Customer Retention: A case study for Natus Inc

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Abstract

This case study focuses on Natus Inc and the ongoing efforts to understand account retention for growing the business. The scope of this project is focused on a specific segment called Neuro Critical Care. There are 483 parts and 8,077 customer accounts represented, with an annual spend in this product category of 50 million and growing. The case study will focus on identifying key variables that impact retention, and to drive actions on variables that will be used to improve retention overall. There will also be a discussion on actions that are competitor-driven that Natus has already started on. This information will be shared with management for implementation, impact and set the course for best practices to retain, and acquire new accounts.

Keywords: Data, Analysis, customer retention, customer churn, revenue, python, regression analysis, growth, decline, top accounts, trend

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# Chapter 1: Introduction to Natus, Customer Retention Study

# Background

# Natus Medical Inc is a provider of medical devices for screening, diagnosing, and treating disorders affecting the brain, neural pathways, and eight sensory nervous systems. The annual revenues for the Natus and affiliates are between 500M and 1B. Natus used to be public company, traded on the Nasdaq stock exchange (ticker: NTUS). In April 2022, a private equity firm based in Italy called Archimed purchased Natus, which then was transformed as a privately held business with the goal of increasing its market share, and in turn returning a large investment back to the private equity shareholders.

# Natus Medical Inc (Natus) has plants located in Middleton WI, US and Gort Ireland. Middleton does on average around 66 percent of the shipments that drive the revenue, while Gort does around 30 percent, and then there are small distribution sites in the Singapore and New Zealand territories. Natus has been in business for over 80 years, offering a portfolio of products including medical devices, software, and supplies for diagnosing, monitoring, and treating impairments and disorders affecting the brain, neural pathways, and eight sensory nervous systems. Competitors of Natus include the following businesses:

# AngelEye Health

# M25 Microincs

# Microfluidics

# EraGen Biosciences

# Molecular Detection

# Nanogen Neuro Diagnostic Devices,

# Xthetix,

# Integra,

# Nihon Kohden

* Cadwell

# *Call to Action*

# During one of the product reviews, as the product marketing manager was presenting a slide that showed the competition and the market share vs Natus, and a pertinent question that was brought forth - how can we increase market share, take away market share of our competitors. Not one person was able to answer that question. We brainstormed, and we thought perhaps we don’t know our customers well enough to find out if they also had spend with the competition. We want to see that problem through the lens of the customer, as to what motivates them to have a relationship with Natus, but also with our competitors, what we need to do to convince them that Natus can be a problem solver for all their diagnostic needs.

# Natus has expanded their portfolio by making purchases of niche products to embark on that journey, and now we are challenging ourselves to do that very action. The call to action is to learn our customers problems, and offer solutions that are either not met, or convince them Natus can the best partner. Thus, we are going to put forward our expertise into answering these objectives:

1. What is the trend in customer expenditure on catheters from 2018 to 2023, focusing on both quantity and revenue growth over this five-year period.
2. Which customer segments exhibit reduced spending and changing purchasing patterns. Identify customers displaying divergent spending behaviors compared to the overarching trends observed.
3. How many customers utilize the Natus Choice platform, and what proportion comprises new customers versus those demonstrating consistent or increased spending aligning with established loyal customers.
4. To what extent does Natus engage with distribution partners for the resale of its products under the third-party labels. Assess the company’s partnerships and presence within these networks.
5. Evaluate the sales growth – measured by product, quantity, and revenue – across the regions where Natus has a business presence. Identify stagnant or declining regions and investigate potential correlations with customer retention strategies.
6. Does Natus have an online social media presence?

*Plan of Action:*

# Restating the statements of the problem and approaching a purpose for the analysis put forth, we are addressing the problem statements head on. Let’s put the most important problem statement into the form of a question: are the Natus accounts purchasing more of our diagnostics, more of the supplies, or have they expanded their spend to those new product offerings Natus now offers in other segments, such as Hearing & Balance. Which accounts are not spending as much per quarter, per year? The purpose of this study is to find data that lend visual evidence to the performance and create action plans for retaining customers, as well as growing the market share.

# Key accounts are vital, and the feedback provided has started on down the path of the online store, which can be found at this link -- [Home (natusmedicalstore.com)](https://www.natusmedicalstore.com/s/) – The online store now allows all accounts to set up an online profile and do their purchasing right on this secure portal. This simplifies the process for the account, improves the time from placing the order to shipping, and more. The online store has product demonstrations, descriptions of the products and which product is more suitable to the type of care the provider offers their patients.

# Another recent change that Natus has put out to the key accounts is a new premier purchasing platform, called Natus Choice. This new selling tool will be explained in greater detail later in the study.

# Natus wants to add more distribution partners (also known as DP) to the Natus platform. Distribution Partners have further reach than Natus selling direct, so this opens up additional channels for increasing revenue and market share. There are many distribution partners in the international markets, but a select few in the US markets.

# Addressing this new approach to securing DPs for the US market, we can work on strategies to improve the distribution channel. Regions are a true challenge. The trend is for medical facilities to merge, to consolidate, so the medical facility that had a presence only in one region, such as Children’s Hospital (CHOP) of New York, now we see CHOP in other states, other regions. Find out where these facilities are and get the business to support all the regions. This has worked for a couple of these medical facilities like CHOP, like Bellevue, among others, so take those successes and make them work. This has the best opportunity for increasing market share and reducing the competitor’s footprint. This business case can go in different directions. One focus can be taking any of the problem statements and fully pursuing that strategy. The expectation is the problem that can be handled successfully within a shorter amount of time will get the resources to make it happen.

# The longer-term goal is to truly know the current customer base, the competitor’s marketplace and look for opportunities to go after the market share using strategies that Natus can put in place. The call to action is to dig deeper into our customers busying patterns, looking for deeper insight and putting that into action. The methods for doing this analysis will be incorporating tools such as regression. Find out which key variables are drivers of customers. Analyzing customers to the extent we are going to do so is known as churn. We can use a variety of techniques to learn about churn and put forth our call to action to regain and increase market share. The challenge is now underway. Learn the customers better through data, understand the history of these customers, and find out what the data shows for why customers may be churning. Knowing this information will aid us in putting forward solutions to increase growth and expand market share.

**Chapter II: Literature Review**

Customer churn (attrition) can be disastrous, in the short term, and more impactful to the bottom line in the long term. Companies in all industries must manage customer churn. The cost of acquiring a new customer is five times higher than maintaining a current customer (Sharma, p1 2021). Publicly held companies must report to the stockholders how each quarter, how each reporting period has gone, and provide guidance on how upcoming quarters, reporting periods are expected to go. The best way to manage those expectations, deliver those results is to know what the customers are going to be purchasing, and make sure those sales happen as expected. The common word applied is Organic Growth. A successful business model requires increased revenue from its customer base. The more customers a business has, and with each customer spending more, that is what drives the growth cycle.

There are two ways to grow a business. The first is acquisition. The second is the current accounts spend more over a reporting period, known as Organic Growth (ITA group 2023 pp 1-11). There are eight ways to increase Customer Lifetime Value (CLV) and each method can be its own data mining process. The eight methods are identified with some brief explanation of what the method means for Natus

1. Stop Leaving Critical Journey Touchpoints to Chance – this means that the Natus team needs to know the customer. Know what the customer needs, and provide solutions on how to make that need a reality
2. Ensure the Renewal – Natus has started on this journey by introducing Natus Choice, a platform of repetitive periodic purchases. The products in the Neuro Critical Care portfolio can be included as a large group or individual.
3. Reduce Churn During Critical Periods with Science & Strategy – this specific point is interesting as it specifies that methods 1 and 2 also cannot be left on its own. The account may now have a repetitive purchasing pattern, but relationships still matter. Do not let the success of methods 1 and 2 suggest that Natus cannot continue to maintain the relationship, especially when the next supply chain shortage changes the pattern of repetitive shipments.
4. Win Back Customers with Honest and Transparent Product Offers – this method is specific to accounts that Natus wants to win back. Address the problem that the account stopped the relationship and find a solution that satisfies the account. Transparency and accountability are paramount to this method.
5. Increase Lifetime Value Through Cross-Selling and Upselling – Natus has made inroads into this method with its online store and tutorials in both print and video form. The key is to get the accounts to know that the store is available for them. There is more than just the online store. Let’s go back to method 1, and know your customers. If the account is expanding, or bringing on new medical staff, find out what the new team has liked in the past, and match up the new products or devices that work for this change. Offer the account to attend a trade show coming to their area. The ideas are endless when trying to increase CLV.
6. Infuse, Surprise and Delight – This one is a crème de la crème. Surprise your accounts beyond just the process of selling products. That surprise can be anything, like offering a new product just introduced and sending the first sample at no cost. Offer a price point enticement for purchasing from the store. Add the account testimonial to the social media site with a link back to the account for free advertising. Anything that may be considered going above and beyond can be considered.
7. Amplify Experiences and Engagement When Customers Increase Spend – This is an extension of method #6. The account does increase their spend and Natus can now offer something more for just that scenario. This is another chance to be creative, and it is always easier to be creative when we know the customer.
8. Deliver Exceptional Customer Experience by Empowering Employees – the most effective customer experience training programs are not learned in a classroom. Engage the Natus team to know the customers, know the products and stay engaged. Retention of customers is not solely on the account rep, or the senior manager, or the brand. It is a truly team effort.

There are two types of loyalty, no matter the industry, even medical like the industry Natus is part of, Customer Loyalty and Quality Relationships. Emotional attachments are common in the medical industry (Baack, Donald p1. 2012). The basis of that statement stems into medical providers like Natus understanding this concern of provider and patient.

The three pillars of customer retention (Baack. Donald p2. 2012) are building customer loyalty, maintain quality relationships and responding to customer complaints. Adapting these pillars is what medical suppliers like Natus have to do.

The products that are in the portfolio of Neuro Critical Care have a special placement for the accounts so this specifically is meaningful for recognizing customer loyalty and quality relationships. Simply stated, failures at any level of the partnership will spiral into the account leaving and creating churn.

Increased competition and availability of products is the primary challenge for medical device companies like Natus, and the accounts that we serve (Fook, Dastane. p7. 2021). Medical care required at these medical facilities do not have the luxury of having patience waiting for supplies like the catheters that are in the Neuro Critical Care portfolio. As we have talked about, branding loyalty as one of the pillars is a necessary step. But, loyalty only goes so far without having the products the account needs. If Natus does not have the device, the account calls on another provider to inquire if the competitor has the device. Over time, this relationship is no longer living by the three pillars and we have churn.

Customers are categorized as 1) new customers, 2) existing customers, 3) churned customers (DataScienceKumar, p2 2014).. The churned customers factor into lost revenue that has to be recovered most often from finding new customers. There is an axiom that is repeated in the business industry: “It costs more to acquire new customers than to retain existing ones” (Inzaugarat, pp 2. 2020)..This is why analyzing and preventing churn can be a challenging business strategy, depending on the type of business industry a company is in. For a medical company, like Natus, there are few new business entries, so the new customer is going after customers that don’t do business with Natus. So, the same analysis would have to be done. The analysis that finds the variables that lead to customer churn has to be also analyzed to win new business. It is really an interesting study in analytics to find these variables and explore solutions.

Let’s now analyze what constitutes the various categories of churned customers:

1. Contractual churn – as the name suggests, customers that choose to leave due to not renewing the contract.
2. Voluntary churn – This category applies more to service type business relationships where the customer decides to end the relationship when there is no contract, or a limited contract.
3. Non-contractual churn – this category applies to online business relationships, such as Natus having an online store, where customers browse but do not execute purchases.
4. Involuntary churn – this category is where the customer can no longer afford to have a business relationship. This usually implies a customer is not able to make purchases or pay bills.

(Inzaugarat pp3, 2020))

A business must work on churn retention as a business practice. A churn prediction model must be employed. That means, finding data mining techniques such as logistic regression, support vector machines (SVM), Random Forest, Artificial Neuro Networks (ANN), and Naïve Bayes Algorithm. What these models do are looking at different features of the customer base and learn with factors (categories) are important. Specific to Natus, those categories would include pricing, lead time, quality, customer service, warranty, just to name a few. We would set up our models to produce algorithms running these categories against each factor, and other factors and storing the data. It would be the prudent strategy to run these algorithms often, and review data looking for confidence in the data, and make decisions to change the models as circumstances change. Such circumstances can be supply chain constraints, new products, retiring products, and as the medical business has a tendency to do, consolidation. The industries can change quickly so what was predicted in the past can change in a quarter, or in the current reporting period.

In conclusion: remember that it costs more to get new customers, than it does to retain current customers. And, by having a process in place to monitor the data and use data mining techniques and utilize a constant strategy of analyzing the data, then customer churn can be just a term used, but not a problem to solve.

**Chapter III: Methodology**

*Introduction:*

The overall scope of the capstone project to focus on customer retention specific to a primary product segment in the Neuro Critical Care (NCC) product portfolio. Examples of products in the NCC portfolio include catheters, needles, shunts, probes, gels, and many others. The scope is a vital lifeline for the business because there are so few competitors in this space. It is not a high margin product portfolio, so the business is not going to grow due to raising price only. The customers will continue to remain with Natus for specific reasons such as customer service, delivery, responsiveness, warranty, and loyalty. There are five specific paths that we will embark on this customer retention analysis, shown below:

1. What is the trend in customer expenditure on catheters from 2018 to 2013, focusing on both quantity and revenue growth over this five-year period.
2. Which customer segments exhibit reduced spending and changing purchasing patterns. Identify customers displaying divergent spending behaviors compared to the overarching trends observed.
3. How many customers utilize the Natus Choice platform, and what proportion comprises new customers versus those demonstrating consistent or increased spending aligning with established loyal customers.
4. To what extent does Natus engage with distribution partners for the resale of its products under the third-party labels. Assess the company’s partnerships and presence within these networks.
5. Evaluate the sales growth – measured by product, quantity, and revenue – across the regions where Natus has a business presence. Identify stagnant or declining regions and investigate potential correlations with customer retention strategies.

We can now start going into the methodologies of evaluating each of these objectives.

*Data Collection:*

We wrote SQL queries to extract the data and download into a spreadsheet. Natus does have multiple sources that collect the data, store it in the Natus cloud and create a lot of different protections around it. Natus has started using the Oracle platform going back to 2012. However, there were multiple sites that Natus used for shipping its various product lines, and not every site used the same instance of Oracle. After doing some basic queries and web scraping from the cloud, we ruled out using anything before 2018. First, the business units seemed to stabilize, with less changing of products that were being shipped to its customer base. The period of consolidating business units started to take shape, and the instances of Oracle started becoming synchronous with this simplification.

Next, the period of purchasing every niche player to grow its portfolio, and customer base stopped happening as well. This period seemed to indicate that Natus finally decided where to take its marketing strategy and revenue hubs and get better performance through each business hub.

Finally, the industry also started changing to become focused on the key players in this niche industry. The small players that were not bought out or merged simply faded from the landscape and a few key suppliers separated from the industry. Natus is one of those players, in fact, probably one of the top two in certain product portfolios.

The data mining process that we used is writing SQL queries to extract the data from the cloud, download it, and then merge it into one large dataset, presented in figure 16.

A close up of a text

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There were most definitely some challenges with this process. As one can expect with multiple data warehouses, the data was not equally entered, and that made using SQL queries that much more difficult to find similar characteristics that were identified for data extraction. The end result was positive, a database that pulled the correct fields that can now be analyzed.

Figure 18 is what an executed SQL query looks like.

A screenshot of a computer

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*Data analysis of SQL extract:*

We analyzed the relevant data from the extract for the project, and fine-tuned the data that will be removed. There are over three hundred column headers that were extracted, and eventually that number of columns that are in the final data set is forty-two. That means, we found forty-two key factors for analyzing the customer data. There are four hundred and fifty three parts that comprise this dataset, with more than half of the items shipped every quarter, and every year from the period of January 2018 through September 2023. There are over one thousand customers in the dataset, and this is where we need to set our focus as identified in our objectives. Then, once we are mostly satisfied that the data is representative of the five years of analysis for customer retention, we are now ready to move on to the next phase of data analysis

*Data Preparation:*

We used a few different types analysis processes to review the data, clean the data, prepare the test and train data sets, and then reported on what we found. The first process we used was opening a Python Jupyter notebook to start this process. The total number of rows is over 300,000. And, there are forty-two columns that were initialized. Once we reviewed the basic types of data we had, and looked for and corrected rows and cells that were missing data, we could start on the next part which is data exploration. Data that was removed included columns that had different naming conventions, but contained the same data. We also removed binary columns that did not support any type of analysis done.

We are looking for any type of trend, any type of outlier that we want to remove from our test and training data sets. The fact that we did such a thorough job with doing this in the data mining process with the queries we executed in SQL really showed the data did not require too much cleaning. We did find some purchase prices missing, and we did find some dates that had a three letter month abbreviation vs a full month spelled out, but we cleaned those variables to ensure we can have consistent formatting as we go the next steps.

Data exploration was running more Python queries to find top ten, top twenty, bottom ten, and other lists for customer spend on product types, part numbers, groups of parts purchased together, frequency of purchases, frequency of multiple part purchases, region spend, state spend, country spend, and a few other nuances, .

We are looking for any type of trend, any type of outlier that we want to remove from our test and training data sets. The fact that we did such a thorough job with doing this in the data mining process with the queries we executed in SQL really showed the data did not require too much cleaning. We did find some purchase prices missing, and we did find some dates that had a three letter month abbreviation vs a full month spelled out, but we cleaned those variables to ensure we can have consistent formatting as we go the next steps.

The best type of data analysis we can do is generate visualizations of the data. We can create bar charts to show whatever we want to show that will point us in the direction we are going. We can use a line graph to show an account with shipment patterns over any window of time, such as a week, a quarter, a year, etc. We can compare a range of accounts for spend based on a timeline, a dollar value, Qty of shipments, and more. What we intend to find when we get into our training model is to use what we have learned from the visualizations to predict this behavior going forward. Let’s look at a few specific initial visualizations.

Figure 2 shows the top ten items from the dataset.*A graph of a number of colored bars

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Figure 1 shows the top ten parts by percentage of revenue

A pie chart with numbers and a number on it

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Table 2 shows the revenue in a clean format

*Top ten items by revenue 2018 thru 2023*

item revenue

1 1104B 30,307,720.18

2 S53153 29,123,694.20

3 S53156 24,928,418.84

4 CAM02 16,638,455.37

5 1104G 13,036,986.02

6 1104BT 10,739,374.34

7 9013S0032 10,692,991.48

8 S53158 9,089,148.12

9 9013S0012 8,144,970.18

10 1104HM 7,985,086.75

Table 4 shows the top ten parts that are going in the opposite direction.

*Top ten items with decreases sales over period 2021 to 2022*

item qty\_2021 qty\_2022 revenue\_2021 revenue\_2022

1 1104B 11375 7652 $6,380,157 $4,938,511

2 1104HM 2691 1933 $1,536,478 $1,242,399

3 1104L 1558 849 $912,157 $601,328

4 25V26 652 447 $38,581 $27,082

5 25V30 2656 2342 $174,787 $154,199

6 6032-TP 781 740 $29,805 $29,662

7 9013L0453 7549 6074 $179,806 $154,691

8 9013S0012 13721 13699 $1,617,849 $1,451,777

9 9013S0032 13478 12338 $2,050,780 $1,948,416

10 9013S0042 3944 3645 $545,443 $492,475

In addition to using Python, because of the size of the dataset, we have set up an account with AWS so we can use some the big data tools that are out there for speed. So, we used spark to also test out the performance of the data and validate the speed as we realize that over time, the sheer amount of data will be too large to use what we are using now. This is also just showing that there are other methods besides using all the Python tools that we have learned. But, visualization is not one of those type of tools on this platform. So, there is one additional tool we are using, with the output shown in figure 19.

A screenshot of a computer

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We also have put together visualizations in the powerBI platform. Natus has truly gone all-in on powerBI as our core team are now expected to put together dashboards for their projects. This tool is challenging to learn and come up with flashier but yet impactful visualizations. But, at the same time, it is live, interactive and more easily shared to stakeholders that are interested in seeing the data, and allow the stakeholders to explore without having to learn a new skill or ask for clarification, please see Figure 20.

A screenshot of a computer

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The header of the dashboard allows the user to change the period, the segment, focus on the region, focus on a wide range of products to show real time the data. I cannot share the details inside this powerBI tool, but this is an example of the tool we have built for customer retention real time.

*Generate models:*

It was a challenge to generate models because the sheer amount of data. We started by running visualizations on products, accounts, product types, periods, etc. There are additional visualizations in the addendum section. We also ran queries to isolate smaller blocks of data and compared against each other. Python can run each type of separation of segment we want, but this is another useful tool for powerBI. We can put multiple visualizations onto one page to show them side by side, and have them easily compared, see Figure 5.

A screenshot of a computer screen

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Choose the models**:**

After exploring the data in all these different patterns of visualization, we set up our python queries to do hyperparameter testing. The models we selected were Ridge Regression and SelectKBest. The models produced the higher r-squared scores which are noteworthy for explaining variance in the data. Variance comes from outliers. An example would be one order to a customer that is ten times the typical average order value. Figure 21 shows a modeling process to produce the Ridge Regression score in the dataset.

A screenshot of a computer program

Description automatically generated

We ran many different tests with many different combinations of categorical variables called dependent variables and then graphed the results. Figure 23 is showing the line chart where the r-squared score increases as we increase the number of k-values, or features. The more values, the higher the score. This higher score is what we want as it gets us closer where the dependent variable in our model is predicted by the independent variable.

We also tried a few other testing models, including correlation testing, that produced heatmaps, which are in the figures section. The heatmaps do not truly define what is happening with the dependent variables, so we decided that we would not include them in our final analysis, but still wanted to show them for content and for the reader to view next to the seaborn plots.

*Conclusion:*

The result of the data extraction, the data analysis, the creation of a test and training model, the number of visualizations is showing interesting trends. The best dependent variables are product types we discovered that produced the higher score are identified in figure 21 on the previous page. We want to have the higher scores so we can predict the variables in the regression analysis. We see that the more variables we introduce into the regression analysis, the better the results.

The result is there is not one variable from our dataset that we can pinpoint as a sign to recognize customer churn. We must use a lot of tools, a lot of analysis. We find that we can predict the model more accurately with more dependent variables. But there is also the concern of over-fitting so there also is a point to recognize the right number of variables to test.

Getting past just the data analysis, the real-world analysis is stated in just general terms of the pillars of customer retention. Knowing your customers, finding new opportunities to engage the customers, providing additional opportunities with products, with the online store, with select purchasing platforms, these are more valuable and cannot be analyzed in just the hyperparameter tools that we have at our disposal.

**Chapter IV: Presentation of Research**

*Review of Analysis:*

There were multiple testing steps done on the data set. As part of trying to find the most relevant independent variables to predict the dependent variable of revenue, many different hyperparameter tuning sequences were performed. The results of these various tests are shared below.

First, we explored the data to determine if any further cleaning of the data was required. When we first did the data analysis, we removed some variables that were redundant, or had many null values. These variables were not worth exploring. We also removed RMA returns. They are not valid in terms of data analysis for customer retention. RMA have their own significance in a business relationship model which was explained earlier. To recap, it is vital that for a solid customer relationship, Natus will address customer complaints, no matter the type of complaint. The data extracted over this time period was about 1900 total lines and would not impact any predictor variable analysis, so the data was removed.

The objectives are stated below, and the type of analysis that was performed for evaluating relevance.

1. What is the trend in customer expenditure on Neuro Critical Care from 2018 to 2023, focusing on both quantity and revenue growth over this five-year period.

The first objective is identifying trends, presented in Table 1. The trend is growth over the five-year period. We did have covid impacts in 2020 and that explains the variance in revenue and quantity shipped. It is also notable that 2022 had a decline in sales which was analyzed as supply chain constraints as the suppliers did not truly yet recover from the covid period. 2023 is not yet a full year so the trend is noticeably positive.

Table 1.

*Total Revenue 2018 thru 2023*

|  |  |
| --- | --- |
| **Total Revenue 2018 thru 2023** | |
| **Row Labels** | **Sum of revenue** |
| **2018** | **50,447,086.44** |
| **2019** | **56,847,907.87** |
| **2020** | **52,249,056.26** |
| **2021** | **57,641,523.92** |
| **2022** | **55,540,607.01** |
| **2023** | **42,067,307.05** |
| **Grand Total** | **314,793,488.55** |

There are 483 total parts that comprise this revenue, presented in Table 2. The items are the top ten saleable parts for Natus.

**Table 2.**

*Top ten items by revenue 2018 thru 2023*

item revenue

1 1104B 30,307,720.18

2 S53153 29,123,694.20

3 S53156 24,928,418.84

4 CAM02 16,638,455.37

5 1104G 13,036,986.02

6 1104BT 10,739,374.34

7 9013S0032 10,692,991.48

8 S53158 9,089,148.12

9 9013S0012 8,144,970.18

10 1104HM 7,985,086.75

The next figure presented in Table 3 shows the quantity of the top ten parts that have been shipped. The data was cleaned as the dataset identified the quantity column as a string. We needed to clean the data to change the type to a float. The data gives us a starting point for what items customers are purchasing and monitoring the sales by time period We do not want to see a decrease in the shipments of these items as that is a leading indicator of accounts purchasing from competitors.

**Table 3.**

*Top Ten Items Sorted by Revenue 2018 thru 2023*

*Total Qty of items shipped 2018 thru 2023*

Top 10 Parts by Quantity Shipped:

Rank item qty

1 S53153 165,749

2 S53156 153,845

3 9013S0012 72,419

4 9013S0032 70,968

5 1104B 55,429

6 S53158 48,981

7 9013L0453 38 887

8 F-E5GH-48 38,279

9 902-DMF37-S 32,443

10 1104G 29,412

The pie chart presented in Figure 1 is another way to look at the data. The pie chart is showing the parts by percentage of revenue to total revenue. We have used this data to know that the highest selling parts are critical in gauging account patterns for retention. If we see that the top selling items decrease in sales, that is the most likely leading indicator for recognizing accounts that may be choosing other competitors.

**Figure 1.**

*Top 10 Items by Percentage of Revenue*

A pie chart with numbers and a number on it

Description automatically generated

1. Which customer segments exhibit reduced spending and changing purchasing patterns. Identify customers displaying divergent spending behaviors compared to the overarching trends observed.

The second objective is asking for trends, but in the downward direction. The table, as presented in Table 4 is a snapshot of the most recent time periods from 2021 to 2022. The table presents the quantity of the top ten parts that shipped and the significant drop in revenue. The analysis we have performed shows the trend that accounts are buying less overall, and not just from Natus. The pandemic is a primary reason, along with the higher cost of credit due to inflation worldwide. It is a very good exercise as part of customer retention to recognize these buying patterns early and address them before the account has completely moved on, viewed in table 4.

Table 4.

*Top ten items with decreases sales over period 2021 to 2022*

item qty\_2021 qty\_2022 revenue\_2021 revenue\_2022

1 1104B 11375 7652 $6,380,157 $4,938,511

2 1104HM 2691 1933 $1,536,478 $1,242,399

3 1104L 1558 849 $912,157 $601,328

4 25V26 652 447 $38,581 $27,082

5 25V30 2656 2342 $174,787 $154,199

6 6032-TP 781 740 $29,805 $29,662

7 9013L0453 7549 6074 $179,806 $154,691

8 9013S0012 13721 13699 $1,617,849 $1,451,777

9 9013S0032 13478 12338 $2,050,780 $1,948,416

10 9013S0042 3944 3645 $545,443 $492,475

We are now showing the top ten customers having a downward trend for total revenue, presented in table 17.

**Table 17.**

*Top Twenty International Accounts showing Revenue Decline Q1 2023 vs Q1 2022*

Top Twenty International Accounts showing Revenue Decline Q1 2023 vs Q1 2022:

actual\_first\_shipped\_quarter

customer\_account\_name 2022 Q1 2023 Q1 growth

SICHUAN SANSHENGCHUANGXIN 457,716.00 204,905.16 -252,810.84

BUTICON INTERNATIONAL CORP 189,615.00 37,627.30 -151,987.70

NEUROLITE AG 146,227.26 11,391.79 -134,835.47

DABASONS IMPORTACAO EXPORTACAO 176,160.65 49,788.60 -126,372.05

BEIJING BEIKE DIGITAL MEDICAL 500,668.00 390,683.50 -109,984.50

SYNGROWTH CO LTD 106,997.28 17,603.04 -89,394.24

DUOMED THE NETHERLANDS 90,575.78 13,203.29 -77,372.49

M. SCHILLING GMBH MEDICAL PROD 110,759.50 75,699.00 -35,060.50

ALLERGAN PHARMACEUTICALS 212,946.64 178,668.10 -34,278.54

PHYSIOTEC MEDICAL EQUIPMENT 143,123.60 110,617.50 -32,506.10

SECOND MEDICAL SAC 48,108.50 17,313.40 -30,795.10

RESMED KOREA 32,951.30 3,027.20 -29,924.10

LÖWENSTEIN MEDICAL SE + CO.KG 39,895.90 11,224.11 -28,671.79

NEUROSWISS AG 72,075.16 45,123.97 -26,951.19

ALMEVAN S.L. 172,390.35 145,942.13 -26,448.22

DUOMED BELGIUM NV 142,722.01 123,507.77 -19,214.24

MEDCAT BV (EUROPE) 24,525.90 5,576.00 -18,949.90

ARENA MEDICAL CARE PVT LTD. 24,314.85 7,643.89 -16,670.96

AP HOPITAL DU KREMLIN BICETRE 18,699.20 2,667.12 -16,032.08

GVB-GELIMED GMBH 62,548.32 46,766.29 -15,782.03

This type of data is very valuable for the analysis as we dive deeper to find out what is happening with these accounts, and to prevent losing the customers completely.

We also ran other simulations for different time periods and that data has also been analyzed.

1. How many customers utilize the Natus Choice platform, and what proportion comprises new customers versus those demonstrating consistent or increased spending aligning with established loyal customers.

This is a project that does not have data from the past five years to analyze. This is a Natus project recently launched based on doing churn analysis and studying customer retention behaviors employed by competitors as well as companies in different industries. The process is now in place, and the screen shot is where Natus is right now, with every expectation this concept will expand. Then, future models of the data analysis will incorporate specific data for this objective. The model in figure 4 is the starting point of December 2022, so we are nine months into this program, and it shows a wonderful trend line.

Figure.4:

*Natus Choice program in its first nine months.*

A screenshot of a computer

Description automatically generated

1. To what extent does Natus engage with distribution partners for the resale of its products under the third-party labels. Assess the company’s partnerships and presence within these networks.

The international market is where distribution partners, also known as DP’s is utilized. The product lines that comprise Neuro Critical Care are mostly shipped from the US to the international DP’s while the other business units have direct markets. The data regarding the quantity and revenue breakdown when we analyze the international markets recognizes this and the downward trends are specific to the DP’s reducing the amount of purchase presented in figure 24. The global markets for the last two years have been under a much higher inflation. Per Eurostat (Eurostat 2023), the inflation rate has started coming down in 2023, since its peak of 9.9% in September 2022. The chart is showing the trend over the last ten years. Note the sharp ski slope December 2020 to September 2022 at the peak. Now, the ski slope is coming down, with inflation rates back in the 4.3% range through the majority of Europe.

A graph of a graph showing the rate of the euro

Description automatically generated with medium confidence

What this means is the capital spend of the direct markets has gone down, which explains the trend of the DP spend going down over the last year. The data shows a better picture for the direct markets and this is where Natus needs to position itself to maintain its relationships which leads to increased sales.

1. Evaluate the sales growth – measured by product, quantity, and revenue – across the regions where Natus has a business presence. Identify stagnant or declining regions and investigate potential correlations with customer retention strategies.

We ran the code to find the top twenty accounts that are showing the largest increase, and also we found the top twenty accounts with decreases , see table 12 and 15.

**Table 12.**

*Top Twenty International Accounts showing Revenue Growth Q3 2023 vs Q3 2022*

Top Twenty International Accounts showing Revenue Growth Q3 2023 vs Q3 2022

actual\_first\_shipped\_quarter 2022 Q3 2023 Q3 growth

customer\_account\_name

ALLERGAN PHARMACEUTICALS 66,181.89 188,414.82 122,232.93

DUOMED THE NETHERLANDS 3,356.82 62,722.47 59,365.65

NEUROSWISS AG 56,935.40 114,284.46 57,349.06

NEUROLITE AG 12,163.50 54,675.13 42,511.63

ALMEVAN S.L. 157,504.34 197,415.85 39,911.51

VITALMEDIC SA 5,272.50 45,101.80 39,829.30

INSTRUMENTOS MEDICOS 38,790.50 74,115.20 35,324.70

ANDOVER ALIANZA MEDICA S.A. 2,884.69 28,676.24 25,791.55

OPTIMA MEDICAL LTD 57,264.40 82,753.27 25,488.87

GVB-GELIMED GMBH 39,885.69 64,851.22 24,965.53

COMED S.C. 20,256.26 43,277.00 23,020.74

SYNGROWTH CO LTD 38,642.76 61,454.64 22,811.88

TKB CORPORATION 0.00 20,555.31 20,555.31

MAG2HEALTH 51,549.58 70,549.45 18,999.87

SANO TECNICA, LDA. 14,951.65 26,887.35 11,935.70

VIRTUS TRADING LLC 1,826.42 12,566.04 10,739.62

CLINIQUES DE L'EUROPE 61.15 10,445.22 10,384.07

MEDCAT BV (EUROPE) 6,230.50 15,497.20 9,266.70

DUOMED BELGIUM NV 183,665.87 192,781.82 9,115.95

HOPITAL SUD REUNION 664.40 8,636.74 7,972.34

**Table 15.**

*Top Twenty International Accounts showing Revenue Decline Q3 2023 vs Q3 2022*

Top Twenty International Accounts showing Revenue Decline Q3 2023 vs Q3 2022

actual\_first\_shipped\_quarter

customer\_account\_name 2022 Q3 2023 Q 3 growth

BEIJING BEIKE DIGITAL MEDICAL 110,6065.00 310,194.00 -795,871.00

SICHUAN SANSHENGCHUANGXIN 31,7430.00 56,176.32 -261,253.68

HANGZHOU QIYUN TRADING CO 13,2172.00 20,650.00 -111,522.00

MEDIX MEDICAL DEVICES SRL 119,392.10 66,673.50 -52,718.60

PHYSIOTEC MEDICAL EQUIPMENT 218,425.60 181,308.00 -37,117.60

MEDLIFE 57,942.21 22,545.26 -35,396.95

MUNDINTER, S.A. 24,679.20 376.00 -24,303.20

DENGG MEDIZINTECHNIK GMBH 38,087.14 17,571.20 -20,515.94

BAROQUE MEDICAL INTERNATIONAL LTD 35,168.25 16,676.35 -18,491.90

YOUNG WOO MEDITECH CO., LTD 178,960.44 161,250.70 -17,709.74

MEDIAL GROUP D.O.O. 25,434.90 10,375.20 -15,059.70

MEDISERV CO. LTD 41,146.98 26,101.54 -15,045.44

AXIS HEALTHCARE 47,219.00 33,803.50 -13,415.50

SYNOPO SRL 64,216.15 51,653.98 -12,562.17

TEKNIKEL PIYALEPASA BULVARI 49,887.12 39,940.93 -9,946.19

INTERNATIONAL CLINICS S.A. 30,402.20 20,617.91 -9,784.29

ASBL HELORA 14,390.80 5,694.70 -8,696.10

AMTRONECH 8,200.00 38.40 -8,161.60

ISOSL 9,587.55 1,836.56 -7,750.99

DANMEDIK SDN. BHD. 12,805.10 5,393.50 -7,411.60

We analyzed these accounts to understand trends inside the data. We are looking for specific data to support the accounts have the same reach with direct markets or perhaps the product groups are now changing inside the DP organizations. As we continue to study customer retention strategies, we want to be able to know what the direct market spend will be going forward and align our DP’s to meet those changes.

We can now start going into the methodologies of how to evaluate the topics and find out what we have uncovered. The predictor models we used are “Ridge Regression” and “SelectBest Regression” for hyperparameter tuning. We used a lot of different predictor variable options to try and find the best predictors for revenue growth. Then we graphed out these models to visualize what the best correlations are for analyzing the dependent variables. We decided that five dependent variables id the best choice of modeling. When we used less than five dependent variables, we wide variances in the r-squared scores The screen print shows the outcomes of choosing the best dependent variables: month, customer\_acount\_name\_ customer\_type, product\_group and product\_sub\_type. We also used multiple sampling values, starting with five and going up to twenty-five. We found that going with higher sampling values, the tighter the spread of the scores for these dependent variables. The figure (as shown in figure 15) shows one such outcome using these five dependent variables in a line graph

A graph with different colored lines

Description automatically generated

The line chart shows as we have more features, known as k-values, the more likely scenario that the data will produce a higher r-squared score. We want the highest possible r-squared scores because we want to explain variance in our data, which we have done in both a quantitative and qualitative perspective. It is noteworthy that with SelectBest resgression, there is a clear peak of the number of k-values before we see a change in the evaluation of the variance. That peak appears to be at 12, not 25. This is data we can use when fine tuning the models.

There are many options to choose for this data analysis and we went through a lot of them. Finding the best model took time, and what we found is there is no best model. We wanted to confirm that we did not have overfitting of dependent variables and the categories we expect are the best selections is confirmed through the visualization line charts we analyzed.

*Conclusion:*

The testing has proved to be useful. We are seeing trends for both the product segments and the customers. For example, the number of customers has reduced by more than ten percent. The spend for the customers has basically stayed within five percent over these five years. We previously discussed that retaining customers is not always about price.

There are many different factors that are not specifically pulled in data that we have access. The biggest factor is the consolidation of hospitals and clinics, and the consolidation is coming from private equity firms. That changes the landscape from a purchasing trend as well as a customer relationship trend. The data we have analyzed will not be included as this type of data is not specifically collected.

Another factor is the private equity firms. The customer data now will show the new account and the previous accounts are no longer visible, but we know they exist. This is another example of having to go deeper into how to explain the data and validate the retention.

The last factor as we analyze the data is we found some rows with no price, and no revenue. That is a case of going to a contract driven business. The contracts are paid, like a retainer is paid to a legal firm. The subsequent sales of the products are now showing as zero-dollar as they are incorporated in the contract pricing. This means, revenue may show overall as not growing as high, but we have to explain it with a new product segment. This is new so this type of analysis will manifest over the next few years.

We hope the analysis performed on the data set, the examples we have found, and the story we can tell will be a fun, detailed exploration into how Natus has done a strong program in managing the customer base and retaining the larger accounts.

**Chapter V: Conclusion:**

*Introduction:*

In this last chapter, the findings of the research study for Natus on customer retention are summarized, conclusions are made based on research questions, implications are discussed and we conclude with a summary of key points.

*Summary of Findings:*

The objectives we explored are restated.

# objectives:

1. What is the trend in customer expenditure on catheters from 2018 to 2023, focusing on both quantity and revenue growth over this five-year period.
2. Which customer segments exhibit reduced spending and changing purchasing patterns. Identify customers displaying divergent spending behaviors compared to the overarching trends observed.
3. How many customers utilize the Natus Choice platform, and what proportion comprises new customers versus those demonstrating consistent or increased spending aligning with established loyal customers.
4. To what extent does Natus engage with distribution partners for the resale of its products under the third-party labels. Assess the company’s partnerships and presence within these networks.
5. Evaluate the sales growth – measured by product, quantity, and revenue – across the regions where Natus has a business presence. Identify stagnant or declining regions and investigate potential correlations with customer retention strategies.

Objective 1, the findings showed that there is a trend upwards from year to year. There was a downturn in 2022 which the data cannot explain away directly, but the supply chain was impacted by the impact and did not recover rapidly. This is not singularly pointed at Natus but at the industry.

Objective 2, we did not find any data that significantly pointed to any customer segments that had reduced spending and changing purchasing patterns.

Objective 3, we placed figure 4 in the figures section that shows more than 200 accounts are now signed up with Natus Choice. These are all part of the actions taken based on customer retention as a high level part of knowing our competition and working to improve on the three pillars.

Objective 4, engaging with distribution partners. Another area that the data does not point to a growth curve by adding more DPs but rather just the fact Natus desires to move away from them as we have increased the number of products on the online store and are actively engaging in developing this tool.

Objective 5, the figures, and tables presented show the trends are going up in regions, and heading in an upward trajectory overall. There are going to be cycles in specific periods that will show up, but the inflation chart presented in figure 24 is a sign the international markets are turning around as well as the inflation path in the US.

*Summarizing:*

The interpretation of the analysis done is that there is not one answer that can prevent customer churn. There is not one answer that can recognize customer churn. There are many pieces of data to review, to understand, and there are many specific processes that an organization like Natus can do to maintain customers and even have sustained Organic Growth. Those actions were shared with senior management recently. The key takeaways are now getting metrics around the online store, growing Natus Choice, which is already over 200 customers, and staying active with customer engagement by any means to improve relationships and let Natus be the one medical device company to work with going forward.

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Tables

**Table 1.**

*Total Revenue 2018 to 2023*

|  |  |
| --- | --- |
| **Total Revenue 2018 thru 2023** | |
| **Row Labels** | **Sum of revenue** |
| **2018** | **50,447,086.44** |
| **2019** | **56,847,907.87** |
| **2020** | **52,249,056.26** |
| **2021** | **57,641,523.92** |
| **2022** | **55,540,607.01** |
| **2023** | **42,067,307.05** |
| **Grand Total** | **314,793,488.55** |

Table 2.

*Top ten items by revenue 2018 thru 2023*

item revenue

1 1104B 30,307,720.18

2 S53153 29,123,694.20

3 S53156 24,928,418.84

4 CAM02 16,638,455.37

5 1104G 13,036,986.02

6 1104BT 10,739,374.34

7 9013S0032 10,692,991.48

8 S53158 9,089,148.12

9 9013S0012 8,144,970.18

10 1104HM 7,985,086.75

**Table 3.**

*Top Ten Items Sorted by Revenue 2018 thru 2023*

*Total Qty of items shipped 2018 thru 2023*

Top 10 Parts by Quantity Shipped:

Rank item qty

1 S53153 165749

2 S53156 153845

3 9013S0012 72419

4 9013S0032 70968

5 1104B 55429

6 S53158 48981

7 9013L0453 38887

8 F-E5GH-48 38279

9 902-DMF37-S 32443

10 1104G 29412

Table 4.

*Top ten items with decreases sales over period 2021 to 2022*

item qty\_2021 qty\_2022 revenue\_2021 revenue\_2022

1 1104B 11375 7652 $6,380,157 $4,938,511

2 1104HM 2691 1933 $1,536,478 $1,242,399

3 1104L 1558 849 $912,157 $601,328

4 25V26 652 447 $38,581 $27,082

5 25V30 2656 2342 $174,787 $154,199

6 6032-TP 781 740 $29,805 $29,662

7 9013L0453 7549 6074 $179,806 $154,691

8 9013S0012 13721 13699 $1,617,849 $1,451,777

9 9013S0032 13478 12338 $2,050,780 $1,948,416

10 9013S0042 3944 3645 $545,443 $492,475

Table 5.

Top ten accounts sorted by revenue

customer\_name revenue

1 BEIJING BEIKE DIGITAL MEDICAL 8,705,835.50

2 MVAP MEDICAL SUPPLY 7,638,032.53

3 SICHUAN SANSHENGCHUANGXIN TECHNOLOGY CO.,LTD 4,872,257.98

4 MEDLINE INDUSTRIES, INC 4,311,840.40

5 ALMEVAN S.L. 3,967,162.09

6 DUOMED BELGIUM NV 3,755,242.58

7 YOUNG WOO MEDITECH CO., LTD 3,662,857.80

8 PHYSIOTEC MEDICAL EQUIPMENT (HONG KONG) LTD. 3,243,579.06

9 ALLERGAN PHARMACEUTICALS IRELAND 3,076,437.78

10 ABBVIE US LLC 2,397,553.00

**Table 6.**

*Top twenty US accounts with revenue growth Q3 2023 vs Q3 2022*

Top Twenty Domestic Accounts showing Revenue Growth Q3 2023 vs Q3 2022:

actual\_first\_shipped\_quarter 2022 Q3 2023 Q3 growth

customer\_account\_name

BEAUMONT HOSPITAL-ROYAL OAK 3,346.00 106,012.01 102,666.01

MEDLINE INDUSTRIES, INC 212,588.00 292,687.00 80,099.00

STANFORD UNIVERSITY MEDICAL CENTER 2,479.72 80,335.56 77,855.84

CARLE FOUNDATION HOSPITAL 6,779.26 68,345.70 61,566.44

UNIVERSITY MC OF SOUTHERN NEVADA 1,703.75 43.578.82 41,875.07

GEISINGER MEDICAL CENTER 20,046.56 61,363.51 41,316.95

COMMUNITY REGIONAL MEDICAL CENTER 25,284.70 62,542.80 37,258.10

UNIV OF TEXAS MEDICAL BRANCH 14,500.07 50,194.95 35,694.88

TEXAS CHILDREN'S HOSPITAL 19,775.10 54,527.61 34,752.51

BLANCHARD VALLEY HOSPITAL 1,671.14 36,092.17 34,421.03

RHYFEL INC 12,763.08 46,507.46 33,744.38

NYU LANGONE HOSPITAL 25,222.00 58,232.20 33,010.20

ABBVIE US LLC 161,125.00 193,350.00 32,225.00

UNIVERSITY OF CONNECTICUT HEALTH 14,365.16 44,731.69 30,366.53

LAKELAND SUPPLY CHAIN - HCA HEALTHCARE 7,415.75 37,145.75 29,730.00

VCU HEALTH SYSTEM 10,878.59 39,817.50 28,938.91

UNIV OF MISSOURI HOSP & CLINIC 2,106.36 28,257.95 26,151.59

NYU LANGONE - LONG ISLAND 4,767.00 30,770.45 26,003.45

SUNY UPSTATE MED CTR 18,753.99 44,212.80 25,458.81

STANFORD HEALTH CARE 7,706.22 33,027.66 25,321.44

**Table 7.**

*Top Twenty Domestic Accounts showing Revenue Growth Q2 2023 vs Q2 2022*

Top Twenty Domestic Accounts showing Revenue Growth Q2 2023 vs Q2 2022:

actual\_first\_shipped\_quarter 2022 Q 2 2023 Q 2 growth

customer\_account\_name

CHOP OF ATLANTA --EGLESTON 1,855.85 256,136.88 254,281.03

NORTH SHORE UH MANHASSET 3,297.00 136,299.60 133,002.03

ST. BERNARD'S HOSPITAL 4,270.09 87,265.44 82,995.35

LAKELAND SUPPLY CHAIN 1,343.75 67,784.50 66,440.75 DEL SOL MEDICAL CENTER 1,070.75 55,668.00 54,597.25

SRW INDUSTRIES 26,936.40 76,672.00 49,735.60

MEMORIAL MEDICAL CENTER 33,371.29 73,100.84 39,729.55

MEDLINE INDUSTRIES, INC 229,971.00 268,814.00 38,843.00

OWENS & MINOR #10 & #98 2,381.00 38,081.00 35,700.00

NATIONWIDE CHILDREN'S HOSPITAL 3,798.54 37,531.64 33,733.10

NYU LANGONE HOSPITAL 34,965.00 68,611.80 33,646.80

VCU HEALTH SYSTEM 16,087.50 48,554.60 32,467.10

MEDIKAL-MUNERIS SA DE SV 16,050.20 46,395.70 30,345.50

SACRED HEART HEALTH SYSTEM INC 6,878.38 36,555.66 29,677.28

MOUNT SINAI HOSPITAL- BRONX 17,309.65 46,970.24 29,660.59

NYU LANGONE - LONG ISLAND 2,319.00 27,323.55 25,004.55

NORTON HEALTHCARE 18,720.19 43,498.20 24,778.01

THOMAS JEFFERSON UNIVERSITY HOSP 16,370.53 40,268.92 23,898.39

FAIRVIEW HEALTH SERVICES 6,921.25 30,354.20 23,432.95

SWEDISH MEDICAL CENTER 2,544.05 25,848.75 23,304.70

**Table 8.**

*Top Twenty Domestic Accounts showing Revenue Growth Q1 2023 vs Q1 2022*

Top Twenty Domestic Accounts showing Revenue Growth Q1 2023 vs Q1 2022:

actual\_first\_shipped\_quarter 2022 Q 1 2023 Q 1 growth

customer\_account\_name

OREGON HEALTH SCIENCE UNIV 12,950.88 62,546.73 49,595.85

CHOP OF ATLANTA --EGLESTON 966.16 49,027.36 48,061.20

ASCENSION ST JOHN HOSPITAL 15,171.06 61,023.68 45,852.62

MOUNT SINAI SOUTH NASSAU 4,600.00 48,297.30 43,697.30

NEW YORK PRESBY -WEILL CORNELL MED 2,215.37 45,906.44 43,691.07

UNIV OF MS MED CTR 11,018.02 48,425.90 37,407.88

MCKESSON #75 5,858.00 42,070.00 36,212.00

ATRIUM HEALTH-CAROLINAS HCS 32,475.14 68,034.59 35,559.45

CHILDRENS HOSPITAL NEW ORLEANS 4,106.40 36,987.00 32,880.60

GEISINGER MEDICAL CENTER 27,022.01 59,223.22 32,201.21

THOMAS JEFFERSON UNIVERSITY HOSP 19,330.67 50,598.07 31,267.40

FMOL HEALTH SYSTEM 123.89 28,175.50 28,051.61

ST JOSEPH MEDICAL CENTER 2,283.08 29,914.00 27,630.92

INLAND VALLEY REGIONAL MED CENTER 12,992.20 40,253.60 27,261.40

NYU LANGONE HOSPITAL 14,542.20 41,710.00 27,167.80

UNIV OF MISSOURI HOSP & CLINIC 2,755.71 28,833.81 26,078.10

UNIVERSITY OF MARYLAND MED SYSTEM 5,803.87 31,669.25 25,865.38

MOUNT SINAI HOSPITAL- BRONX 20,565.96 46,110.00 25,544.04

SAINT FRANCIS HOSPITAL-TULSA 16,169.00 41,658.00 25,489.00

BETH ISRAEL DEACONESS MED CENTER 13,236.27 38,255.70 25,019.43

**Table 9.**

*Top Twenty Domestic Accounts showing Revenue Decline Q3 2023 vs Q3 2022*

Top Twenty Domestic Accounts showing Revenue Decline Q3 2023 vs Q3 2022:

actual\_first\_shipped\_quarter 2022 Q3 2023 Q3 growth

customer\_account\_name

REGIONAL MEDICAL CENTER OF SAN JOSE 144,620.50 1,156.50 -143,464.00

UNIVERSITY OF VERMONT MEDICAL CENTER 106,950.94 21,046.97 -85,903.97

MCHS HOSPITAL - MARSHFIELD MEDICAL CENTER 73,802.72 2,994.28 -70,808.44

GEORGE WASHINGTON UNIVERSITY HOSPITAL 81,235.80 13,876.00 -67,359.80

RADY CHILDRENS HOSPITAL - SAN DIEGO 76,388.70 15,414.22 -60,974.48

CAPITAL HEALTH REGIONAL MEDICAL CTR 55,687.32 8,286.82 -47,400.50

LAHEY CLINIC MEDICAL CENTER 52,964.67 5,620.80 -47,343.87

OUR LADY OF THE LAKE REG MED CTR 50,760.45 8,879.35 -41,881.10

COMPUMEDICS USA, INC 43,420.95 3,320.00 -40,100.95

LUTHERAN HOSPITAL OF INDIANA 41,137.00 2,516.25 -38,620.75

MAYO CLINIC HOSPITAL JACKSONVILLE 39,606.28 7,696.04 -31,910.24

CHILDRENS NATIONAL MEDICAL CENTER 39,565.47 7,750.43 -31,815.04

UNIVERSITY OF COLORADO HOSPITAL-AURORA 41,981.85 11,814.54 -30,167.31

BOSTON MEDICAL CENTER 52,679.92 22,633.70 -30,046.22

NORTH SHORE LIJ HUNTINGTON HOSPITAL 25,977.00 268.80 -25,708.20

MVAP MEDICAL SUPPLY 297,367.95 271,820.61 -25,547.34

ADVOCATE CONDELL MEDICAL CENTER 32,850.75 8,298.00 -24,552.75

CLEVELAND CLINIC HEALTH SYSTEM 73,352.00 49,092.51 -24,259.49

SRW INDUSTRIES 47,672.00 23,989.00 -23,683.00

NEW HANOVER REGIONAL MEDICAL CENTER 25,413.20 3,576.36 -21,836.84

**Table 10.**

*Top Twenty Domestic Accounts showing Revenue Decline Q2 2023 vs Q2 2022*

Top Twenty Domestic Accounts showing Revenue Decline Q2 2023 vs Q2 2022:

actual\_first\_shipped\_quarter 2022 Q2 2023 Q2 growth

customer\_account\_name

OCALA REGIONAL MEDICAL CENTER 226,688.84 4,801.50 -221,887.36

ABBVIE US LLC 161,125.00 75,599.85 - 85.525.15

MVAP MEDICAL SUPPLY 343,667.71 274,154.35 - 69,513.36

OWENS & MINOR #45 62,706.70 17,521.00 - 45,185.70

HENRY SCHEIN, INC 128,588.00 94,345.00 - 34,243.00

HARBORVIEW MEDICAL CENTER 39,339.75 5,931.02 - 33,408.73

SAINT ALPHONSUS 43,063.30 12,534.60 - 30,528.70

BOSTON MEDICAL CENTER 33,104.35 2,943.75 - 30,160.60

MERCY HOSPITAL FORT SMITH 26,236.00 763.25 - 25,472.75

CHOP SYSTEM OF TEXAS 46,147.57 21,134.59 - 25,012.98

VA SAN DIEGO HEALTHCARE SYSTEM 26,749.60 2,260.00 - 24,489.60

UC HEALTH 34,842.31 11,011.05 - 23,831.26

AKRON CITY HOSPITAL 48,941.53 25,426.83 - 23,514.70

BJC HEALTH CENTER 44,550.94 21,167.60 - 23,383.34

KAISER PERMANENTE 34,755.46 12,334.51 - 22,420.95

PARKVIEW HOSPITAL 41,241.53 19,106.17 - 22,135.36

RUSH UNIVERSITY MEDICAL CENTER 27,519.67 6,221.80 - 21,297.87

MCKESSON #81 41,892.00 20,812.00 - 21,080.00

MEDICAL CITY OF ARLINGTON 22,765.59 2,303.25 - 20,462.34

UNIV OF MS MED CTR 62,218.46 43,400.73 - 18,817.73

**Table 11.**

*Top Twenty Domestic Accounts showing Revenue Decline Q1 2023 vs Q1 2022*

Top Twenty Domestic Accounts showing Revenue Decline Q1 2023 vs Q1 2022:

actual\_first\_shipped\_quarter 2022 Q1 2023 Q1 growth

customer\_account\_name

HENRY SCHEIN, INC 104,909.00 17,319.00 -87,590.00

KP VACAVILLE MEDICAL CENTER 53,175.40 279.30 -52.896.10

DEACONESS HOSPITAL-EVANSVILLE 46,377.60 820.84 -45,556.75

ABBVIE US LLC 161,048.00 117,750.15 -43,297.85

ST LOUIS CHILDREN'S HOSPITAL 39,090.36 8,128.07 -30,962.29

MONUMENT HEALTH RAPID CITY 39,266.00 9,044.00 -30,222.00

ST ELIZABETH HEALTH CENTER 29,098.36 957.00 -28,141.36

BSA HEALTH SYSTEMS 29,162.25 2,475.25 -26,687.00

CHILDRENS HEALTH SYSTEM OF TX 45,369.14 18,814.79 -26,554.35

MEMORIAL MEDICAL CENTER 42,445.27 17,858.77 -24,586.50

MEDLINE INDUSTRIES, INC 216,712.00 192,211.00 -24,501.00

UNIVERSITY OF COLORADO HOSP 53,674.08 29,512.34 -24,161.74

METROPOLITAN METHODIST HOSP 26,300.75 3,344.00 -22,956.75

MEDIKAL-MUNERIS SA DE SV 23,688.50 1,013.76 -22,674.74

OWENS & MINOR #60 47,716.00 25,716.00 -22,000.00

ROBERT WOOD JOHNSON UNIVERSITY 33,250.14 11,676.89 -21,573.25

REGIONAL ONE HEALTH 40,505.28 20,004.18 -20,501.10

MUHA - MED UNIV HOSPITAL AUTH 21,333.23 1,624.49 -19,708.74

COMMUNITY REGIONAL MED CENTER 41,809.20 22,857.70 -18,951.50

KAISER PERMANENTE ROSEVILLE MED 23,847.20 6,040.96 -17,806.24

**Table 12.**

*Top Twenty International Accounts showing Revenue Growth Q3 2023 vs Q3 2022*

Top Twenty International Accounts showing Revenue Growth Q3 2023 vs Q3 2022

actual\_first\_shipped\_quarter 2022 Q3 2023 Q3 growth

customer\_account\_name

ALLERGAN PHARMACEUTICALS 66,181.89 188,414.82 122,232.93

DUOMED THE NETHERLANDS 3,356.82 62,722.47 59,365.65

NEUROSWISS AG 56,935.40 114,284.46 57,349.06

NEUROLITE AG 12,163.50 54,675.13 42,511.63

ALMEVAN S.L. 157,504.34 197,415.85 39,911.51

VITALMEDIC SA 5,272.50 45,101.80 39,829.30

INSTRUMENTOS MEDICOS 38,790.50 74,115.20 35,324.70

ANDOVER ALIANZA MEDICA S.A. 2,884.69 28,676.24 25,791.55

OPTIMA MEDICAL LTD 57,264.40 82,753.27 25,488.87

GVB-GELIMED GMBH 39,885.69 64,851.22 24,965.53

COMED S.C. 20,256.26 43,277.00 23,020.74

SYNGROWTH CO LTD 38,642.76 61,454.64 22,811.88

TKB CORPORATION 0.00 20,555.31 20,555.31

MAG2HEALTH 51,549.58 70,549.45 18,999.87

SANO TECNICA, LDA. 14,951.65 26,887.35 11,935.70

VIRTUS TRADING LLC 1,826.42 12,566.04 10,739.62

CLINIQUES DE L'EUROPE 61.15 10,445.22 10,384.07

MEDCAT BV (EUROPE) 6,230.50 15,497.20 9,266.70

DUOMED BELGIUM NV 183,665.87 192,781.82 9,115.95

HOPITAL SUD REUNION 664.40 8,636.74 7,972.34

**Table 13.**

*Top Twenty International Accounts showing Revenue Growth Q2 2023 vs Q2 2022*

Top Twenty International Accounts showing Revenue Growth Q2 2023 vs Q2 2022

actual\_first\_shipped\_quarter 2022 Q2 2023 Q 2 growth

customer\_account\_name

SICHUAN SANSHENGCHUANGXIN 222,194.00 842,129.00 619,935.00

BEIJING BEIKE DIGITAL MEDICAL 324,552.00 774,930.00 450,378.00

PHYSIOTEC MEDICAL EQUIPMENT7 987.92 181,697.67 173,709.75

HANGZHOU QIYUN TRADING CO 61,590.00 188,402.00 126,812.00

MEDIX MEDICAL DEVICES SRL 10,250.00 116,814.70 106,564.70

BUTICON INTERNATIONAL CORP 10,500.00 106,787.30 96,287.30

ALLERGAN PHARMACEUTICALS 66,181.89 121,104.88 54,922.99

MEDISERV CO. LTD 16,548.43 70,067.84 53,519.41

NEUROSOURCE MEDICAL INC 42,800.80 89,741.19 46,940.39

MEDLIFE 22,307.52 68,027.20 45,719.68

OPTIMA MEDICAL LTD 29,381.82 59,712.66 30,330.84

COMED S.C. 9,348.00 34,277.29 24,929.29

SANO TECNICA, LDA. 4,823.24 29,686.84 24,863.60

DABASONS IMPORTACAO 117,615.35 142,218.40 24,603.05

INSTRUMENTOS MEDICOS 4,805.50 20,975.50 16,170.00

NEUROLITE AG 9,989.79 21,399.95 11,410.16

MEDCAT BV (EUROPE) 3,697.50 14,761.10 11,063.60

BIONIC IBERICA SA 9,037.00 19,630.25 10,593.25

TEKNIKEL PIYALEPASA BULVARI 100,383.63 110,259.70 9,876.07

RESMED KOREA 20,152.00 29,727.20 9,575.20

**Table 14.**

*Top Twenty International Accounts showing Revenue Growth Q1 2023 vs Q1 2022*

Top Twenty International Accounts showing Revenue Growth Q1 2023 vs Q1 2022

actual\_first\_shipped\_quarter 2022 Q1 2023 Q1 growth

customer\_account\_name

YOUNG WOO MEDITECH CO., LTD 148,742.05 235,584.74 86,842.69

AP HOPITAL PITIE SALPETRIERE 1,461.52 32,641.51 31,179.99

KEGO CORPORATION 43,240.41 72,551.56 29,311.15

TEKNIKEL PIYALEPASA BULVARI 1,113.60 30,116.40 29,002.80

MEDLIFE 36,528.91 65,380.52 28,851.61

OPTIMA MEDICAL LTD 40,682.31 69,422.47 28,740.16

HE NAN HAOKUN MEDICAL DEVICES 12,555.00 35,870.00 23,315.00

ASCO 90 SRL 112.32 19,068.28 18,955.96

PT TIARA KENCANA 2,763.20 17,441.60 14,678.40

DANMEDIK SDN. BHD. 8,876.10 22,063.15 13,187.05

HANGZHOU QIYUN TRADING CO., LTD. 75,000.00 85,875.00 10,875.00

ATOMEDICAL SARL 820.00 10,660.00 9,840.00

AXIS HEALTHCARE 11,948.25 20,499.10 8,550.85

MEDIAL GROUP D.O.O. 14,728.15 22,259.46 7,531.31

GOLDENGATE JSC 22,860.10 29,800.00 6,939.90

IMPORTADORA Y COMERCIALIZADORA 929.28 7,741.36 6,812.08

MEDIAL D.O.O. 6,280.75 11,908.75 5,628.00

INSTRUMENTOS MEDICOS INTERNAT 29,404.20 34,626.80 5,222.60

CSSS DE ST-JEROME 1,549.16 6,696.60 5,147.44

DANMEDIK (S) PRIVATE LIMITED 15,120.00 20,133.00 5,013.00

**Table 15.**

*Top Twenty International Accounts showing Revenue Decline Q3 2023 vs Q3 2022*

Top Twenty International Accounts showing Revenue Decline Q3 2023 vs Q3 2022

actual\_first\_shipped\_quarter

customer\_account\_name 2022 Q3 2023 Q 3 growth

BEIJING BEIKE DIGITAL MEDICAL 110,6065.00 310,194.00 -795,871.00

SICHUAN SANSHENGCHUANGXIN 31,7430.00 56,176.32 -261,253.68

HANGZHOU QIYUN TRADING CO 13,2172.00 20,650.00 -111,522.00

MEDIX MEDICAL DEVICES SRL 119,392.10 66,673.50 -52,718.60

PHYSIOTEC MEDICAL EQUIPMENT 218,425.60 181,308.00 -37,117.60

MEDLIFE 57,942.21 22,545.26 -35,396.95

MUNDINTER, S.A. 24,679.20 376.00 -24,303.20

DENGG MEDIZINTECHNIK GMBH 38,087.14 17,571.20 -20,515.94

BAROQUE MEDICAL INTERNATIONAL LTD 35,168.25 16,676.35 -18,491.90

YOUNG WOO MEDITECH CO., LTD 178,960.44 161,250.70 -17,709.74

MEDIAL GROUP D.O.O. 25,434.90 10,375.20 -15,059.70

MEDISERV CO. LTD 41,146.98 26,101.54 -15,045.44

AXIS HEALTHCARE 47,219.00 33,803.50 -13,415.50

SYNOPO SRL 64,216.15 51,653.98 -12,562.17

TEKNIKEL PIYALEPASA BULVARI 49,887.12 39,940.93 -9,946.19

INTERNATIONAL CLINICS S.A. 30,402.20 20,617.91 -9,784.29

ASBL HELORA 14,390.80 5,694.70 -8,696.10

AMTRONECH 8,200.00 38.40 -8,161.60

ISOSL 9,587.55 1,836.56 -7,750.99

DANMEDIK SDN. BHD. 12,805.10 5,393.50 -7,411.60

**Table 16.**

*Top Twenty International Accounts showing Revenue Decline Q2 2023 vs Q2 2022*

Top Twenty International Accounts showing Revenue Decline Q2 2023 vs Q2 2022:

actual\_first\_shipped\_quarter 2022 Q2 2023 Q2 growth

customer\_account\_name

GOLDENGATE JSC 92,573.50 432.96 -92,140.54

TKB CORPORATION 108,941.45 40,707.42 -68,234.03

DUOMED BELGIUM NV 176,180.08 126,107.26 -50,072.82

SYNGROWTH CO LTD 71,920.68 25,725.96 -46,194.72

DUOMED THE NETHERLANDS 53,129.56 14,181.03 -38,948.53

SYNOPO SRL 84,989.20 50,932.98 -34,056.22

YOUNG WOO MEDITECH CO. 176,057.35 143,929.12 -32,128.23

GVB-GELIMED GMBH 58,526.24 30,550.61 -27,975.63

SCHUMACHER MEDTECH GMBH 26,151.95 5,201.13 -20,950.82

KEGO CORPORATION 99,491.58 79,851.91 -19,639.67

INTERNATIONAL CLINICS S.A. 51,437.06 32,396.60 -19,040.46

P.T. PETAN DAYA MEDICA 17,562.40 987.58 -16,574.82

BJC HEALTHCARE COMPANY LTD 17,594.22 1,361.25 -16,232.97

MUNDINTER, S.A. 30,719.00 16,203.12 -14,515.88

AXIS HEALTHCARE 34,406.70 20,335.50 -14,071.20

ALMEVAN S.L. 272,160.88 259,950.11 -12,210.77

LÖWENSTEIN MEDICAL SE 14,009.03 7,068.46 -6,940.57

PT TIARA KENCANA 10,507.20 4,131.00 -6,376.20

WALTER GRAPHTEK CZ S.R.O. 8,919.10 3,647.75 -5,271.35

BUHLER PHARMA, S.A. 7,844.00 2,868.80 -4,975.20

**Table 17.**

*Top Twenty International Accounts showing Revenue Decline Q2 2023 vs Q2 2022*

Top Twenty International Accounts showing Revenue Decline Q1 2023 vs Q1 2022:

actual\_first\_shipped\_quarter

customer\_account\_name 2022 Q1 2023 Q1 growth

SICHUAN SANSHENGCHUANGXIN 457,716.00 204,905.16 -252,810.84

BUTICON INTERNATIONAL CORP 189,615.00 37,627.30 -151,987.70

NEUROLITE AG 146,227.26 11,391.79 -134,835.47

DABASONS IMPORTACAO EXPORTACAO 176,160.65 49,788.60 -126,372.05

BEIJING BEIKE DIGITAL MEDICAL 500,668.00 390,683.50 -109,984.50

SYNGROWTH CO LTD 106,997.28 17,603.04 -89,394.24

DUOMED THE NETHERLANDS 90,575.78 13,203.29 -77,372.49

M. SCHILLING GMBH MEDICAL PROD 110,759.50 75,699.00 -35,060.50

ALLERGAN PHARMACEUTICALS 212,946.64 178,668.10 -34,278.54

PHYSIOTEC MEDICAL EQUIPMENT 143,123.60 110,617.50 -32,506.10

SECOND MEDICAL SAC 48,108.50 17,313.40 -30,795.10

RESMED KOREA 32,951.30 3,027.20 -29,924.10

LÖWENSTEIN MEDICAL SE + CO.KG 39,895.90 11,224.11 -28,671.79

NEUROSWISS AG 72,075.16 45,123.97 -26,951.19

ALMEVAN S.L. 172,390.35 145,942.13 -26,448.22

DUOMED BELGIUM NV 142,722.01 123,507.77 -19,214.24

MEDCAT BV (EUROPE) 24,525.90 5,576.00 -18,949.90

ARENA MEDICAL CARE PVT LTD. 24,314.85 7,643.89 -16,670.96

AP HOPITAL DU KREMLIN BICETRE 18,699.20 2,667.12 -16,032.08

GVB-GELIMED GMBH 62,548.32 46,766.29 -15,782.03

Figures

Figure 1.

Top ten items by Percentage of Revenue

A pie chart with numbers and a number on it

Description automatically generated

**Figure 2.**

*Top Ten Counts for item in the Neuro Critical Care Dataset*

*A graph of a number of colored bars

Description automatically generated with medium confidence*

Figure 3.

*Online Supply Store Revenue YTD and projected*

A screenshot of a computer

Description automatically generated

Figure 4.

*Natus Choice Standard Order Program*

A screenshot of a computer

Description automatically generated

Figure 5.

*Natus Online Supply Store average revenue per order*

A screenshot of a computer screen

Description automatically generated

Figure 6.

*Item Order Counts year over year*

A graph of a number of columns

Description automatically generated with medium confidence

Figure 7.

*Revenue (in millions) year over year*

A graph of a number of different colored bars

Description automatically generated with medium confidence

Figure 8.

*Correlation heatmap – quantitative variables that show correlation.*

A screenshot of a computer screen

Description automatically generated

Figure 9.

*Cramer’s heatmap: correlation for the following qualitative variables:*

*Order Type, Customer Type, Product Group, ABC Classification*

A screenshot of a graph

Description automatically generated

Figure 10.

*Cramer’s heatmap: correlation for the following qualitative variables:*

*Order Type, Customer Type, Product Group, Item*

A chart of different colors

Description automatically generated with medium confidence

Figure 11.

*Cramer’s heatmap: correlation for the following qualitative variables:*

*Order Type, Product Sub Type, Customer Name, Item*

*A screenshot of a chart

Description automatically generated*

Figure 13.

*Cramer’s heatmap: correlation for the following qualitative variables:*

*Customer Category, Siebel Account Type, Customer Name, Item*

A screenshot of a graph

Description automatically generated

Figure 14.

*Cramer’s heatmap: correlation for the following qualitative variables:*

*Customer Category, Siebel Account Type, Customer Name, Product Class*

A screenshot of a graph

Description automatically generated

Figure 15.

*Ridge Regression and SelectKBest r-squared scores in a line graph:*

A graph with different colored lines

Description automatically generated

Description:

A screenshot of a computer code

Description automatically generated

Figure 16.

SQL code snippet

A close up of a text

Description automatically generated

Figure 17.

*What the SQL query looks like after executing, a snapshot*

A screenshot of a computer

Description automatically generated

Figure 18.

Pyspark query in AWS, showing top twenty parts with growth driving revenue.

A screenshot of a computer

Description automatically generated

Figure 20.

*Power BI header snapshot*

A screenshot of a computer

Description automatically generated

Figure 21.

Ridge Regression code that produces the high R-Squared training score

A screenshot of a computer program

Description automatically generated

Figure 22.

*Screen print of the SelectKBest regression dependent variables*

A screenshot of a computer code

Description automatically generated

Figure 23.

*Screen print of the graph showing the dependent variables.*

A graph with colored lines and numbers

Description automatically generated

Figure 24.

Inflation trend over the last ten years in the Europe region

A graph of a graph showing the rate of the euro

Description automatically generated with medium confidence

**Appendix**

[**https://github.com/mrhanson1/Capstone**](https://github.com/mrhanson1/Capstone)