

Social Media Analysis

NLP Analysis of Continuous Glucose Monitoring (CGM) for Diabetes

Making Products Count: Data Science for Product Managers Final Project Report

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1. Background

Diabetes is a metabolic disease that causes high blood sugar, when the body can't produce enough insulin (Type 1 – 10%) or can't use the insulin it does make (Type 2 – 90%). In 2019, diabetes was the direct cause of 1.5 million deaths in 2019, and with the advent of the COVID-19 pandemic, is a major contributor to mortality from COVID-19. Diabetes cannot be cured, but can be managed. The goal of diabetes management is to reduce A1C levels, which measure the amount of hemoglobin (a protein in red blood cells) that has glucose attached to it. Glucose levels are usually measured with finger-stick blood glucose tests, but an emerging alternative is use of continuous glucose monitoring (CGM) which analyzes data from a sensor inserted under the skin. Since CGM is always on, glucose levels can be tracked in real time to see how glucose levels change throughout the day. CGM is usually used for type 1 diabetes.

2. The Data

Anupam Singh and the team at 113 Industries have kindly provided a sample of over 37K social media posts from a variety of sources related to CGMs available in Canvas as Diabetes Continuous Glucose Monitoring – Data Export.xlsx. Each row of the Excel file consists of a field of text called Sound Bite Text, along with a variety of other more structured metadata fields such as the source and when the Sound Bite Text field were extracted.

3. Problem statement

Analyze social media data on Continuous Glucose Monitoring (CGM) and understand the general trend and emotions of users around CGM and CGM products, discover insight to help companies and customers improve their decisions.

4. Target Customers

The following are our target customers for CGM:

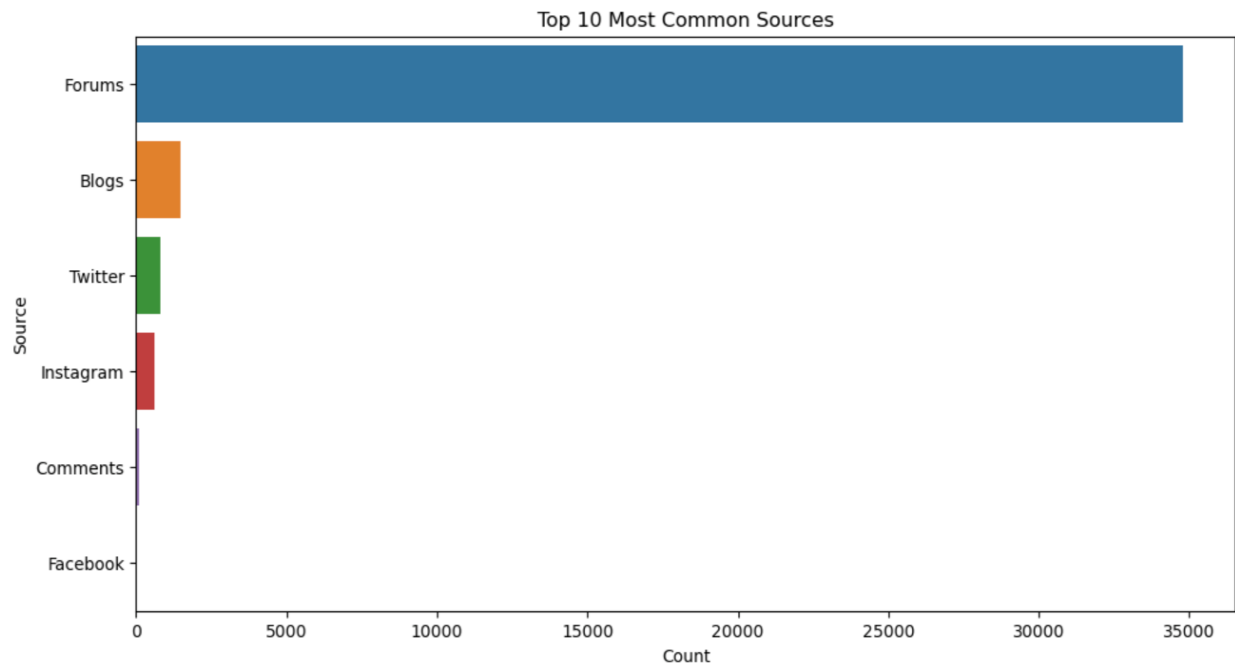
- **Business Stakeholders**
With diabetes being a widespread and serious disease, the CGM market is substantial. The report offers real user insights to guide stakeholders in product development, marketing, and addressing concerns.
- **Potential end users and consumers of CGM products**
Potential users want to learn from current users about CGM effectiveness, user-friendliness, common issues, and how CGMs compare to finger-stick methods. The report data offers insights for informed decision-making.
- **Insurance companies**
Insurance companies would be interested in the real-world feedback of CGM users to assess its efficacy, utility, and cost-effectiveness. If CGMs prove to be more effective in managing diabetes and reducing complications (which can be costly to treat), insurance companies might be more inclined to provide coverage for CGMs. Understanding user feedback might also give them insights into potential claims or issues related to the device.

5. Methodology:

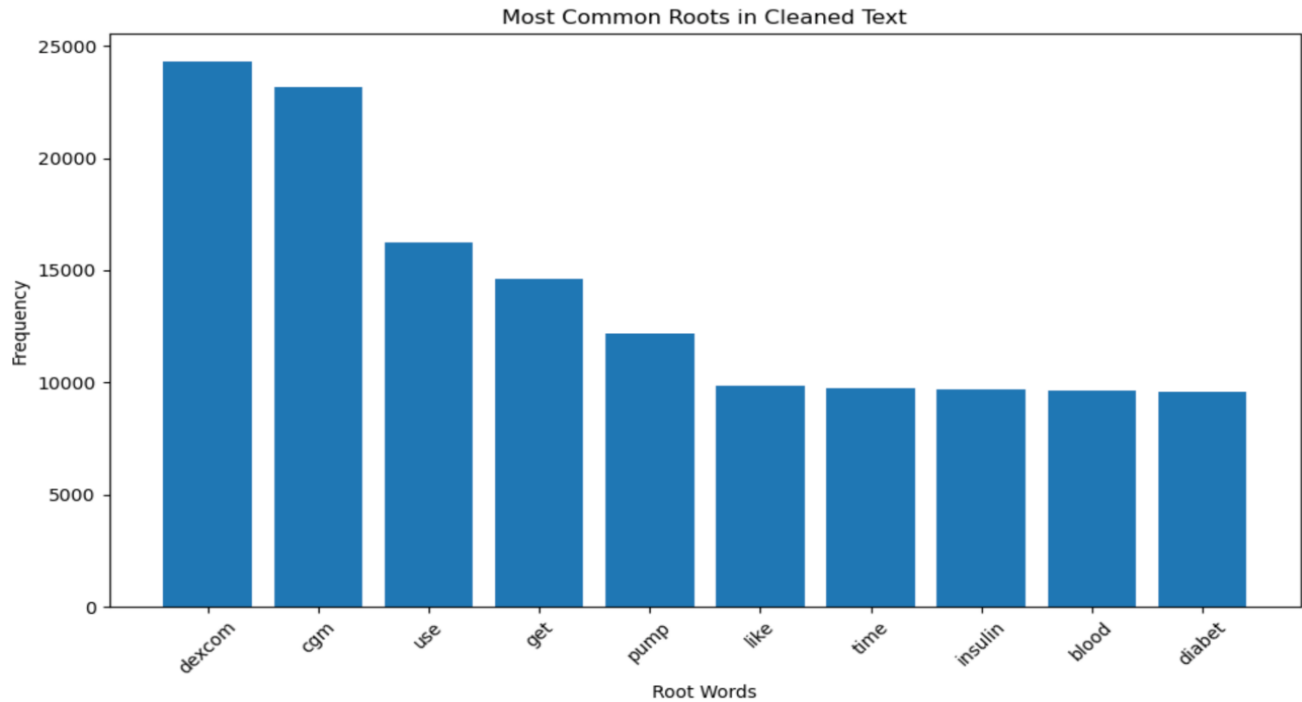
5.1 Exploratory Data Analysis

1. Importing relevant packages.
2. Understanding the data segmentation and division of customers across different products that customers are using.
3. Checking the Metadata and variables type.
4. Cleaning and tokenizing the data.
5. Removing null values, punctuations, tags, and stop words.
6. Calculating frequencies of bigrams and trigrams.
7. Perform Stemming and Lemmatization on the data.
8. Finding most common roots in the cleaned text.
9. Finding the most common sources.

Raw Data Overview : Top 10 common sources of the data



Data cleaning : Most common roots in cleaned Text



5.2 Sentiment Analysis using a Model

Topic Modelling Using LDA

Objective:

Extract and summarize key trends, consumer needs, and other relevant insights from a vast dataset of social media posts related to Continuous Glucose Monitoring (CGM) products by employing the Latent Dirichlet Allocation (LDA) topic modeling technique.

Methodology:

1. Model Determination:

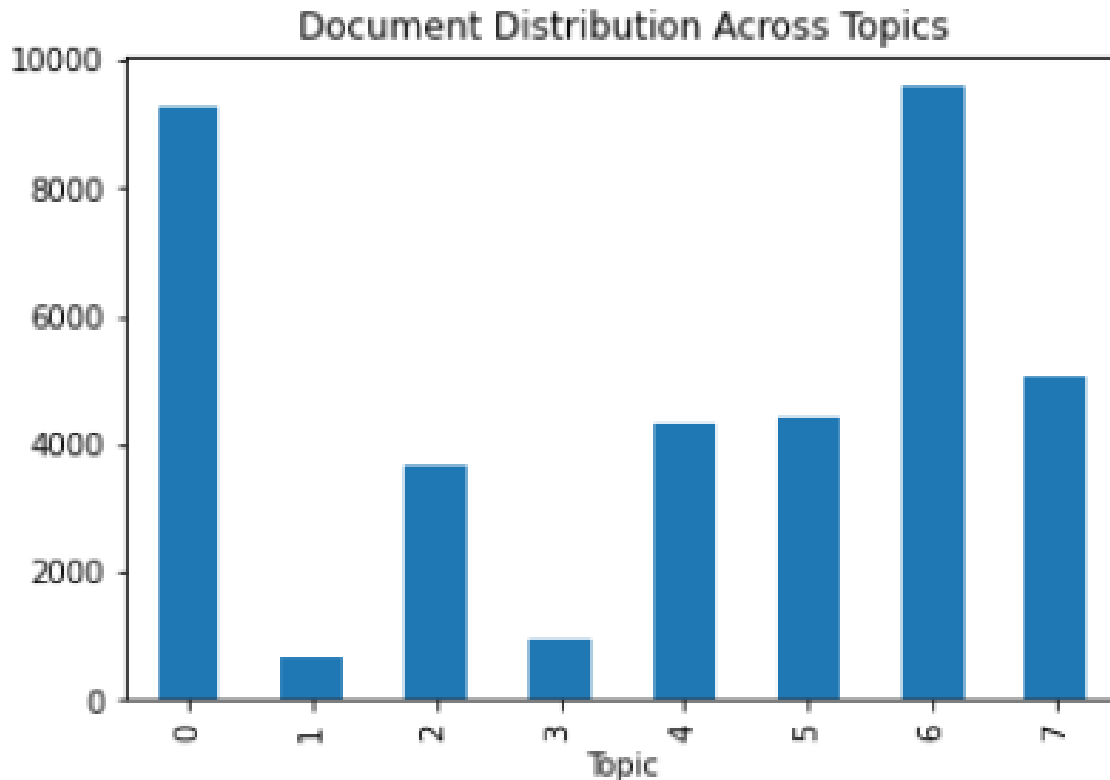
- Preliminary models were trained based on varying k-values derived from initial analysis and domain knowledge.
- An optimal topic separation was achieved when k=8. This determination was cross-validated by examining the most frequent words in each topic and referencing with OpenAI.

2. Model Training:

- Cleaned and tokenized texts served as the input data.
- LDA assigned topics to each document and words to topics based on probability and co-occurrence patterns.

Topic Key Words

Topic 1:
cgm year insurance insulin dexcom pump month got supply diabetic ive doctor dont diabetes know type like libre cover diagnosed
Topic 2:
diabetes device glucose freestyle people libre cgm type monitoring patient health medical data technology product company cgms totally na care
Topic 3:
glucose blood sugar monitor continuous level insulin cgm food diabetes eat diet diabetic meal carbs spike body eating carb type
Topic 4:
arm site skin wear stomach use pain issue left adhesive place area dexcom patch body hurt kept thigh upper abdomen
Topic 5:
dexcom sensor libre app phone use freestyle watch g6 day transmitter reading work using new apple data need time like
Topic 6:
cgm pump like make dont insulin control really thing think help good lot better know work need youre want life
Topic 7:
low cgm time day high finger like sugar dexcom ive blood hour dont night alc got feel going reading number
Topic 8:
dexcom pump sensor g6 ive medtronic tandem omnipod year tslim use using used love libre day new accurate issue work



The figure above corresponds to the most frequently occurring top 10 words in each topic and the histogram represents their distributions in each topic.

Topic Summarization

Here's the summary of what each topic entails after manually going through the sample texts from each topic and also called OpenAI as validation.

Topic 6: Specific readings, accuracy, and personal experiences with different insulin types and regimens.

Topic 0: General discussion about selecting a CGM. Mentions popular brands like Dexcom and Freestyle Libre. It focuses on the practicalities of selection, costs, and insurance implications.

Topic 7: Discussions on specific brands, models, and their features. This includes mentions of transitioning between different models or brands.

Topic 5: Feedback and recommendations regarding specific brands and device models.

Topic 4: Technology-related issues with the devices. This involves signal issues, technical glitches, and experiences with different brands.

Topic 2: Personal experiences with using CGMs, their impact on understanding blood sugar trends, and the comparison between finger pricking vs. CGMs.

Topic 3: Experiences related to wearing the device. Examples include adhesive issues, site selection, and physical interactions with the device.

Topic 1: Importance and utility of CGMs for managing diabetes, especially in differentiating between Type 1 and Type 2 diabetes. There are mentions of the NHS, which suggests a UK context.

6. Tasks

6.1 General CGM Analysis

a. What are patient expectations of CGMs?

Relevant Topics: Topic 6 and Topic 0

a) Accuracy of Readings: Patients expect CGMs to provide accurate blood glucose readings consistently. Even small inaccuracies can lead to incorrect insulin dosages or incorrect responses to perceived high or low blood sugar levels.

b) Real-time alert: One significant advantage of CGMs is their ability to alert users about potential hypoglycemia (low blood sugar) or hyperglycemia (high blood sugar) events

c) Continuous glucose monitoring: CRM should offer uninterrupted monitoring. Patients expect consistent data without extended periods of downtime or "blind spots" in the readings

b. What are patient knowledge gaps with CGMs?

Relevant Topics: Topic 4, Topic 6, Topic 7

a) Understanding Sensor Limitations and Duration: Some users express doubts that certain models, like the Dexcom G6, can last their full advertised duration.

b) Technical and Software Challenges: Users experience issues related to connectivity, software glitches, and calibration errors.

c) Feature Awareness: Some patients might not be fully aware of all the features their CGM offers, such as alarms, control-IQ features, or data-sharing capabilities and how to use certain functions.

c. What benefits are most important to diabetes patients?

Relevant Topics: Topic 4, Topic 5

a) Awareness of Emotional Attachment to Food: Monitoring helps patients recognize and manage emotional eating and cravings. By tracking, individuals can identify when they're genuinely hungry or when it's just a craving, helping in maintaining stable sugar levels.

b) Safety and Real-time Monitoring: Devices like Dexcom provide real-time glucose readings. While they might sometimes have issues like signal drops or discrepancies, they provide an immediate indication of glucose levels, which can be lifesaving, especially during nighttime.

c) Encourages Blood Testing for Accuracy: Patients are often advised to perform a blood test if symptoms don't match device readings, reinforcing the importance of accurate data and regular monitoring.

d. What unmet needs do patients have related to CGMs (something patients want but are not getting)?

Relevant Topics: Topic 6, Topic 0 Topic 7, Topic 5

a) Insurance Issues: A significant concern is the insurance coverage for CGMs. Many patients struggle with the expenses, and some insurance plans either don't cover CGMs at all or require rigorous justification for them. Cost-sharing plans or special programs sometimes become more attractive due to these limitations.

b) Reliability: Several mentions indicate that certain CGMs can be unreliable, with some failing shortly after being applied or not being accurate.

c) Ease of Access: Patients have difficulty accessing certain CGM brands or models, either due to stock issues at local pharmacies or insurance stipulations.

d) Affordability: Even with insurance, the out-of-pocket cost for some patients can be high. This makes affordability a significant concern, especially for specific models or brands that might be seen as more reliable or desirable.

e) Integration and Compatibility: Several users talk about the integration of their CGM with other systems, like the Tandem pump, highlighting a desire for seamless integration between devices.

6.2 CGM Product-related analysis

a. What are praises & complaints and features of Dexcom & Freestyle Libre?

Praises of Dexcom

1. Dexcom is covered by insurance and there is less copayment and that is something people love. (Topic 0)
2. The amount of overhead cost that customers have to pay are low. Most of the cost is covered by insurance companies.(Topic 0)
3. Does not require fingersticks for calibration and that makes the customers feel safer and reduces discomfort. (Topic 1)
4. The Dexcom G5 is accurate and provides real-time glucose readings.(Topic 2)
5. Recommendations provided by Dexcom for their workout regime are being liked by people. (Topic 2)
6. Can be paired with apple and android devices. (Topic 3).
7. Accurate reading as compared to Lifestyle libre. (Topic 4 and 5).
8. Life changing experience as it helps in keeping sugar well controlled.(Topic 7)
9. Highly recommended as gives accurate readings.(Topic 8 and 9)

Complaints of Dexcom

1. The sensors of Dexcom fail needs to be replaced every once in a while. (Topic 1)
2. First time user have faced symptoms like vomitting and feeling nauseous. (Topic 1)
3. Getting the parts of Dexcom replaced is a pain for customers. Either they are not readily available or insurance companies take a lot of time for replacement. (Topic 1)
4. Sometimes defective Dexcom were delivered to patients. (Topic 1)
5. Not compabitable with some of the the older phones and devices. (Topic 3)
6. Resetting phone or other devices makes dexcom non-functional with the new ones. (Topic 4)
7. People have been having issues regarding the bluetooth readings and calibration. (Topic 6 and 7).

Praises of Freestyle Libre

1. Covered under insurance but might require medical prescription. (Topic 0 and 8)
2. Helps inspire other people by connecting through social media. (Topic 2)
3. Helps in constantly monitoring glucose every 5 minutes. (Topic 2)
4. The patched app comes with libre 2s which sends bluetooth signal to the receiver phone app every 5 minutes.(Topic 3)
5. Dexcom app worse than Libre app. (Topic 3)
6. Better than finger sticks. (Topic 4)

Complaints of Freestyle Libre

1. First timers need some help from the company. (Topic 0)
2. People found Dexcom better than Freestyle Libre. (Topic 0)
3. Dexcom gave better readings comparatively. (Topic 1)
4. Received defective products. (Topic 1)
5. Accuracy and frequency of data is low as compared to dexcom. (Topic 6 and 7)
6. Complaints of product failing and inaccurate data (Topic 5)

b. What product features are being talked about?

Features being talked about are:

1. Compatibility with devices such as smartphones and smartwatches
2. Calibration issues being faced by customers.
3. Accuracy of the readings in the two products.
4. Insurance coverage for both the devices.
5. Recommendations based on customer's personal experiences.

c. How do consumer opinions of Dexcom and Freestyle Libre compare?

Consumer opinions of Dexcom and Freestyle Libre show both products have their own set of advantages and disadvantages.

Dexcom:

- **Pros:** Good insurance coverage, accurate readings, real-time monitoring, works on Apple and Android, offers workout recommendations
- **Cons:** Sensor failures, new user symptoms, part replacement issues, device compatibility problems, Bluetooth and calibration issues.

Freestyle Libre:

- **Pros:** Insurance coverage (with prescription), social connectivity, regular monitoring, reliable app
- **Cons:** Less accurate and frequent than Dexcom, defects reported, first-time user assistance needed, some prefer Dexcom.

d. What is the overall sentiment regarding the two products?

Both products are valuable for glucose monitoring, but Dexcom is preferred for accuracy and user-friendliness, while Freestyle Libre excels in its app and social connectivity.

e. Based on your analysis, which one would you recommend?

Based on the provided analysis, **Dexcom** appears to have a slight edge over Freestyle Libre due to its higher praise for accuracy, real-time monitoring, and compatibility. However, the final recommendation would depend on individual user preferences, specific needs, and insurance situations.

f. What would you tell each of these brands to improve?

Dexcom:

- Address and improve the lifespan and reliability of sensors.
- Ensure a smoother process for replacing parts.
- Enhance compatibility with a wider range of devices, including older models.
- Address Bluetooth connectivity and calibration issues to ensure seamless user experience.

Freestyle Libre:

- Improve the accuracy and frequency of glucose readings to match or surpass competitors.
- Enhance onboarding and support for first-time users.
- Address the issue of delivering defective products and ensure stringent quality checks.
- Consider enhancing the features to provide real-time insights and recommendations similar to Dexcom.

6.3 a. Different types of Segments

We have identified the following two types of segments :

- People using Dexcom : 18840
- People using Freestyle Libre : 3189
- People using other : 15815

The overall sentiment for both segments has been positive:

- Percentage of Dexcom users that are satisfied: 66.97%
- Percentage of Freestyle Libre users that are satisfied: 67.1%

b. Are different benefits more important to different consumer types?

There are some benefits that are common to both user segments, and some are different, please find below:

Benefits important to Dexcom users:

- Insurance coverage and lower co-payment
- No need for fingersticks for calibration
- Real-time glucose readings
- Compatibility with Apple and Android devices

- Accurate readings, especially when compared to Freestyle Libre
- Recommendations for workout regimes
- Life-improving experience in sugar management

Benefits important to Freestyle Libre users:

- Insurance coverage (with a possible need for a prescription)
- Social connectivity through the product
- Regular glucose monitoring every 5 minutes
- Reliable app functionality, which some find better than Dexcom's
- An alternative to fingersticks

7. OpenAI API usage

7.1 General CGM analysis:

a. What are patient expectations of CGMs? What are patient knowledge gaps with CGMs?

Patient expectations of CGMs :

Patients expect CGMs to be accurate, reliable, and affordable. They also expect CGMs to be easy to use and to provide them with useful data that can help them better manage their diabetes. However, patients also have knowledge gaps with CGMs. For example, they may not be aware of all the features and benefits of CGMs, or how to interpret and use the data from CGMs to make informed decisions about their diabetes care.

Patient knowledge gaps with CGMs include:

- How to use them effectively
- How to interpret the data
- How to adjust insulin doses based on CGM readings
- The cost of CGMs
- The availability of CGMs

b. What benefits are most important to diabetes patients?

The most important benefits for diabetes patients are the ability to monitor their blood sugar levels, the ability to manage their diabetes with medication and supplies, and the ability to see a doctor regularly.

c. What unmet needs do patients have related to CGMs (something patients want but are not getting)

1. Patients want CGMs that are more affordable.
2. Patients want CGMs that are more accurate.
3. Patients want CGMs that are easier to use.
4. Patients want CGMs that have fewer disruptions.

7.2 CGM Product-related analysis:

a. What are praises & complaints and features of Dexcom & Freestyle Libre?

Praises of Dexcom :

1. The Dexcom G5 is a continuous glucose monitor (CGM) that helps people with diabetes to better manage their condition.
2. The Dexcom G5 is the first CGM system that does not require fingersticks for calibration.
3. The Dexcom G5 is accurate and provides real-time glucose readings.
4. The Dexcom G5 can be used to make treatment decisions, such as adjusting insulin doses.
5. The Dexcom G5 is easy to use and can be worn on the body for up to 7 days at a time.
6. The Dexcom G5 is covered by many insurance plans, making it affordable for many people with diabetes.
7. The Dexcom G5 has been shown to improve glycemic control in people with diabetes.
8. The Dexcom G5 is a life-changing technology that has helped many people with diabetes to better manage their condition.

Complaints of Dexcom :

1. Complaints about the cost of Dexcom
2. Complaints about the accuracy of Dexcom
3. Complaints about the app
4. Complaints about the sensor
5. Complaints about the customer service

Features of Dexcom:

Some features of Dexcom include:

- A1C tracking
- Blood sugar level tracking
- Insulin pump integration
- Automatic insulin dosing
- Predictive low glucose alerts

Praises of Freestyle Libre :

Some people think that the Freestyle Libre is a great tool that can help them manage their diabetes. Other people think that the Libre is not accurate enough and that it is not worth the money.

Complaints of Freestyle Libre :

- The cost of Freestyle Libre
- The accuracy of Freestyle Libre
- The lack of alerts on Freestyle Libre
- The difficulty of using Freestyle Libre

Features of Freestyle Libre:

- Continuous glucose monitoring (CGM)
- A1C tracking
- Insulin dosing
- Automatic bolus bolusing
- Pattern recognition
- Predictive low glucose alerts
- Remote monitoring

b. What product features are being talked about?

Some common features of the Dexcom and Freestyle Libre products that are being talked about include their accuracy, their ability to help people control their diabetes, and the fact that they are relatively expensive.

c. How do consumer opinions of Dexcom and Freestyle Libre compare?

Based on the tweets above, it seems that Dexcom is generally well-liked, with many users finding it to be a life-changing product. There are some complaints about the app and the G6 sensor, but overall, users seem to be happy with the product. In contrast, Freestyle Libre seems to have more mixed reviews, with some users finding it helpful and others finding it disruptive and annoying.

d. What is the overall sentiment regarding the two products?

Overall Sentiment regarding Dexcom :

The sentiment could be seen as generally positive, with people talking about how helpful Dexcom is and how it has helped them manage their diabetes. There are some negative comments, but they are mostly about specific issues with the product rather than the product itself.

Overall Sentiment regarding Freestyle Libre :

The sentiment in these tweets seems to be mostly positive, with people talking about how helpful Freestyle Libre is and how it has helped them manage their diabetes. There are a few negative tweets, but they are outnumbered by the positive ones.

e. Based on your analysis, which one would you recommend?

Based on the above tweets, I would recommend Dexcom over Freestyle Libre.

f. What would you tell each of these brands to improve?

1. Make sure that the app is updated to the most recent version, and that it is compatible with the Dexcom receiver.
2. Make sure that the sensor is placed correctly and that it is presoaked before use.
3. Make sure to check the readings on the Dexcom receiver regularly to ensure accuracy.
4. Make sure to use the correct codes when ordering supplies.
5. Make sure that the patient is comfortable with the use of the Dexcom system before using it.

7.3 CGM Consumer related analysis

a. Can you identify different types (segments) of consumers or create segments?

1. People with Type 1 diabetes who use Dexcom CGM sensors and pumps
2. People with Type 2 diabetes who use Freestyle Libre CGM sensors
3. People with Type 1 diabetes who use Medtronic 630g pumps
4. People with Type 1 diabetes who use Tandem Dexcom pumps

b. Are different benefits more important to different consumer types?

Based on the above tweets, it seems that different consumers place different levels of importance on different benefits. Some benefits, such as accuracy and ease of use, seem to be more important to all consumers, while others, such as cost and insurance coverage, seem to be more important to some consumers than others.

8. Comparative analysis

OpenAI answers versus manual topic modelling answers

1. Provided Similar Results and recommendations
2. Picked up Additional Features, missed by manual analysis
3. Some incidents of Hallucinations observed
4. Comprehensive and easily understandable analysis
5. Can be used as a helping tool
6. Cannot be relied completely
7. Gave some wrong answers. For example, the recommendation provided for Dexcom products were not relevant for the brand. They were more like recommendations for customers.

9. Division of work:

Aditi - Jupyter notebook (Exploratory data analysis, cleaning and tokenizing, Sentiment Analysis using Vader), LDA topic modeling for CGM-product related analysis - Dexcom and Freestyle Libre (General expectation, product features, praises, complaints, recommendation, improvements), OpenAPI for comparative analysis, presentation, and final report.

Mia - Topic Modelling for General Analysis of CGM Questions (General expectation, Knowledge Gaps, Benefits and Consumer Needs), Target Consumers Analysis

Akshita - Open API Analysis (General expectation, product features, praises, complaints, recommendation, improvements), Extra Credit (customer segmentation & different benefits), presentation and final report.

Kaushal-Extra Credit (Customer segmentation & different benefits) Product related analysis- Dexcom and Freestyle Libre/Strategies for both products based on data, Background research for different CGM devices, their use-cases and benefits, presentation and final report.

10. References

- Used Open API for analysis and comparing results with nlp techniques.
- Diabetes - PAHO/WHO. (n.d.). Pan American Health Organization. Retrieved October 15, 2023, from <https://www.paho.org/en/topics/diabetes>