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ANALYSIS OF TOP SELLING PRODUCTS USING BUSINESS INTELLIGENCE

TANJA STEFANOVA, ZORAN ZDRAVEV AND ALEKSANDAR VELINOV

Abstract. Recently, there are three significant periods, which changed the world in almost all aspects – health, economy, education, travel and tourism, way of working, global cooperation, global energy crisis etc. Based on that, this paper analyses the top selling product in a company for each period, and presents their selling trend. The analysis was performed on a dataset from a company selling print services and products, using the concept of Business Intelligence (BI), i.e. the powerful combination of Data Warehouse (DWH), ETL process and PowerBI. The results of the research confirmed that the announced periods made a significant impact on the world, businesses, and customer behavior. On the other side, the tools that we used in the research proved to be effective in transforming data and analyzing customer behavior.

1. Introduction

The most significant recent events that made a huge impact and changed the world are the COVID-19 pandemic and the Russian invasion of Ukraine.

The COVID-19 pandemic made a huge impact on the world in a few ways: public health (the importance of public health infrastructure was highlighted and investment in this area was increased), economy (closed businesses, loosed jobs, economies struggling to recover etc.), education (disrupted education around the world, many schools and universities closed and/or shifted to online learning), travel and tourism (closed borders and travel restrictions), remote work (businesses forced to adopt remote work policies – the new normal), mental health (many people experiencing anxiety, depression, and other mental issues) and global cooperation (highlighted need of global cooperation in addressing global challenges such as pandemics and climate change).

The Russian invasion of Ukraine, on the other side has caused: humanitarian crisis (civilians caught in the crossfire and displaces from their homes, shortages of food, water and medical supplies, not only in Ukraine but widespread), economic impact (the sanctions and restrictions that are imposed by the international community leads to economic disruptions and a global recession) and geopolitical tensions (worsen geopolitical tensions between Russia and the West, potentially leading to implications for global security, international diplomacy and cooperation).

Because of the above, the analysis on the dataset from a company selling print services and products, using BI, has been done. During the analysis, the top selling products were selected and their selling trend was compared based on three periods: “Period 1” – before the COVID-19 pandemic (from 01 January 2013 until 30 December 2019), “Period 2” – the COVID-19 pandemic (from 31 December 2019 until 23 February 2022) and “Period

Keywords. Top selling product, Data Warehouse, ETL process, PowerBI.

3” – the start of the Russian invasion of Ukraine (from 24 February 2022 until 31 December 2022).

Why these periods are chosen? These three periods represent crucial milestones in global economic history as they caused significant changes in the way the world functioned. Each of these periods brought about unique challenges and opportunities for businesses worldwide, leading to changes in customer behavior and the demand for different products.

The rest of the paper is structured as follows: “Section 2” – presents the research objectives, “Section 3” – presents the source data the research is based on, “Section 4” – describes the tools used in the research, “Section 5” – presents the methodology used for data transformations and analysis, “Section 6” – presents the results from the research and discussion, and “Section 7” gives the general conclusion of the research.

2. Research Objectives

The objective of this research is to identify and analyze the top selling products during the three significant periods.

Through this research, we aim to provide insights into the changing dynamics of the market during the three periods from the prism of one company selling print services and products, and analyze its top-selling products during each of these periods. The study will examine how consumer behavior shifted. It will also provide an understanding of how the top-selling products evolved with the changes in demand.

Additionally, this research will delve into one of the most important parts of an organization – the profit, and how it has changed over the periods. Furthermore, it will identify the most influential human factors that affected the success of the business.

3. Research data

Data is the foundation upon which any research is built. It is the raw material that researchers use to draw conclusions and make decisions. It can come in various forms. Regardless of the form, data is the backbone of the research, and without it, researchers would not be able to answer critical research questions or test hypotheses [9].

In order for data to be analyzed, it first needs to be transformed into a readable format. This process is known as data preparation. Data preparation involves several steps, including data cleaning, data transformation, and data integration.

Data cleaning involves removing any errors or inconsistencies in the data, such as missing values, duplicates, or outliers. Data transformation involves converting the data into a format that is suitable for analysis, such as scaling or normalizing the data. Data integration involves combining data from multiple sources into a single dataset [11]. This can be a complex process, as different datasets may have different formats or structures.

Data preparation is a critical step in the research process, as the quality of the data directly affects the validity and reliability of the research findings. By ensuring that the

data is prepared correctly, researchers can increase the accuracy and credibility of their research results.

In order to prepare the data that is used in the research, a solution using Visual Studio was built. The solution has been built using four projects: “Source Database”, “Data Warehouse”, “Daily ETL” and “Multidimensional Cube”. Each project has a specific role in the solution, and together they provide a comprehensive data management and analysis solution.

The first project, Source Database, creates the MS SQL database, with size of 40.551GB, containing the source data. Since this data comes from a company selling print services and products, it consists of 19 tables that serve different purposes and support various aspects of the retailer's operations. Some of the main tables in the database are:

- Sales – contains information about each sale, including the date, customer, salesperson, and products sold. Serves to track the retailer's sales and revenue over time. This table presents the base of the research with more than 5000000 records;
- Customers – contains information about each customer, including their name, address, and contact details. Serves to manage customer information and provide insights into customer behavior and preferences;
- Products – contains information about each product sold by the retailer, including its name, description, and price. Serves to manage product information and provide insights into product sales and popularity;
- Suppliers – contains information about each supplier that provides products to the retailer. Serves to manage supplier information and track the retailer's relationships with its suppliers;
- Stock – contains information about the retailer's current stock levels for each product. Serves to manage inventory and ensure that the retailer has sufficient stock to meet customer demand;
- Purchase Orders – contains information about each purchase order that the retailer has made to its suppliers. Serves to manage the ordering process and track the retailer's purchases.

When this project is published, the database can be seen in the SQL Server with all its data. This database is transactional i.e., represents the OLTP (Online Transaction Processing), which means that it focuses on managing and executing individual transactions in real-time or near-real-time.

It is important to note that the database used in this research is proprietary and confidential, graciously made available by the cooperating company for the purpose of advancing this study. Unfortunately, due to the sensitive and proprietary nature of this data, the company has imposed restrictions that prevent us from publicly sharing the database itself. We respect and understand these constraints and are unable to grant access to the dataset beyond the scope of the research. However, we remain committed to providing as much detail as possible regarding the dataset's structure and content within the confines of these confidentiality agreements.

The rest of the data transformation projects are covered in Section 5.

4. Used Tools

In conducting research, the use of appropriate tools is critical in ensuring the accuracy, validity, and reliability of the findings. The tools used in this research are:

- SQL Server 2016 (with Integration Services (SSIS) and Analysis Services (SSAS)) [14];
- SQL Management Studio (version 18) [15];
- Visual Studio 2019 with SQL Server Data Tools [16];
- PowerBI (version 2.116.966.0) [17].

The use of these tools plays a vital role in enabling researchers to manipulate and analyze data effectively.

SQL Server 2016 is a relational database management system (RDBMS) designed and developed by Microsoft Corporation. This tool is used to store, retrieve, and manage large amounts of data. It is widely used in research because it can handle large amount of data and it has a robust security model, and provides high availability and disaster recovery capabilities [3].

Integration Services (SSIS) is a tool used for building, deploying, and managing data integration solutions. It provides a platform for extracting, transforming, and loading data from various sources into a target database. Researchers use SSIS to automate the process of extracting and transforming data from various sources and loading it into a database for analysis [6].

Analysis Services (SSAS) is a tool used for building and deploying analytical solutions. It enables researchers to create multidimensional data models, data mining models, and BI solutions. Researchers use SSAS to perform complex data analysis, generate reports, and provide insights into the data [7].

SQL Management Studio is an integrated environment used for managing and administering SQL Server databases. It is a widely used tool in research because it provides an easy-to-use interface for managing and analyzing databases [4].

Visual Studio 2019 with SQL Server Data Tools is an integrated development environment (IDE) designed for building applications, websites, and services. It includes SQL Server Data Tools, which is used for developing, testing and deploying SQL server databases. This tool provides a comprehensive set of features that enable researchers to create and maintain databases with ease [5].

PowerBI is a business analytics service developed by Microsoft that provides interactive visualization and BI capabilities with an interface simple enough for end users to create their own reports and dashboards. Key features of PowerBI include: data visualization, data exploration, data modeling, dashboards, collaboration and integration. PowerBI is widely used by businesses and organizations of all sizes to gain insights into their data and make better decisions. It is a powerful tool for analyzing data, identifying trends and patterns [8].

These tools have been chosen specifically for our research purposes because of their ability to handle large volumes of data and provide powerful analytics capabilities.

5. Methodology for Data Processing and Analysis

In Section 3 we have mentioned the importance of processing the data for every research. There, the first project was introduced and covered.

The second project, Data Warehouse, is responsible for managing the DWH for the solution. This project contains the code that creates and updates the DWH schema, as well as Extract, Transform and Load (ETL) code to load data from the transactional database into the DWH. Also, in this project, the dimensions and the measures for the DWH are defined. Once this project is published, the structure of the DWH can be seen into the SQL Server. This database represents OLAP (Online Analytical Processing).

The Daily ETL project, is responsible for running the daily ETL process, along with the SSIS package, to load data from the transactional database into the DWH. This project contains the code for extracting data from the transactional database, transforming it if needed, and loading it into the DWH. Deploying the project creates the ETL packages needed to load data into the DWH, and can be seen into MS SQL. The packages can be run by activating the "DailyETLMain.dtsx" file from MS SQL or schedule them to run on a daily basis. The ".dtsx" extension indicates that it is a file containing SSIS package information. After this, the DWH contains all required data. It provides historical data for analysis and reporting.

Fact tables contain the numerical data that is analyzed and aggregated. The fact tables included in the DWH are: "FactOrder" (contains information about sales orders, consists of 5002021 records, the main table for this research), "FactPurchase" (contains information about purchase orders), "FactSale" (contains information about sales transactions) and "FactStock" (contains information about stock movements).

The Dimension tables provide context and descriptive information about the data. Some of them, included in the DWH, are: "DimCustomer" (information about customers), "DimEmployee" (information about employees), "DimPaymentMethod" (information about payment methods), "DimPurchase" (information about purchases), "DimStockItem" (information about stock items), "DimSupplier" (information about suppliers), etc.

These tables serve to provide a consistent and accurate view of historical data that can be used for BI and analytics purposes.

The last project is the Multidimensional Cube project, responsible for creating a multidimensional cube, processed by SSAS. This project contains the code that defines the dimensions, measures, and hierarchies for the cube, as well as the code for processing. Any further corrections can be made inside the ".cube" file. After the process, the cube with its facts and dimension tables can be seen in MS SQL.

Once the dataset has been prepared, it can be analyzed using various techniques, such as statistical analysis, machine learning, or data visualization. These techniques enable researchers to identify patterns, relationships, and trends in the data and draw conclusions based on the results.

Briefly, we chose to use the tools described in Section 4, because they help us manage, manipulate, and analyze data effectively, leading to accurate and reliable research findings. We load our data into SQL Server 2016 using SSIS, which allows us to perform

ETL operations and transform the data into a format suitable for analysis. Then we use SSAS to create multidimensional models that aggregate and summarize the data. In the last step, we use PowerBI to create visualizations and reports that communicate our findings effectively (Figure 1).

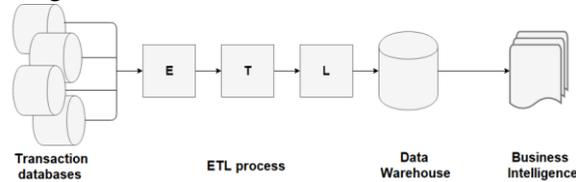


Figure 1. *BI and DWH concept*

PowerBI is known for its versatility in report creation, primarily through a “drag and drop” approach. With this intuitive method, users can create reports by selecting and arranging data elements through a visual interface. This approach is especially useful for quick and straightforward report generation, where users can effortlessly design visuals by dragging relevant fields onto the canvas and configuring them to suit their analytical needs. The process of creating reports typically involves the following steps:

- Data Connection – connects to the data source, supports various sources;
- Report Design – user-friendly, drag-and-drop interface for creating visuals, can customize the appearance, apply filters, and add interactivity to reports;
- DAX Calculations – for custom calculations;
- Data Visualizations – wide range of data visualization options to represent the data effectively;
- Filters and Slicers –interact with reports dynamically, focus on specific data points or time periods;
- Publish and Share – allows sharing and collaboration, can export reports to various formats.

This approach enables researchers to transform complex data into meaningful insights, making it an invaluable tool for sales performance analysis and other data-driven investigations.

PowerBI caters to advanced users by offering the flexibility to create reports using custom Data Analysis Expressions (DAX) queries, to meet specific reporting objectives. The fundamental steps for creating customized reports with DAX queries are:

- Defining DAX Measures – specific calculations on the data;
- Rank and Aggregate Data – additional DAX functions to rank and aggregate data such as RANKX or SUMX;
- Filter Logic – display data according to specific requirements;
- Visualize Insights – visualizations within the report that leverage the custom DAX measures and filters;
- Publish and Share – for sharing and collaboration, can be shared with the team, clients, or relevant stakeholders.

This approach empowers users to conduct intricate calculations and tailor reports to meet highly specific analytical needs, regardless of the dataset or domain under consideration. Whether focused on sales analysis, financial reporting, or any other field,

custom DAX queries in PowerBI provide a versatile solution for in-depth data analysis and dynamic reporting.

We chose to utilize the “Direct SQL query” approach within PowerBI for creating reports. This method provides advanced users with the capability to craft custom SQL queries, allowing for precise control over data extraction and manipulation to tailor reports to specific analytical requirements and gain insights not easily accessible through a traditional “drag and drop” interface. In conjunction with PowerBI, it can be used to retrieve and import data for report creation. In order to achieve this:

- Connect to Data – in PowerBI select the “Get Data” option to connect to the “Database” or other relevant data source, then select the database type and provide the connection details;
 - Write SQL Queries – choose “SQL Query” or ”Query Editor” and write the queries in the editor;
- SQL queries used in the research for creating the reports:

Algorithm 1 Top selling products

Input: this text / **Output:** top selling products

```
select * from ((select month([Order Date Key]) [Month],year([Order Date Key]) [Year], sum(Quantity) as [Quantity],
Description from Fact.[Order] where [Stock Item Key] = (select [Stock Item Key] from (select top 1 [Stock Item Key],
sum(Quantity) as [Quantity], Description from Fact.[Order] where [Order Date Key] < '2019-12-31' group by [Stock Item
Key], Description order by [Quantity] desc) as t) group by year([Order Date Key]),month([Order Date Key]), Description)
union (select month([Order Date Key]) [Month],year([Order Date Key]) [Year], sum(Quantity) as [Quantity], Description
from Fact.[Order] where [Stock Item Key] = (select [Stock Item Key] from (select top 1 [Stock Item Key], sum(Quantity)
as [Quantity], Description from Fact.[Order] where [Order Date Key] >= '2019-12-31' and [Order Date Key] <= '2023-
02-23' group by [Stock Item Key], Description order by [Quantity] desc) as t) group by year([Order Date Key]),
month([Order Date Key]), Description) union (select month([Order Date Key]) [Month],year([Order Date Key]) [Year],
sum(Quantity) as [Quantity], Description from Fact.[Order] where [Stock Item Key] = (select [Stock Item Key] from
(select top 1 [Stock Item Key], sum(Quantity) as [Quantity], Description from Fact.[Order] where [Order Date Key] >=
'2023-02-24' group by [Stock Item Key], Description order by [Quantity] desc) as t) group by year([Order Date Key]),
month([Order Date Key]), Description)) as t order by [YEAR], [Month], Description, [Quantity]
```

Algorithm 2 Top customer

Input: this text / **Output:** top customer

```
select * from ((select 'Period 1' as [Period], sum(Quantity) as [Quantity], ('Customer ' + CONVERT(VARCHAR,
[Customer Key])) as Customer from Fact.[Order] where [Customer Key] = (select [Customer Key] from (select top 1
[Customer Key], sum(Quantity) as [Quantity] from Fact.[Order] where [Order Date Key] < '2019-12-31' group by
[Customer Key] order by [Quantity] desc) as t) and [Order Date Key] < '2019-12-31' group by [Customer Key]) union
(select 'Period 2' as [Period], sum(Quantity) as [Quantity], ('Customer ' + CONVERT(VARCHAR, [Customer Key])) as
Customer from Fact.[Order] where [Customer Key] = (select [Customer Key] from (select top 1 [Customer Key],
sum(Quantity) as [Quantity] from Fact.[Order] where [Order Date Key] >= '2019-12-31' and [Order Date Key] <= '2022-
02-23' group by [Customer Key] order by [Quantity] desc) as t) and [Order Date Key] >= '2019-12-31' and [Order Date
Key] <= '2022-02-23' group by [Customer Key]) union (select 'Period 3' as [Period], sum(Quantity) as [Quantity],
('Customer ' + CONVERT(VARCHAR, [Customer Key])) as Customer from Fact.[Order] where [Customer Key] = (select
[Customer Key] from (select top 1 [Customer Key], sum(Quantity) as [Quantity] from Fact.[Order] where [Order Date
Key] >= '2022-02-24' group by [Customer Key] order by [Quantity] desc) as t) and [Order Date Key] >= '2022-02-24'
group by [Customer Key])) as t order by [Period], Customer, [Quantity]
```

Algorithm 3 Top salesperson

Input: this text / **Output:** top salesperson

```
select * from ((select 'Period 1' as [Period], sum(Quantity) as [Quantity], ('Salesperson ' + CONVERT(VARCHAR,
[Salesperson Key])) as Salesperson from Fact.[Order] where [Salesperson Key] = (select [Salesperson Key] from (select
top 1 [Salesperson Key], sum(Quantity) as [Quantity] from Fact.[Order] where [Order Date Key] < '2019-12-31' group
by [Salesperson Key] order by [Quantity] desc) as t) and [Order Date Key] < '2019-12-31' group by [Salesperson Key])
```

```

union (select 'Period 2' as [Period], sum(Quantity) as [Quantity], ('Salesperson ' + CONVERT(VARCHAR, [Salesperson
Key])) as Salesperson from Fact.[Order] where [Salesperson Key] = (select [Salesperson Key] from (select top 1
[Salesperson Key], sum(Quantity) as [Quantity] from Fact.[Order] where [Order Date Key] >= '2019-12-31' and [Order
Date Key] <= '2022-02-23' group by [Salesperson Key] order by [Quantity] desc) as t) and [Order Date Key] >= '2019-
12-31' and [Order Date Key] <= '2022-02-23' group by [Salesperson Key] union (select 'Period 3' as [Period],
sum(Quantity) as [Quantity], ('Salesperson ' + CONVERT(VARCHAR, [Salesperson Key])) as Salesperson from
Fact.[Order] where [Salesperson Key] = (select [Salesperson Key] from (select top 1 [Salesperson Key], sum(Quantity)
as [Quantity] from Fact.[Order] where [Order Date Key] >= '2022-02-24' group by [Salesperson Key] order by [Quantity]
desc) as t) and [Order Date Key] >= '2022-02-24' group by [Salesperson Key])) as t order by [Period], Salesperson,
[Quantity]

```

Algorithm 4 Profit

Input: this text / **Output:** profit

```

select month([Order Date Key]) [Month], year([Order Date Key]) [Year], sum([Total Including Tax]) from Fact.[Order]
group by year([Order Date Key]), month([Order Date Key]) order by [YEAR], [Month]

```

- Data Transformation – additional data manipulations directly in the SQL queries;
- Load Data – loading the data into PowerBI by clicking the “Load” button, the data will be imported as a dataset;
- Report Creation – create report, design visualizations, add filters, create interactive reports;
- Publish and Share – providing access or generating shareable links.

PowerBI's primary strength is data visualization and interactive reporting, so combining SQL queries with the PowerBI enables working with the data in a more flexible and dynamic way.

6. Results and Discussion

In order to highlight the top selling product during the three most significant periods recently, the source database was managed, manipulated and transformed into readable format, processed and stored into DWH and cube, and finally connected to PowerBI to analyze it effectively and reach the research objective. For that purpose, the PowerBI has been utilized to create a powerful report that effectively visualize the research data. The report provides clear and concise overview of the key findings, with interactive visualizations that enable deeper exploration of the data.

The report is not only highlighting the top selling product during the period, but it is also showing how the selling of that product varied during the other periods.

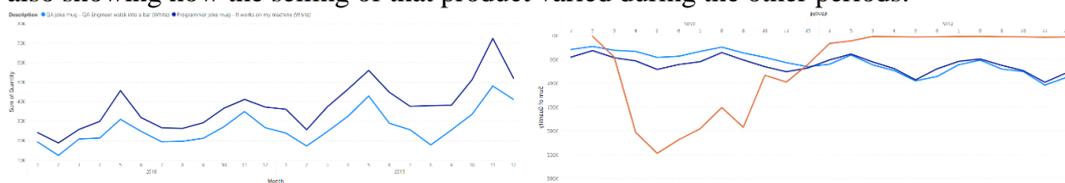


Figure 2. Top selling products (2018/19)

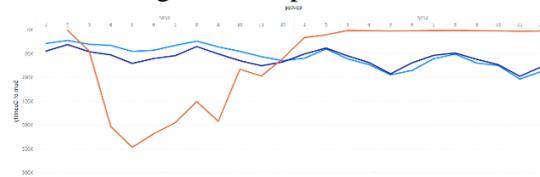


Figure 3. Top selling products (2020/21)

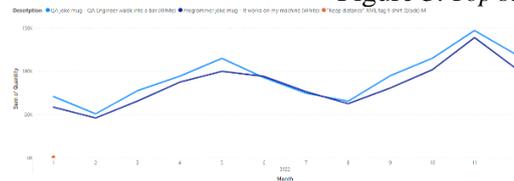


Figure 4. Top selling products (2022)

The top selling product during the Period 1, was a white programmer joke mug “It works on my machine” (Figure 2). In this period the demand of this product is high (Figure 5), and the selling trend is increasing during the next two periods (Figure 6 and Figure 7).

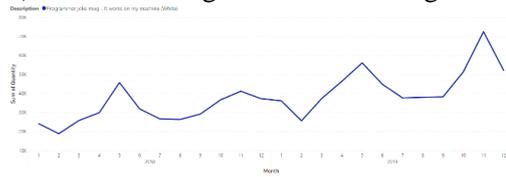


Figure 5. Programmer joke mug – selling trend (2018/19)

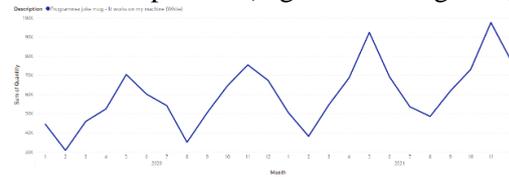


Figure 6. Programmer joke mug – selling trend (2020/21)

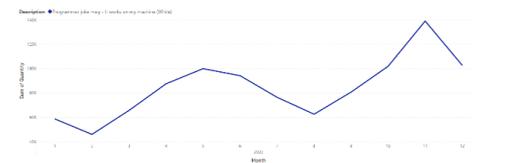


Figure 7. Programmer joke mug – selling trend (2022)

The top selling product during the Period 2 was a black “Keep distance” t-shirt (Figure 3). The product first appears in this period, it is reaching its maximum and then, at the end of 2020, the selling trend decrease intensively (Figure 8 and Figure 9).

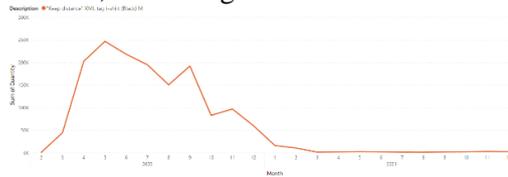


Figure 8. “Keep distance” t-shirt – selling trend (2020/21)



Figure 9. “Keep distance” t-shirt – selling trend (2022)

The top selling product for the Period 3 is a white QA joke mug “QA Engineer walks into a bar” (Figure 4). Although, it is present in the database from the beginning (Figure 10), the selling trend is increasing in the last two periods (Figure 11), where it reaches its maximum in the last period (Figure 12).

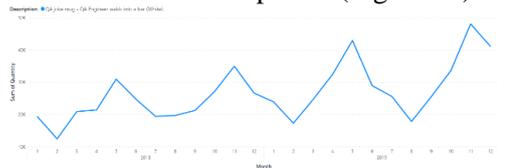


Figure 10. QA joke mug – selling trend (2018/19)

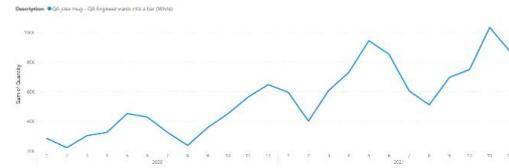


Figure 11. QA joke mug – selling trend (2020/21)

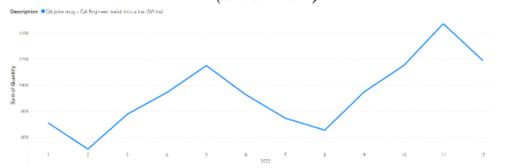


Figure 12. QA joke mug – selling trend (2022)

Several other reports were created in addition, as part of the research. The reports where personal identity appears have been anonymized and presented with numbers.

The top customer (Figure 13), customer with the highest number of purchased items, for Period 1 is “Customer 307”. That title for Period 2 belongs to the “Customer 509”, while for Period 3 that is “Customer 1234”. Although on a first sight looks like the “Customer 307” has purchased a lot more in its period than the “Customer 1234” in Period 3, that is not correct because the Period 1 consists of around 7 times bigger time interval than the Period 3. The top customer report shown by years (Figure 14) gives a completely different picture than the previous report. None of the top customers by period appears, which indicates that the constant customers are very important for the business. Top customers by year are “Customer 1715”, “Customer 1704”, “Customer 1212”, “Customer 646”, “Customer 270”, “Customer 1112”, “Customer 848”, “Customer 1548”, “Customer 1547” and “Customer 555”.

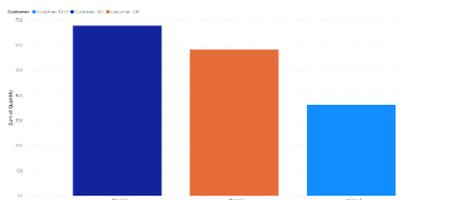


Figure 13. Top customer by period

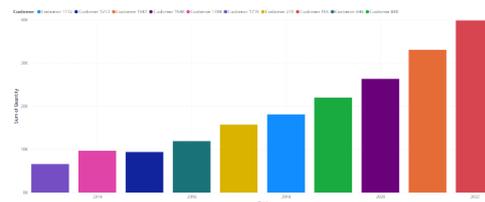


Figure 14. Top customer by year

The top salesperson (Figure 15), salesperson with the highest number of sold items, of all time (Period 1, Period 2 and Period 3) is “Salesperson 133”. It confirms its dedicated work in report shown by years (Figure 16), where it appears on the top for 8 years. Two of the salespeople, take his/her place only 2 years, in 2016 and 2021.

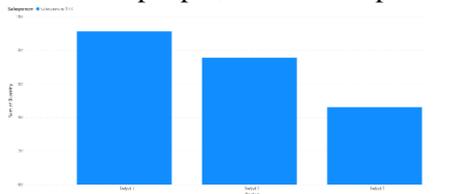


Figure 15. Top salesperson by period

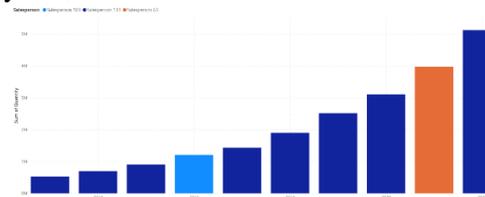


Figure 16. Top salesperson by year

The following report (Figure 17) shows the organization’s profit (in percent) for the announced periods. 43,41% of total organization’s profit belong to the Period 1, which in the same time represents the longest time interval of almost 7 years. The Period 2 owns 35,21% of the profit for time interval of more than 2 years, and the third period with less than year time interval has 21,38% of the overall profit. Having in mind the time interval that the periods consist of, this result indicates a profit increase between each of the periods. The organization’s profit for each year is shown in Figure 18. The proportions between each year and its percentage are as following:

- 2013 – 2,65%;
- 2014 – 3,49%;
- 2015 – 4,43%;
- 2016 – 5,51%;
- 2017 – 6,73%;
- 2018 – 8,90%;
- 2019 – 11,74%;
- 2020 – 14,35%;
- 2021 – 18,48%;
- 2022 – 23,72%.

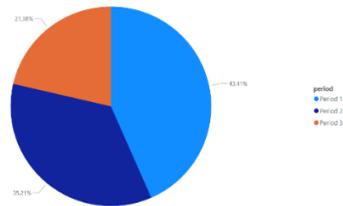


Figure 17. Profit percent by period

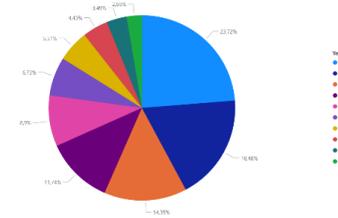


Figure 18. Profit percent by year

Additionally, the report below (Figure 19) shows that the overall transactions are experiencing a trend of overwhelming increase in the last two periods.

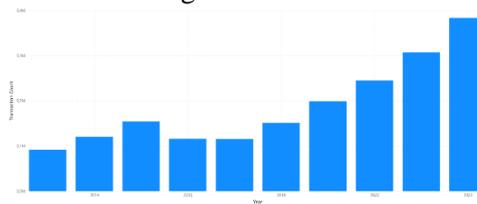


Figure 19. Transactions

Overall, this research provides valuable insights into the emerging trends in the industry. These findings are particularly relevant in the research context, where social distancing (although in short period) and remote work have become the new normal for many businesses.

7. Conclusion

The results of the research indicate that the announced periods have made a significant impact on the world, businesses, and customer behavior. As a result, organizations are now looking for ways to adapt to these changes and stay competitive. One of the key ways they can do this is by investing in relevant tools that will help them understand the new trends and adapt their strategies accordingly. In this research, tools were utilized that proved to be effective in transforming data and analyzing customer behavior.

Overall, this research provides important information for decision-makers and stakeholders in the industry to make informed decisions and plan for the future.

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