Twitter-more than just a social media network? Identifying customer needs on Twitter through machine learning

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ABSTRACT,

There are many ways for organizations to find out about customer needs, but most of them are either time consuming or expensive. Nowadays many users of consumer electronic products post about their options and experience with the product on social media. This data is publicly available and on mass in the social media networks. Therefore, it is only needed to filter out the needs of customers from the rest of the data that is on the social media sites.

In this thesis, we will try to make use of these free customer needs which are expressed on the social media platform Twitter. Therefore, we will try to make use of a need mining algorithm to filter out the needs of the user and test if this approach is the new way of gathering customer needs. This thesis, therefore, builds upon Kühl et al. (2016) who did a similar approach with German user needs for the e-mobility industry. The product which we will focus on in the thesis are the "Airpods Pro" by Apple.

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Big Data, Innovation, Customer needs, Twitter, Social Media, Need mining, machine learning

1. PROBLEM STATEMENT

For organizations, the customer is often seen as a purpose of what they do (Zaria, 2000). Therefore, organizations today focus on creating customer loyalty, satisfaction, and retention. To achieve this, organizations need to understand the various needs of customers (Singh, 2006).

The importance of finding customer needs led to a trend of market research. In this trend methods like interviews, surveys or focus groups got used to finding out the needs of customers, but these methods bear a lot of disadvantages because they are very costly (Fisher et al., 2014) and time-consuming (Hauser and Griffin, 1993). With the rise of big data and the social media market, researchers began to focus on social media platforms like Facebook, Instagram, and Twitter for finding out customer needs through data mining because the approach is more efficient and accurate than the traditional methods (Kuehl et al., 2020). Twitter is one of the top ten social media sites worldwide and focused on sharing short messages, called "tweets" with others, or receiving real-time updates (Misopoulos et al., 2014). Since the rise of social media organizations started to use social media for marketing purposes and customer interaction. Even people like the 45th President of the United States Donald Trump made use of Twitter during his campaign to generate free media and helped him to allow his information to go straight to the public (Francia, 2017). Moreover, CEOs like Elon Musk, founder of PayPal and Tesla uses Twitter to publish information directly to their customers (Malhotra et al, 2016). With more and more people posting on social media and mentioning opinions about products these social media platforms have the potential to become a goldmine for market research (Edvardsson et al., 2011) since this data is open to the public and can be processed fast with need mining.

There are already some articles and researchers trying to make use of this approach. One of the researchers is Niklas Kühl who is an expert on the topic and has written many articles and scientific papers relating to need mining. In his 2016 published paper, he tried to find out the customer needs of e-mobility users in Germany, which the users expressed in form of tweets on Twitter. This paper will build upon his approach by focusing on the user needs which are expressed by Airpods pro users via tweets on Twitter. The consumer electronic product Airpods pro got published in 2019 by Apple and is a perfect product for this research since Apple is known for identifying user needs and innovating their products according to the user needs (Thomke et al., 2009). This paper will intend to answer the following research questions:

1. Can one identify the needs of "Airpods Pro" users by analysing tweets on Twitter?

2. What percentage of tweets contain relevant information?

3. Can machine learning help to automatically detect relevant tweets by using the Bidirectional Encoder Representation for Transformers (BERT) method?

4. Do users also offer innovative ideas to the product which would fulfil their needs and could be beneficial for the company?

2. LITERATURE REVIEW

To give some background information this section will provide a foundation into the topics of customer needs, big data, and open innovation. Moreover, the potential of social media for organizations will be presented with a focus on Twitter. After that, an introduction to need mining and the sentiment analysis will be given. In the end, the consumer electronic product "Airpods Pro" will be explained, which this research case is about.

2.1 Customer needs

Customer requirements can be divided into three categories according to Kotler and Armstrong (2001). These three categories are first: "Needs" which are basic human requirements like food for example. The second category is: "Wants", which are their desire for specific satisfiers shaped by society and their personal preference. If the "wants" are built on the ability to buy them one can call these "demands". Lastly, the third needs are mostly intangible and could therefore be turned into wants and demands by individuals. But the customer needs can also express requirements of products or services according to Harding et al. (2001). In this research, we will use all three categories of need terms related to customer requirements for simplicity.

Karimi-majd et al. (2015) said that in the process of new product development (NPD) it is the main challenge to generate pragmatic and useful ideas as a good starting point. To end up with an effective idea it is important to extract and realize the customer needs and requirements in the product development process. The discovered customer patterns put managers in a better position because of a higher level of service that can be presented by appropriate strategic decisions (Karimi-Majd et al., 2015). If customer needs are underestimated or wrong interpreted companies can face problems like too small product sales numbers and losses in R&D investments, like in the example provided by Bayus (2008) of moist bathroom wipes by the company Kimberly Clark where the company thought there was a clear market need for that product and invested $100 million in R&D and manufacturing, but ended up with sales that were so small that they were financially insignificant. Therefore, the most important factor in the new product development is to understand the user needs and incorporating these into the new product (Cooper, 1979).

Another important customer for organizations is a "lead user". Von Hipple defines a lead user as: "users whose present strong need will become general in marketplace month or years in the future." (von Hipple, 1986, p.791). Therefore, lead users can serve as need-forecasting because they are familiar with conditions that are in the future of other consumers. Furthermore, they try to fulfil their need which they are missing. Moreover, their insights can provide companies with new product concepts and ideas (von Hipple, 1986). Lead users are important in the fast-moving high technology industries because the experience of ordinary users is often obsolete by the time a product is developed, but lead users have real-life experience and they are familiar with conditions that lie in the future (von Hipple, 1986). Additionally, lead users have two important characteristics which make them valuable. First, they face needs that are important for a marketplace but they identify their month or years before the general users. Second, they are beneficial because they obtain a solution for their indicated needs. Therefore, lead users are important for organizations and need to be identified. To utilize the lead users in research von Hipple suggest a four-step approach:

1) Identify an important market or technical trend

2) Identify lead users who lead trends in terms of

(a) experience and

(b) intensity of need.

3) Analyze lead user needs data.

4) Project lead user data onto the general market of interest.

2.2 Big Data and Open innovation

The overall topic of nearly every research that has to do with acquiring online data nowadays is big data and the rise of big data over the last years because during these times, the world is inundated with data generated every minute and this growth rate is increasing every day (Del Vecchio, 2018).

Drexler et al. (2014) describe big data characteristics as the four V's: "Volume, Velocity, Variety and Veracity". "Volume" has to do with the increasing size of the databases which could result in storage issues and analytical problems. "Velocity" means how fast the data must be processed or how fast the data is produced. These two V's were already introduced back in the 1990s but big data continue to rise which expanded into a horizon with data from a "Variety" of sources. In 2001 Douglas Laney introduced the three V model. The problem that most of the data come from outside of the company is described by "Veracity". This tackles the credibility of the data sources and the suitability for target analysis. A good example of the four V's could be the consumer-generated media buzz that influenced the brands nowadays. (Drexler et al.,2014).

These huge amounts of data offer great opportunities to obtain benefits and create values, for example in terms of new products or making faster and better decisions (Del Vecchio, 2018). "Big data refers to any set of data that, with traditional systems would require large capabilities in terms of storage space and time to be analyzed" (Kaiser, Armour, Espinosa, & Mooney, 2013, Ward & Barker, 2013). For that reason, big data needs to be analyzed to get a better insight and be effective for the use of companies (Chen et al, 2012). Furthermore, big data can enable a more complete picture of customers preferences and demands, by enabling deeper understanding. As a result, organizations are finding new ways of engaging with existing and potential customers (Schroeck et al., 2012). For example, Oleary Reputation monitored over 100 websites where consumers of the hospitality industry left reviews which helped them to understand the customer base and react to the feedback in a short time. Additionally, big data also offers many opportunities to update business models and even create new ones (Sorescu, 2017).

The concept of open innovation is connected to big data in the way that nowadays companies can no longer base their development only on their knowledge, especially with all that potential and data being available outside of the company (V=Veracity). The concept of open innovation "…requires intuitive tools that integrate data into the day-to-day process and translate them into tangible business actions." (Dexter, 2014). Hence, it is important to scan, interpret and incorporate external knowledge and partners into the open innovation process. Customer innovation is nowadays an essential strategy for organizations survival according to Desouza et al. (2008). In his article about customer-driven innovation Desouza et al. (2008) mentioned three aspects of how the innovation can come from the customer side which is:" …1) by identifying, analyzing, and communicating with them, 2) incorporating them into their existing innovation process through transformation of their business process and 3) through encouraging customers to engage in improving existing products and services…" (p35). Especially social media and data mining tools are a key

technology in the concept of open innovation with all the potential idea generation, ideas sharing and responses to ideas (Dexter, 2014).

2.3 Potential of Social media with a focus on Twitter

Nowadays social media is something that most people are using daily, even companies try to use and navigate the social media landscape as a business tool to enhance their performance (Roberts et al., 2016). But many studies out there only focus on social media as a tool for marketing and not focus on the other potentials that social media could provide for companies (Fischer et al, 2011). Roberts et al (2014) investigated the use of social media network sites and business performance with the focus on three purposes: "…market research guiding the development of new products, for getting customers to collaborate in the NPD process, and for new product launch.". His findings were that about 60% of his 351 sample companies made use of social media in the NPD process, in terms of market research social media did not improve the performance of the NPD process. But the use of social media in customer collaboration showed a positive relationship and the use of social media for product launch an even higher correlation. Another important conclusion is that in Roberts opinion companies have still not learned how to effectively use social media network sites for market research.

Especially, Microblogs are allowing users to post their content in short messages with the public, the most frequently used providers are "SINA Weibo" in China and Twitter which is the biggest service with 316 million active daily users (Kühl et al., 2016). Therefore, I will use Twitter data for my research. Moreover, the use of social media and data mining tools have the potential for idea generation, idea sharing and measuring the response to ideas (Dexter 2014). The potential of Twitter as a tool for business has already been shown in several studies. One of the pioneers is Niklas Kühl who tested an approach where he analyzed user needs in form of tweets for the e-mobility domain (Kühl et al., 2016). Another approach was done by Misopoulos et al. (2014) who made use of sentiment analysis to identify customer needs in the airline industry. The traditional tools for finding customer needs which are for example observations, surveys, and interviews (Edvardsson et al. 2012; Hauser and Griffin, 1993) have some downsides if you compare them against Twitter data. First up the traditional ones are time-consuming (Hauser and Griffin, 1993) and cost-intensive (Fischer et al., 2014) which the Microblog data is not, because it is freely available for everyone and companies can even purchase large datasets from Twitter. Additionally, the data can be analyzed via machine learning which is faster than analyzing traditional ones. Another downside of the original techniques is that they cannot scale across large numbers of potential customers, which Twitter can because there is data out there from more than 316 million daily active users all around the world which create 500 million tweets per day (Kühl et al, 2016).

On the other hand, social media does not always have a positive effect on the company's performance, because there are many pitfalls and things to watch out for when using social media as a company. First, the diversity of input from social media could result in a distraction in the product development because the traditionally used filter for the input, like consumer demographics, do not work anymore (Roberts, 2016). Besides, that companies can waste resources by not approving the sources or reliability of the information published on social media (Roberts, 2016). To not run into these pitfalls and use social media effectively, a strategy needs to be developed beforehand

and the company needs to be sure to have the right processes and people in place. Moreover, the company need to understand the latest trends in their market and collect the right customer insights (Roberts, 2016).

2.4 Need mining and Sentiment analysis

As already mentioned above data mining tools are key technologies in the process of open innovation, often need mining and sentiment analysis are used to collect the data. The sentiment analysis is an approach to classify pieces of text into clusters that contain opinions on certain topics (Misopoulos, 2014). Ku et al. (2009) noted that each opinion is characterized by its holder, the target, and the polarity. The use of sentiment analysis, therefore, allows to identify subjects of options, classify them into viewpoints and determine their emotional connotation. This gives the researcher a better inside into what aspect of customer experience brings up certain responses and feelings (Misopoulos, 2014).

Niklas Kühl (2016) already used the need mining approach to identify microblog data that contains customer needs in his 2016 published paper, but he did it under the topic of E-mobility and focused on only German tweets. Even though the topic is already known and established there is still some research needed to see the full potential of need mining. But he offered a five-step approach which will also be used for this data gathering and analysis, the full five steps will be explained in more depth in the methodology section below. There was also other research done on identifying customer needs through Twitter. For example, the identification of customer service experiences in the airline industry by Misopoulos et al. (2014), therefore it is already some research done related to this topic. Furthermore, companies have formed around the analysis and identification of customer needs and converted it into a business model or service which they can offer, for example, Clarabridge, Qualtrics, Medallia and many more, so the topic is not a brand-new innovation anymore but probably still not used to his full potential.

2.5 Airpods Pro

Steve Jobs and Steve Wozniak founded the company Apple Computer Inc. in 1976 in Steve's parents' garage. First, the company was focused on building computer's only, but as the company grew into a multinational organization, they also started to produce other products like the "iPhone" or the "iPad" (MC Steinwart et. Al, 2014). In September 2016 Apple introduced their "Airpods" which were wireless equivalents to their wired headphones (Hunn, 2016).

The "Airpods Pro" was the third wireless earbuds created by Apple after the "Airpods" Gen 1 and Gen 2. Their initial release was on 30 October 2019. The earbuds work with a Bluetooth connection and differentiating themselves from the previous generations by making use of active noise-cancelling technology, automated frequency profile setting, IPX4 water resistance and a different charging case. All these features come in at 249$ which relatively expensive compared to other earbuds which have similar features to the "Airpods Pro". For example, Samsung "Galaxy Buds" only cost 199$. Apple as a multinational company with many followers on social media sites and the "Airpods Pro" with their different features offer research case which could be analyzed in terms of finding customer needs on social media.

3. METHODOLOGY

This section will show the different steps regarding research preparation and data analysis.

The overall goal of this research was to find the needs of consumer electronic users on social media and to detect them by using the Bidirectional Encoder Representation for Transformers (BERT) method. Therefore, the research will be focused on the consumer electronic product "Airpods Pro". In terms of social media platforms, Twitter will be used, because of the different reasons named in the literature review under: "2.3 Potential of social media with a focus on Twitter". The data for my research will be provided by "tweets" from Twitter, which are short messages with a max. of 280 characters that users can share with others. The tweets will be in English, and the data is available to the public and even free to use for research purposes. The analyse from the dataset will contain tweets from a duration of one year. By doing this a long-term insight into the customer needs of the "Airpods Pro" will be provided. Moreover, the research tries to find out how many of the collected tweets of the product contain relevant information with customer needs and if it is possible to make use of a machine-learning algorithm to automate the process.

The whole dataset was around 200.000 tweets which were one year of tweets. These all contained the keywords which related to "Airpods Pro" and were decided upon before the start. For the analysis of the data, the programming language Python was used. Furthermore, this research tried to identify tweets that contain innovative ideas or features that the customer wished for the future of the "Airpods Pro". A model of the process and more details to the different steps can be found below:
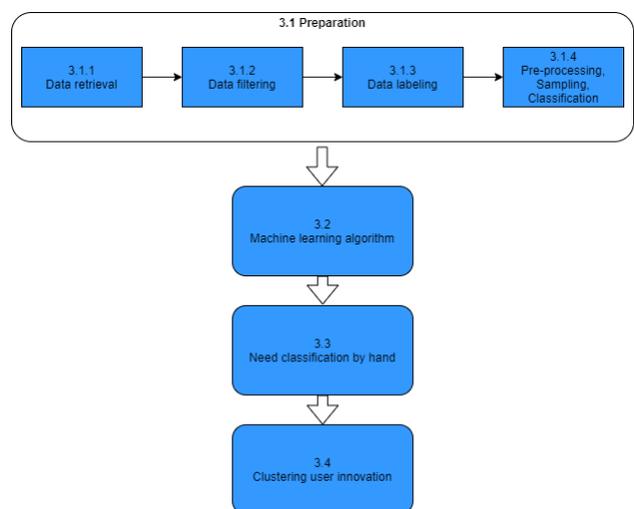

Figure 1: Methods model

3.1 Preparation

To ensure sufficient research there is some preparation needed beforehand. Firstly, before starting the research the Twitter database has been checked to ensure that enough data relating to the "Airpods Pro" is available. After this, it can be continued with the data preparation which is described in Kühl's (2016) article where he mentions five steps for the preparation. But in this research, the data coding step will be skipped and therefore only four steps are needed which will be presented below:

3.1.1 Data retrieval

In data retrieval, the acquisition of the microblog data will take place. Twitter offers a streaming API to fetch data in real-time or from the past. API stands for 'application programming interface' and is a software intermediary which allows communication between two applications. To get data about the "Airpods Pro" search terms and keywords need to be defined to ensure fitting Twitter comments. The keywords used for this research were:" Airpods pro" and "Air pods pro". The keywords should be as specific as possible to not get too much data or include other things that are irrelevant for this research. The tweets which contain these keywords were selected under a specific time frame, which was from the release day in the market (30.10.2019) until one year later (30.10.2020). This means that the product is on the market for one year and the consumer was able to test the product which should give him an opinion or ideas about the product.

Dataset background	
Keywords	"Airpods pro", Air pods pro"
Duration	1 year (30.10.2019-30.10.2020)
Tweet Language	English

3.1.2 Data filtering

Data filtering is the third step where all the tweets selected from above will be reduced by excluding the irrelevant subsets of the data to end up with a higher share of tweets that contain a need.

The streaming API will already filter out some tweets by only concentrating on English tweets and excluding retweets or duplicates. First, all tweets that are shorter than 25 characters will be eliminated, because these are too short for offering a user need. Then all duplicates will be excluded if there were any left after the data retrieval step because they do not include any further information. Furthermore, tweets containing an URL will be cut out, because they are often advertisements, or it would be too much extra work to also check the websites. Moreover, tweets with "stop words" will be eliminated to filter out spam and promotions by excluding them if they contain a word like: "deal", "win" or "sale". Lastly, all tweets that are duplicates will be eliminated because they do not offer new additional information. It is important to mention that with higher data filtering the risk of losing valuable tweets will rise, which could contain customer insights. After the data filtering, there were 43.704 tweets left from the original 199.669 tweets in the beginning, which concludes that 155.965 tweets got filtered out. The 43.704 tweets are therefore the remaining dataset that will be used for this research.

3.1.3 Data labelling and clustering

After the filtering, a training dataset of 10,000 random tweets out of the 43.704 tweets is developed which is then manually assess to find out if the tweets in the training data set contain a user need or not. This will be done via classifying an exemplary data set. Therefore, one will put the tweets in an excel sheet and label them with a 1 behind the tweet if they contain a need and with a 0 if they do not contain a need. The manual assessment of the tweets can have some downsides and limitations because it is about judgement if this is a need or not. This could open a problem if there are tweets that address an indirect need, then a decision needs to be made. Based on the comment that all tweets

should contain a real need this research will strictly exclude indirect needs.

Moreover, the tweets which contain a user need will be clustered into categories after they have been identified in the training dataset to provide a better structure of what different user needs are expressed. For the clustering, it was important to keep the categories as wide as possible to not have more than 10 categories in the end.

3.1.4 Pre-processing, Sampling, Classification

The last step in the data preparation is called Pre-processing, Sampling, Classification. To implement this step the Bidirectional Encoder Representations from Transformers (BERT) model will be used (Devlin et al., 2018) in Python. The BERT method is different to other pre-processing models because it does not exclude "stop-words", words are not tokenized or stemmed down or put lower cases. Since the method can recognize the presence of a user needs and make use of the stop-words because these words can also be an indicator for a user need.

3.2 Machine learning algorithm

After the preparation, the BERT algorithm starts by assigning each tweet in the dataset a probability of containing a need based on the training data. The BERT model is modified to label tweets as user need ("1") if they at least show a 50% probability of containing a need. If not, the tweets will be labelled "0" which mean that they do not contain a need.

For the algorithm, a 66.6 / 33.3 split for training and validation has been used. In the end, the BERT model will provide four performance metrics to interpret the results, which are: accuracy, precision, recall and the F-score.

3.3 Clustering User innovation tweets

Lastly, all tweets which will be mentioned under the topic of user innovation will be clustered into categories again to test if the user offers similar ideas for innovation and which innovative ideas got mention most often around the training dataset. Again, it will be tried to limit the categories to get a better overview.

4. RESULTS

In this chapter, an overview of all results which were derived from the research will be presented and put into context. All results below were derived with a split of 66.6 / 33.3 for training and validation. As measurements and comparisons, four performance metrics were used: accuracy, precision, and the F-score. A model of the whole process which shows the steps taken in this case analysis and the number of tweets in each step can be found in *Figure 2*.
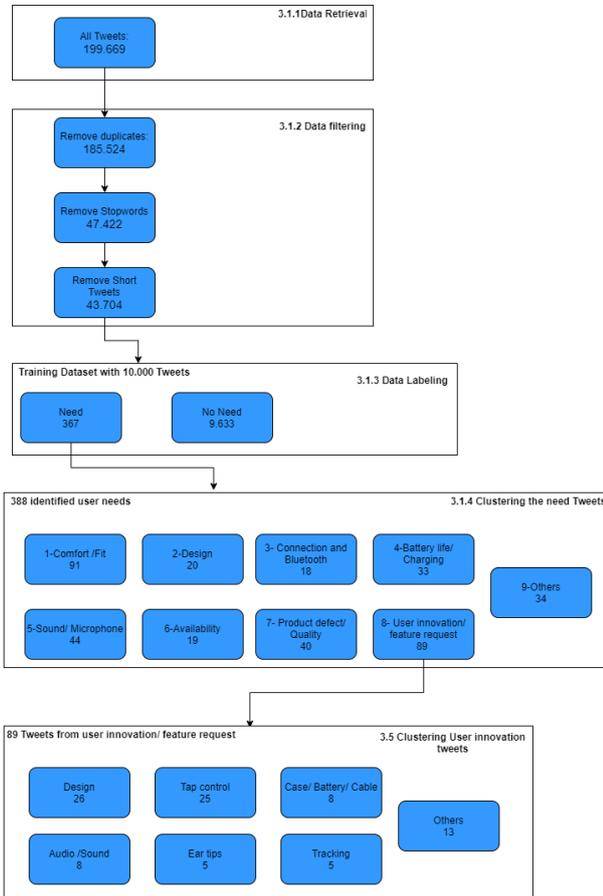

Figure 2: Process model and number of tweets

4.1 Identified User needs

Based on the training data set 367 tweets could be identified as a need tweet. But the total number of needs mentioned was 388 because 21 tweets had multiple needs mentioned in them. These 388 needs were then grouped into 9 categories which will be present below by explaining the category, showing the number of needs belonging to the category and giving one example for this category:

1. Comfort/ Fit-91 tweets

The first category is all about the comfort of wearing the "Airpods Pro" and their fit inside of the ear. Needs identified in this category were the wish for more comfort and a better fit so that the "Airpods Pro" would not fall out all the time.

"Why do my AirPods pro keep falling out of my ears I changed the tips to find the accurate fit for me , and nothing, I've barely had them for 1 week, and I've dropped them every single day ?"

2. Design-20 tweets

The second category is about the design, here needs regarding the overall design of the product or the design of the charging case would be mentioned.

"@AndroidAuth The airpods new design is a downgrade from the older one in every way. Imagine having the new airpods pro case initially, and then having the regular airpods case. Smaller, nicer, sleek!"

3. Connection and Bluetooth-18 tweets

There were some tweets relating to connection issues or issues with the switching device function which indicated a need for a fix for these problems. All needs regarding connection issues and Bluetooth were grouped here.

"Dear @Apple #Airpods Pro ($250 value) has a constant issue of one ear disconnecting from the other all the time. Its charged but does not connect. Its has a mood of its own. Put a simple button on the pod to reconnect. Clearly the awesome tech I paid for is not working. Fix it."

4. Battery life /Charging-33 tweets

The need for more battery life and faster charging was something that got mentioned a lot. Furthermore, the difference in charging cable between different Apple devices.

"@tim_cook Update : the AirPods is actually 14 months old now but it is still disappointing to see such a drastic deterioration in the battery life. My old Sony with an even more diminutive battery took abt 3 years! Makes me rethink getting the AirPods Pro now."

5. Sound / Microphone-44 tweets

In the fifth category are some needs mentioned regarding the Sound which seems to relate to a product issue (Category 7) and some needs about better sound quality. Moreover, the microphone quality during calls also seemed to be an issue that people want to get solved.

"@shafmiester @Apple @AppleUK_ @AppleSupport I have airpods pro and experience the same issue this morning when calling into a meeting on the bus, people said my voice is very low and can not hear me."

6. Availability-19 tweets

Another need that was identified is the missing availability of "Airpods Pro" in stock or certain countries. Therefore, users wanted better availability.

"Come on @Apple ...There isnt a apple store in the United States with Air Pods Pro in stock.. The wait is over a month.... Come on your better than THAT! Please help @appl#noairpods4me"

7. Product defect/ quality- 40 tweets

Needs about better product quality or a need for a product that does not show defects got mentioned a lot. Often these needs

were mentioned connecting to other categories like a defect of the sound or quality issues with the design of the case.

"@AppleSupport AirPods Pro right headphone makes clicking/rattling noise but only when NC or AM is on. If it's turned off, it works fine. Hoped for software update, didn't help. Do you guys have any idea how I can fix this problem? More people seem to have this issue. #AirPodsPro"

8. User innovation / feature request -89 tweets

These categories got created for innovative ideas which tweet offered or people who wanted a change in features. This category was often connected to other issues and users offered a solution or ideas on how to fulfil their needs.

"My #apple #AirPods pro are brilliant and #stevejobs wouldï¿½ve fired the team. It doesnï't include a gesture/click to pause audio and ensure transparency is on for listening, leaving is fumbling for the right combination or ripping them out of ears to hear #applefail #airpodspro"

9. Others-34 tweets

The last category is about all the needs that could not be put into one of the categories above. These needs were also relevant but to different or less often mentioned to get an own category.

"@AppleSupport Hey Apple support, why do the AirPods pro have a strong chemical smell? I've been using them for 5 days and that smell is very strong. I've read many users experience it...."
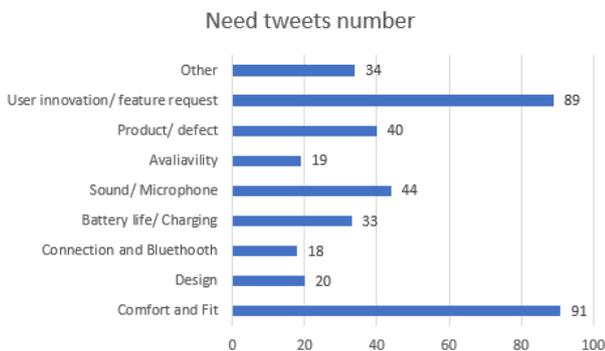

Figure 3: Need tweets clustered

Therefore, the answer to the first research question is yes, it is possible to identify user needs by analyzing Twitter comments. Because it was possible to find 367 tweets that contained at least one sometimes even more than one clear user needs in the training data set of 10.000 tweets. In total 388 needs got to be identified which is about 3,88% of the total training dataset. It was even possible to cluster these needs into categories to get a better overview of the needs which the users mention. The biggest need category was the "Comfort /Fit" category with 90 needs, which could mean that the user needs a better fit or comfort for the "Airpods Pro". The second biggest category was about users offering product innovation or requesting features which they wish the "Airpods Pro" might have. These categories might be interesting to the innovation department of the "Airpods Pro" since it would offer them ideas for updates or new features for the next version of the "Airpods Pro"

4.2 Performance metrics results

The second research question was about what percentage of tweets contains relevant information. After letting the algorithm learn from the training data the results were measured by the four metrics: accuracy, precision, recall and the F-score.

Performance Metrics	
Accuracy	0.9570
Precision	0.37755102040816324
Recall	0.30327868852459017

F-scores	
F_0,5-score (β=0,5)	0.359922178988327
F_1-score (β=1)	0.33636363636363636
F_2-score (β=2)	0.31569965870307165

Van Rijsbergen (1979) who is an expert at information retrieval defined precision as: "the ratio of the number of relevant documents retrieved to the total number of documents retrieved" and recall as: "the ratio of the number of relevant documents retrieved to the total number of relevant documents" (p6.). The innovations team now can decide in which direction they want to go with their research by focusing on one of them. If they aim for a higher recall, it will mean that they do not want to miss articulated user needs but also evaluate more user needs. But if they do not want to spend too much time on the evaluation of the needs they should go with higher precision, this has the downside of maybe missing out on some user needs. The accuracy in our case was at 0.9570 which means that the proportion of correct guesses from the whole dataset was at 96%. The precision was at 0.37755102040816324 which indicates that around 38% of the tweets were considered a need by the algorithm and considered a need in the training dataset. The false-positive ones are indicated via the recall which was in the "Airpods Pro" case at 0.30327868852459017. This means that 30% of tweets that contain a need were also identified by the algorithm as a need.

The answer to the third research question, which was if machine learning could automatically detect user needs with the BERT method, can be answered by the F-score which is the weighted average for precision and recall (Van Rijsbergen, 1979). The F-score can be adjusted with different β-values, depending on the purpose of the research. The formula for the F-score and the meaning of the different β-values can be found below:

$$F_\beta = (1 + \beta^2) * \frac{precision * recall}{(\beta^2 * precision) + recall}$$

Figure 4: F-score formula

β- value meanings	
β < 1	Focus on precision
β = 1	The harmonic mean between precision and recall
β > 1	Focus on recall

For the "Airpods Pro" research case, the F_1-score is will be calculated, because the F_1 score emphasizes a harmonic mean between precision and recall. The F_1 score found for the "Airpods Pro" case was 0.33636363636363636 which means around 34%. If the focus should lie on precision the $F_{0.5}$ score can be used (0.359922178988327). Or if the research focuses on recall the F_2-score can be used (0.31569965870307165).

4.4 User innovation ideas

For the last research question about if users offer innovative ideas, one could look category: "user innovation, request". For these category 89 tweets were identified. To get a better overview the tweets were again clustered into groups which can be seen below:

Design-26 tweets

The design user need innovations were mostly about customization of the "Airpods Pro" which often focused on the colour of the product where users mentioned the need to have a specific colour.

"I wanna one day see at the Apple Store earphones and AirPods and AirPods Pro in all sorts of colours as I hate the standard white as it gets dirty easier and starts to look old after a few years"

Tap control- 25 tweets

Here a lot of users mentioned the wish for bringing back the old function of the normal "Airpods" which was a taping on the stem to pause the music. But there were also different functions requested, like having a mute function or audio control on the stem.

"Feature idea: allow for a mute/unmute option when squeezing your AirPods Pro stems"

Case / Battery /Cabel- 8 tweets

In the third category, there is a mix of users suggesting a different USB port for charging and other things around battery improvement/charging case.

"#AirPods (Pro) feature request @Apple : Charging Case sends a push notification to your iPhone when it needs to be charged / battery is at 20%. Would be very convenient"

Audio/ Sound- 8 tweets

In terms of audio and sound users offered ideas around the volume/bass control and features for the noise-cancelling or transparency mode.

"Yo @tim_cook AirPods Pro feature request...Transparency mode kicks in automatically when I start talking then goes back to ANC when the conversation stops. ? #Apple #AirPodsPro"

Ear tips-5 tweets

Since there were a lot of users' needs mentioning about the fit of the "Airpods Pro" already under the category: "Comfort/ fit". Here the user offers innovative ideas on how to make the "Airpods Pro" fit better into their ears.

"Apple couldï¿½ve made these AirPods Pro's with a ear vaccum because these mfs fall out after 2 mins"

Tracking-5 tweets

Some user needs were also about losing their "Airpods Pro" and missing a function to track them.

"Dear @Apple why can't I track my AirPods Pro IN THE CASE? I'm INFINITELY more likely to misplace them while they're charging than I am to lose one of the Pods individually. I'm fastidious about putting them back in their charger, but that's so small and easy to lose!"

Others-13 tweets

The last category was about all the other innovative ideas which did not get mention enough to get an own category. These were ranging from recycling options…

"Why don't you allow trade in for AirPods Pro @tim_cook? Think green! Recycle it! ?"

…to ideas how Siri could help during a workout and many more:

"Product idea: can we have Siri (in my AirPods Pro) give a countdown when I am working out. Will massively help instead of having to rely on a timer. Especially during isometric and HIIT. @cue @pschiller side petition, can we have Craig on twitter please :)".
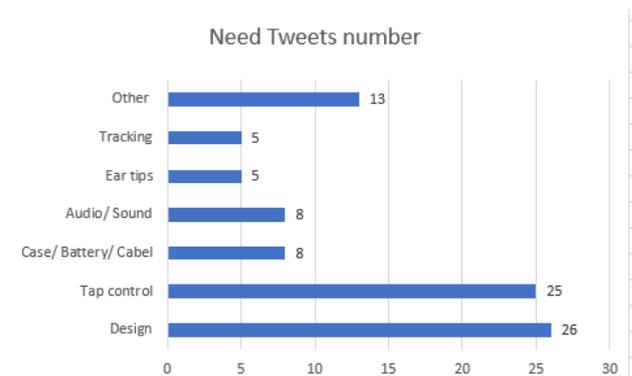

Figure 5: User innovation /feature request clustered

5. DISCUSSION

Looking back at the findings of the research it would be possible to identify user needs of "Airpods Pro" users by analysing their Twitter comments. This can be supported by the result of the 388 user needs which got identified manually out of the 10.000 tweets from the training dataset, which is about 3,8%. It is even possible to cluster the user needs into categories to identify needs that are especially important or got mentioned more often over others. From the training dataset, the need categories which got mentioned most often were: "Comfort/ Fit" with 91 needs tweets identified. Therefore, many "Airpods Pro" users seem to have a wish for a more stabilized fit of the product in their ear or a need for better comfort when wearing the "Airpods Pro". The second-best category was "User innovation/ feature request", this category was interesting because the users here often offered a solution on how to fulfil their needs with an innovative idea. This category got cluster again to find out about what users have for innovative "Airpods Pro" ideas. It seems to be that the design with 26 need tweets and the tap control with 25 need tweets are the things that users have the most innovative ideas about. For the design, a need for colour innovation for the "Airpods Pro" seems to be a thing that a lot of users wish for. With the tap control, it seems to be those users want back the old "Airpods" tap control, which enabled them to pause, skip. Other users wanted to innovate this function by making the function customizable too for example mute themselves during calls or control the volume over the "Airpods" stem.

The answer to the third research question which was about the automatic detection of user needs by the BERT method can be explained by the result of the F_1-score for my research which was at around 34%. This result is like Niklas Kühl's findings who is an expert and pioneer in this topic, from his research paper published 2016 which was about finding tweets expressed by German e-mobility users. He found 332 need tweets in his 2.396 tweets. Therefore, our case study regarding the consumer product "Airpods Pro" contributes as a positive example and show that the need mining approach work and that customer needs can be identified using the algorithm. The case study also adds parts of open research to the existing topic with the last research question where we focused on the user who offers innovative ideas which help to full fill their needs. But this will be presented in more detail below.

Regarding the last question about if it was possible to identify innovative ideas by the user one must look at the category: "User innovation/ feature request", like I have already mentioned above here 89 needs tweets were identified with a focus on design and the tap control as their main need for innovation or ideas for innovation around these aspects.

5.1 Airpods Pro update by Apple

Relating to the user need innovation, at apple's Worldwide developer's conference (WWDC) which was held on June 7, Apple announced some beta updates regarding the "Airpods Pro", which show some similarities with the innovative user needs found. The first function is a conversation boost function which works in a way that the microphone will focus on a person speaking in front of you and the "Airpods Pro" will then cut out the conflicting noises and even be adjusted in ambient noise. The wish for this feature got not mentioned directly but there were some wishing for self-adjusting the noise cancellation:

"@appleparody_usa @AppleSupport I know you guys probably don't read these but can we get a EQ editor for the AirPods Pro like if we hold down the volume it has a EQ option and can we control the intensity of the noise canceling ?"

A function that got mentioned with 8 need tweets under the "user innovations/ feature request" category is the tracking of the "Airpods Pro". This will also be available in the IOS15 version. Apple said the "Find My" app will be available for "Airpods Pro" now. In addition to that, there will be a feature where the "Airpods Pro" can play a chime if they are nearby, or you can see it by using "Proximity View". Moreover, there will be a "Separation Alert" if you leave without your "Airpods Pro".

"I lost only one of my AirPods pro and there is no tech way to find it or at least to know where I lost it #airpods #findmy #Apple #LostAndFound"

Regarding the need tweets in the category "Sound/ Microphone" where people mentioned a need for only filtering out background noises without playing music, this function connects to the ambient noise function mentioned above:

"The one thing I wish AirPods Pro had was a noise cancelation mode that allowed voices to be heard.For example, on a plane. No one wants to hear the engines, but it is sometimes useful to talk to the person next to you."

Apple announced an upgrade of a new background sound to minimise distraction or help to focus.

Lastly, some users were asking for more innovation regarding Apple's virtual assistant called "Siri", like this tweet:

"Product idea: can we have Siri (in my AirPods Pro) give a countdown when I am working out. Will massively help instead of having to rely on a timer. Especially during isometric and HIIT. @cue @pschiller side petition, can we have Craig on twitter please :)"

In the conference, they also mentioned that Siri can now read out your shopping list or functions to use her for her time-sensitive notification. Therefore, "Siri" will get more functions in the IOS15 update.

Based on all these improvements which come with the IOS15 update there will be some user needs to be fulfilled by Apple. Some of them even have similarities with user needs mentioned in the training dataset. Coming back to the last research question the conclusion would be that there are user needs that can benefit Apple and the "Airpods Pro". Of course, here is hard to focus on one need because there are so many different ones out there. Moreover, some needs are just some smaller improvements to the product which could be fixed with a software update. Other ones would need Apple to produce a new product or a new version of the "Airpods Pro".

6. LIMITATIONS AND FUTURE RESEARCH

To begin with the limitations, it is important to notice that the training data was labelled by only one person, which means that there was only one opinion about if the tweet contains a need or not. To reduce this limitation the labelling was done in two rounds where first everything that looked like a need was selected and in the second round, the list of tweets labelled as a need was filtered to find out if the tweets labelled as a need contained a true user need.

Another limitation is that this research only focuses on Twitter users only. For this reason, the research excludes individuals

which do not have a Twitter account. Additionally, there is not an equal distribution of males and females since there are more male Twitter users. Alan Mislove who wrote an article about understanding the demographics of Twitter users published 2011, concluded that Twitter is predominantly used by male and therefore do not represent a random sample of overall race/ ethnicity distribution. This means that probably older people get excluded because they do not have a Twitter account.

Moreover, it is important to think about when product users mention a need or write a review, mostly when they are super satisfied or unsatisfied with a product. Therefore, the tweets show a lot of these reviews but people who are normally satisfied or do not want to post their thoughts get excluded. Also, users who write longer reviews or feedback will be excluded since Twitter is only allowing 280 characters max per tweet. Lastly, the time selection and data selection are clear limitations since it only concludes data from one year worth of tweets, to fix this limitation one could of course code all data relating to "Airpods Pro" which would only take some more time but compared to traditionally used methods still be fast since it is done by an algorithm.

Future research is important for this topic because it is still a newer method of finding customer needs. The research domain could be changed to research if it works in other areas like health care for example or on customer service in different industries. Moreover, the whole need mining process could be used on other online platforms. YouTube would be a great example because under a product review video there are probably a lot of comments about the product and therefore there will not be too much filtering needed. Furthermore, under such videos, a lot of lead users come together and mention their opinions or ideas on further improvements. Another platform could be internet sites or forums where lead users come together to discuss the product because a downside of Twitter is that there are also a lot of comments which do not contain a user need and just mention the product under a different context. Under the specific YouTube videos or on these internet sites there will be a high potential in finding lead users since these are specific videos or sites where the users can come together to discuss. By focusing on these specific networks or websites one would probably already filter out a lot of data that does not contain a need which would make the data labelling step easier.

As the next step for this case research, it would also be interesting to program the algorithm to also cluster the whole dataset into the nine categories which I have used for the training dataset to see how many needs were mentioned relating to each category in total from the whole data. Moreover, the duration could be made wider so from the product launch until now to get a broader option and see if needs change over time. Based on the user innovation ideas one could also try to design different new feature or versions of the "Airpods Pro" to see how they might look like.

7. CONCLUSION

This research paper shows that it is possible to first identify user needs for "Airpods Pro" from Twitter. It was even possible to cluster the needs into categories. Moreover, it was also possible to make use of the Bert method to identify relevant tweets using machine learning, because of the reliable results which came up in the end. While going through the dataset even some user innovative ideas could be identified from the tweets and could also be clustered into categories. Therefore, this thesis perfectly filled the domain gap by showing that it is possible to derive user needs from social media by making use of a machine learning

algorithm. Furthermore, the thesis is a great addition to Niklas Kühl's work because it provides sufficient results that his approach works well even in other domains. In the end, there are still some limitations like the one that Twitter user data does not represent a random sample or that there is still human interaction needed to label the tweets according to if they contain a need or not. But with more and more research in this field, the need mining can become a valuable tool in the future to find out user needs for organizations since it has a lot of advantages over traditionally used methods to identify customer needs.

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