,57M€	2,13M€	40,97M€	0,66M€	123,87M€	78,86M€	121,96M€
Med Dev IV Infusion Products	13M	-0,97M€	2,58M€	32,55M€	0,03M€	58,78M€	22,71M€	57,84M€
Med Dev Other	0M	-0,01M€	0,03M€	0,74M€	0,00M€	2,02M€	1,24M€	2,01M€
Med Dev Pain Mgmt	1M	0,00M€	0,70M€	12,57M€	0,02M€	25,60M€	12,35M€	25,62M€
Med Dev Surgical Pain	1M	-0,55M€	0,33M€	21,58M€	0,03M€	44,75M€	22,32M€	44,23M€
Total	1 756M	-7,35M€	22,07M€	284,17M€	2,18M€	541,37M€	229,96M€	536,20M€

Figure 27: Product Details Matrix

VI Deployment

In this phase, we will explore the deployment of our solution.

VI.1 Application

After developing our report, we created a Power BI Server workspace and published our report to it.

Figure 28: Microsoft Power BI workspace

At that point, we packaged and deployed our application.

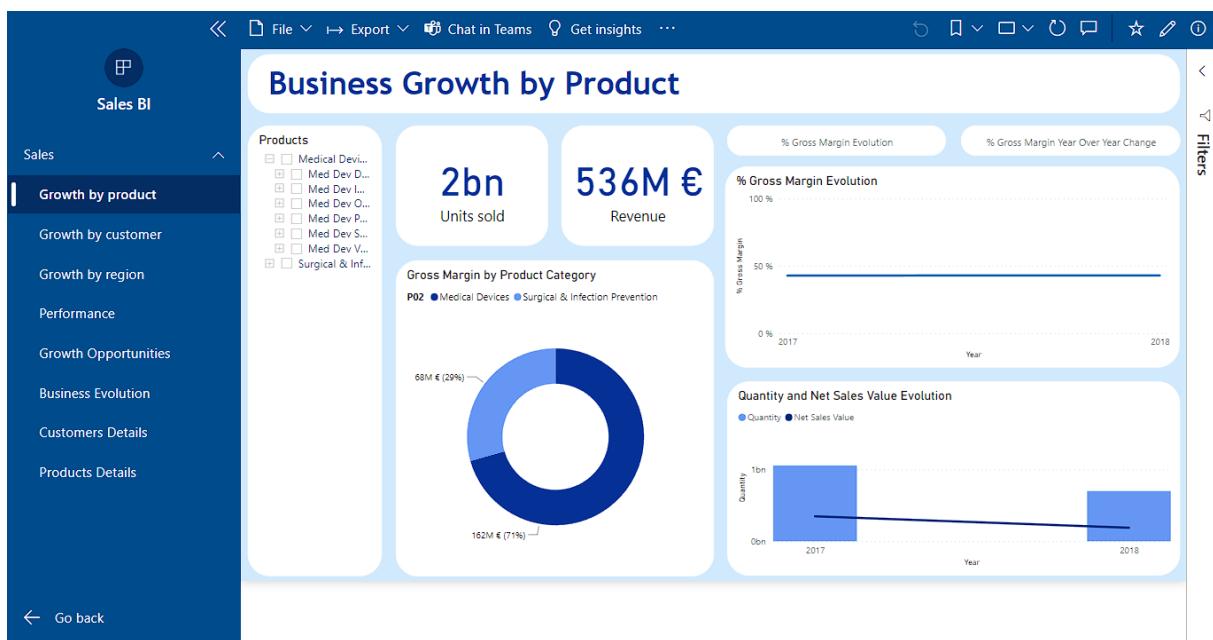


Figure 29: Microsoft Power BI application

VI.2 Administration

Users in the organization should be granted permission on the Power BI workspace and to the various cloud resources with specific roles depending on their interaction with the solution.

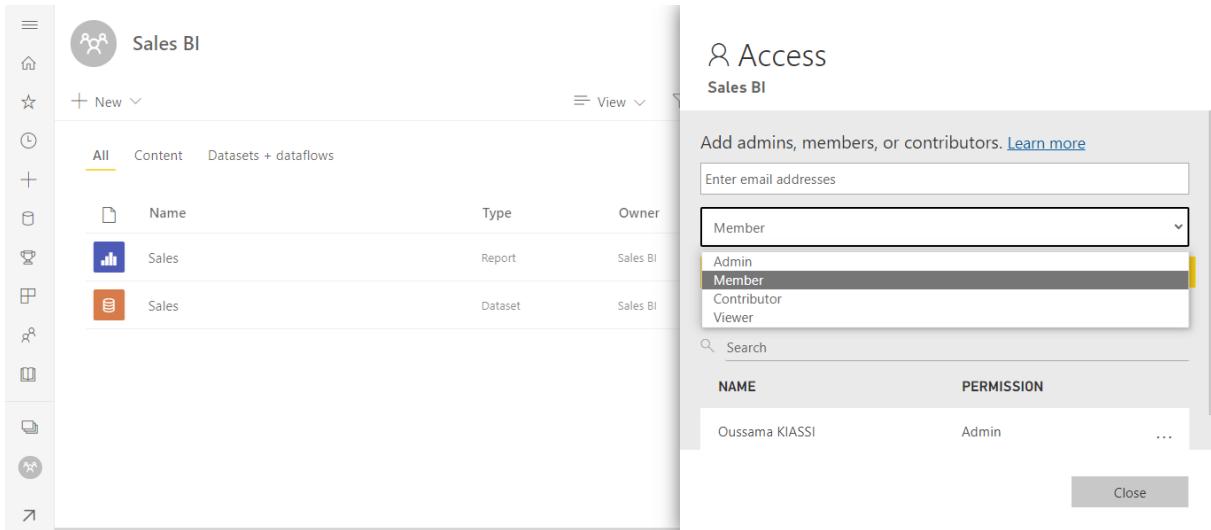


Figure 30: Microsoft Power BI workspace access

We included row-level security in our solution to allow personalized visibility to managers, they can access only data in their scope.

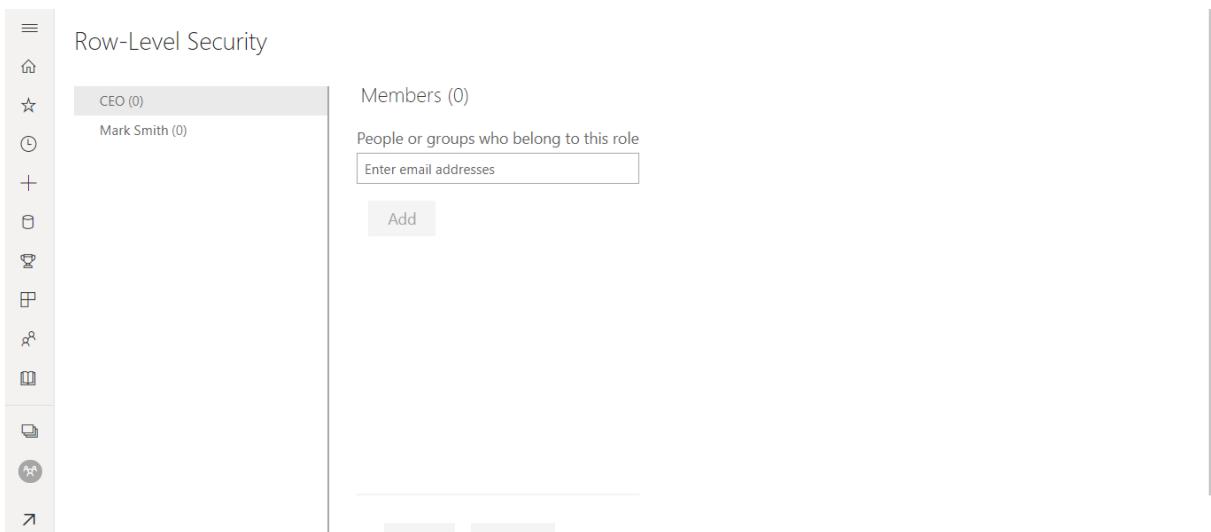


Figure 31: Microsoft Power BI Server row-level security

N.B: We might also add the email to Dim_salesmanager or other tables to enhance row-level access strategy.

Users outside the organization should be added first to the organization's Azure Active Directory and then to the Power BI workspace.

VII Key Takeaways

Thanks to our solution, we can precisely answer our business problem:

- The wholesale business did not evolve that much.

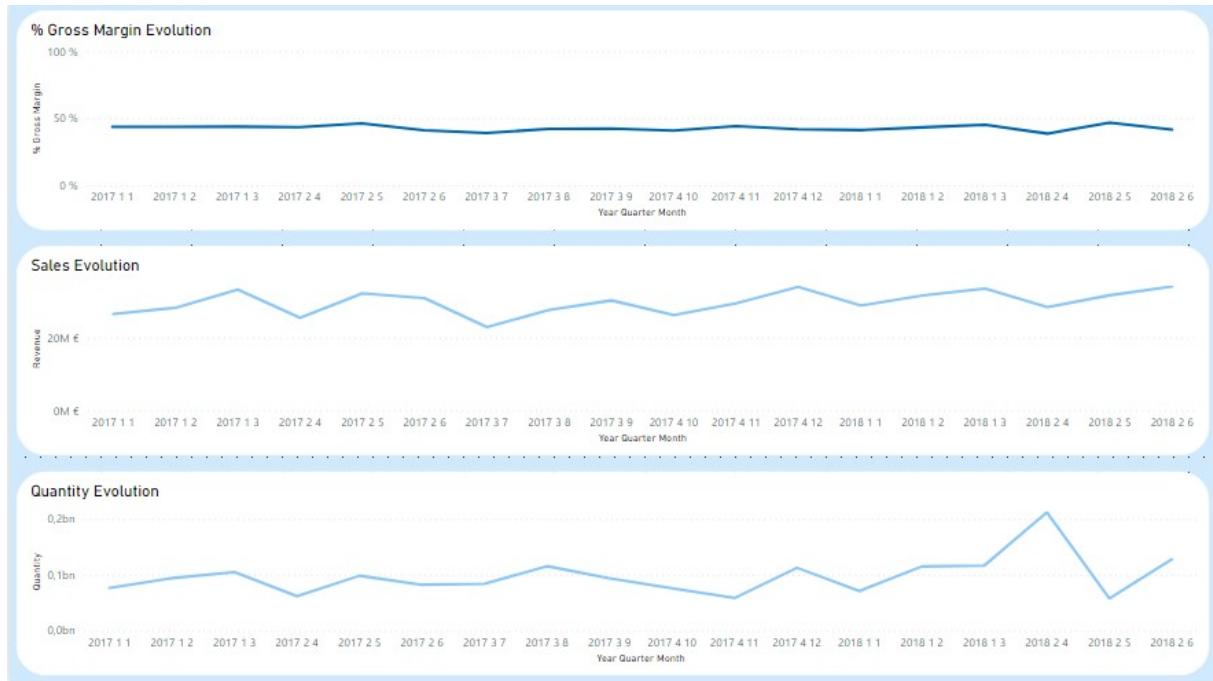


Figure 32: How are the sales' performance and evolution?

- No region is completely behind the target. Two persons did not reach the goal, who are both sales representative and manager: Kees Brom and Sarah Arnals.

Business Performance 2018

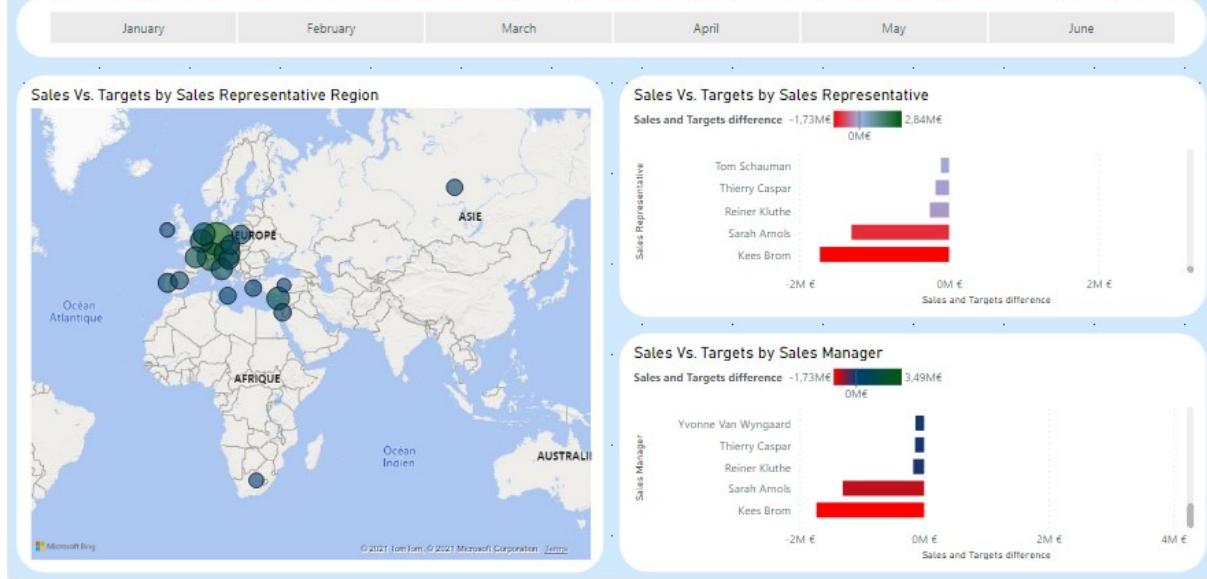


Figure 33: How are we performing compared to the target?

- Usha Pillay is the sales representative with the lowest gross margin percentage (negative margin).

Business Growth Opportunities



Figure 34: Where do sales make low margins?