The continuous exploration of needs: Sentiment feedback from Twitter for product innovation and improvement. (At the example of the Apple iPhone)

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Businesses must know what their customers want so that they can provide the optimal value for them. If they are unable to learn about their customer's needs and provide products that are no solution to their customer's pains, their product, or the company itself, ceases to exist. Thanks to customer's social media posts about the products they buy, an opportunity emerges to aggregate and analyse their statements to learn from them. Exploring the aggregated needs will be done by building upon Kuehl et al.'s (2016) approach for "Needmining" and utilizing the Bidirectional Encoder Representations from Transformers (BERT) machine learning model with Twitter posts on the Apple iPhone. The performance of the model was insufficient; nonetheless, insights regarding the needs of customers were identified. This paper further investigates how the insights could be used for generative design to develop new, computer-generated design iterations. The problem with this is that the input to such generative design models is quantitative, while the collected sentiment is qualitative in nature.

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1. PROBLEM STATEMENT

The reason for a business to exist is to create value. If a product or a service is not generating value for its customers nor solves their problems, it is perceived as waste and will not exist for the long term. A lack of value provided by other companies can be seen as an opportunity to answer unsatisfied market demand better. Some user needs are constant, e.g., that they always want the lowest possible prices (Especially for commodity products. Luxury products, on which customers willingly spent a higher amount of money, are exceptions). Other needs are permanently changing through technological and social developments and inner personal changes. Because of that, the perceived value of a product changes relative to the customer's frame of reference (Zeithaml, 1988). The strategy of Amazon is based on three assumptions about customer needs that will always hold: "customers want low prices", "Fast delivery", and "Vast selection". It would not make sense to assume that these will change over the next ten years because a customer seriously demanding: "I wish you would have higher prices and slower delivery" would be unimaginable. Amazon's business strategy is built around those three assumptions (Bezos, 2019).

The natural scientist and evolutionary theorist Charles Darwin stated that only the life forms best adapt to their environment will survive and reproduce, while species poorly adapted to their living conditions will not survive in the long run and perish (Darwin (1869) and Huxley, 2003).
Relating this insight from the evolution of life to modern businesses, it shows that companies need to constantly adapt to the changing preferences and needs of their customer and other stake- and shareholders. They need to balance what they can offer and what is demanded by the environment to survive (Morgan, 2006).
The pressure for companies to deliver more value on a product of similar competitors is increased by the readily available information potential customer can find on the internet. In the present times, it is easy for customers to find numerous reviews and feedback on products, which pushes companies to anticipate customer preferences and expectations, as they would be otherwise filtered out of the market and end to exist.
The reasons for businesses to deliver value to their customers are (among others): Defending products & brands and winning against the competition by achieving cost leadership or differentiation (Porter, 1985), meeting the needs of new customer segments, increasing profitability, etc. (Notice that profitability is just one of the reasons to create value for customers. It is arguable if the primary purpose for a business to exist is to enrich the owners of the business (Friedman, 1970) because if the business does not create any marketable value, it cannot generate profits for its owners)

Traditionally manufacturers produced with a focus on internal, efficient, and superior product-centric development (Levitt, 1960) to increase their market share with economics of scale and scope, as success in conquering market share was measured in profits incurred by whoever bought the products. (Buzzell and Gale, 1987). In the late 20th century, with the advent of Information Technology, the focus shifted to organic, more agile ways that involve customer-centric input and feedback for product development (Shah et al., 2006). Customer Relationship Management became a critical investment opportunity for companies to deliver the best possible value to their customers. The underlying philosophy is that "All decisions start with the customer and opportunities for advantage".
(Shah et al., 2006).
The Lean Start-Up approach, in which as much customer value as possible is created while eliminating waste, can be seen as a helpful approach for continuous value creation (Ries, 2011).
This is also known as "validated learning" for which companies (or Start-Ups) must rigorously gather 'potential' customer feedback, for example through surveys and other means.

Today, everyone with access to the internet can publish their opinions and experiences with a brand and its goods via social media channels. Because of that, social media platforms such as Twitter pose an attractive resource of easily accessible feedback, to increase the value of a product.
Companies can mine comments of Twitter users, that are also customers of that companies, to gather large datasets of several thousand customer inputs. Then they can run sentiment analyses to extract and aggregate valuable insights from the feedback. Based on this, companies can focus on increasing value while cutting out waste as far as possible, or as limited by internal constraints such as costs, resource availability and technological feasibility. The sentiment available from competitors could also be mined to determine where the differences in satisfaction between own products and similar products are.

Next to exploring whether such feedback can be used to arrive at more satisfactory products, this study aims at explaining how such insights could be used to arrive at machine-generated product iterations to aid the design process and help find the cross-section of an external opportunity and internal capability (Porter, 2018)

The following research questions are addressed in this research paper (These are not standing on their own, but 2 builds upon 1)

1) How can identified needs and complaints from Twitter posts be used to arrive at product innovation and improvement?

2) How can the insights from the first research question be used to arrive at computer-generated alternatives toward innovation and improvement?
(Using Design/ Intuitive AI to generate product iterations based on aggregated customer feedback)

2. LITERATURE REVIEW

2.1 Defining deeply rooted human needs

Maslow's Theory of Human Motivation (1943) states that humans have basic needs for shelter, rest, and security. The psychological needs build upon those needs, including the need for intimate relationships and being part of a social group. Esteem needs that include the desire for prestige and accomplishment are also part of the Psychological needs. If all of those needs are satisfied, the human being strives for self-actualization, the need to achieve one's full potential.
Those needs are constant. It is unimaginable that those will ever change for the general population, except for individual human anomalies in the form of psychological disorders.

2.2 Defining customer needs

In contrast to the deeply rooted human needs, Y. Chong and C. Chen (2009) define customer needs as fast-moving and rapidly evolving targets, which brings along uncertainty and risks on whether a product will succeed or fail in the market, as "*...It is the customer that determines what a business is, what it does, what it produces and whether it will prosper...*" (Drucker, 1954). Because of that, it is essential to minimize this risk with careful evaluation of customer requirements to increase customer satisfaction as much as possible. The dynamics of customer needs result from complex, multivariable relationships between the customer's internal factors, believes and past experiences, and external factors such as social norms, laws and technological advances (Y. Chong and C. Chen, 2009; McCarthy, 1960).

A consensus emerges in the literature regarding the high complexity of interrelated factors that make up customer needs. The data collected even by simple questionnaires is beyond the scope of interpretation just by inspecting it (Ross, 2015). To anticipate the rapid changes in customer needs, it is suggested to continuously conduct the information gathering and analysis. This can be described as the company's need for initiating mechanisms and sustaining mechanisms, to identify new possibilities and ideas and testing them to create more value for the customers (Ross, 2015).
Thanks to today's access to social media, a constant stream of information, or customer feedback, is always available and updated in real-time. Paired with adequate analysis methods, the conditions are met to arrive at innovation and product improvement to meet customer needs better. According to Lush et. al. (2007), service-dominated logic perceives the customer as the co-creator of value and advocates the customer as a resource that influences other resources and thus should be oriented on.

2.3 Analysis to identify opportunities

From the perspective of a Start-up, that yet does not know a lot about its potential customer needs, it is essential to test an initial hypothesis on what the customer needs might be. This can be done by releasing a minimum viable product (MVP), which is used to further explore customer needs by constantly iterating the product to the customer's feedback using the Build-Measure-Learn loop (Ries, 2011).

A large, established company with a huge social media following can use its customer's feedback on e.g., Twitter to analyse which variables influence the perceived product value provided to the buyers. As the literature agrees on the high complexity, a viable mechanism to analyse the gathered feedback could be regression analysis to explore what product properties and their according feedback influence the overall product satisfaction or dissatisfaction.

Fundamental to answer the first research question (**How can feedback sentiment from Twitter be used to arrive at product innovation and improvement?)** is the Customer-Centric Approach (CCA), which will be used as a guideline. The Customer-Centric Approach is focussed on identifying customer (or potential customer) needs, and in the best case identifies opportunities to exceed them in providing additional (or unexpected) value (Kano et. al., 1984) while highlighting product benefits to meet the individual customer needs (Shah et al., 2006). This drives business growth and profitability, establishes loyal relationships with the customers (Kumar and Shah, 2004), and commits to customer satisfaction (Oliver, 1999).

Looking aside from the literature and theory of the academic relevance to practical, real-world examples of successful founders and executives such as Steve Jobs and Jeff Bezos. They have a self-proclaimed "obsession" with delivering precisely what the customer wants or unaware that they want or need it. "*…Start with the customer experience and work backwards to the technology. You cannot start with the technology and try to figure out where you are going to sell it…*" (Jobs, 1997). "*…The most important single thing is to focus obsessively on the customer. Our goal is to be earth's most customer-centric company…*" (Bezos, 2013). The success of both companies is proven by their company valuations, with Apple being the world's most valuable company, with a total value of USD 2256 billion and Amazon is the fourth most valuable company in the world, with a total value of USD 1634 billion (Market valuation of Apple (AAPL) and Amazon (AMZ) from January 2021.) As Webster (1980) proposed, the orientation on "customer-oriented values" is the responsibility of top management and needs to be communicated throughout the organization. This also relates to the "customer first" paradigm, in which management should focus on superior quality of services and relationships, time spent on listening to the customer to learn about their point of view and paying attention to emerging market and social trends, opportunities and needs (Day, 1999).

Before it is possible to analyse the data, it is essential to structure the data first. Because the vastness of content generated on social media is very high in variety, velocity, volume, veracity, and value (If properly utilised), it is also referred to as Big Data (Hiba et al., 2015). These datasets can grow so large that it becomes difficult to manage them with traditional database systems (Elgendy and Elragal, 2014), which is why proper storage and computation capabilities must be in place. These can be private facilities or rented out to e.g., Amazon Web services or other cloud computing providers to constantly analyse and understand changes in customer needs.

The automatic aggregation and analysis of customer needs can also be described as "Needmining". It helps to design better, and innovative products suited to the aggregated customer needs explored via social media channels (Kuehl, 2016).

2.3 Apple's iPhone as the basis to find answers to this paper's research questions

When the iPhone was released in 2007 it profoundly impacted the mobile phone industry and society. From the way business is conducted, how internet and telecommunication providers operate, and privacy concerns are regulated. The high functionality of the touch screen and the design created a huge following ever since. In total 29 models (including "Plus" and "Max" models) have been released, enabling access to a lot of historical social media feedback generated. The mass of historical data is especially interesting, as comparing an old model's feedback to the succeeding model can give insights into how Apple used the feedback and how customer needs were interpreted. It can also give insights into how customer needs changed and in what way between 2007 and 2021.

2.4 Generative Design

If insights about needs are gained from the sentiment analysis to increase value for customers, it is important to think about ways in which the requests can be realized. The method that this research paper addresses in the form of the second research question, is how to arrive at computer-generated design alternatives based on the feedback. Those alternatives then are recommended to a human designer for further consideration. (Buonamici et al., 2020). Generative design is a technique used to optimize specific typologies (physical characteristics) that are 1) constraint by a set of design constraints and 2) must maximize a goal. An example of structural optimization is the design of airplane parts with the usage of the least material possible (constrain weight/ material), while maximizing its sturdiness and stability at crucial places. The result is a so-called solution space with alternatives that meet the required constraints and goals. The outcome for such an optimization task is a bone-mash looking shape that due to its organic, or alien-like, appearance may be disturbing to some (Lobos, 2019). Buonamici further elaborates on the framework of Autodesk's Generative Design tool, which will be related to the example of the iPhone, and the in this paper analysed sentiment to evaluate the usage of such a technique. Briefly explaining the generative design framework process: 1) The user sets objectives (e.g., 'minimize dislike Z', 'maximize need Y'). 2) The designer defines the product's geometry that needs to be left untouched by the design algorithm (e.g., The charging port of the smartphone must stay where it is to be in line with the hardware inside). 3) Apply load cases, or pressure points (This one is e.g., for heavy-duty objects like robotic grippers). 4) The designer defines manufacturing constraints (e.g., shapes that can be produced with current machineries like milling or additive manufacturing) 5) The designer defines the material that will be used. 6) Final check and initiation of design algorithm. 7) Results. 8) After the designer received the results, they can explore the solution space for the most favorable alternative and 9) select them. 10) The alternatives are exported into another design software in which the human designer can 11) modify or fine-tune the favorable alternatives. 12) The final designs are passed on for validation with e.g., tangible prototypes.

It is important to note that this process will only be related to the cosmetic design needs of users towards products in the scope of this research. As this research question builds on the first research question, an answer to the possibilities of generative design will be explored after the results and discussion of the first objective.

In general, the output from generative design is based on a rough idea or vision that is already existing in the mind of the designer. The novelty in this approach is described by Lobos (2019) with four design supporting characteristics: 1) Automated creation of forms (key goal). 2) Generated number of alternatives is virtually infinite. 3) Increased creativity through exploring solutions that are unimaginable to human designers. 4) The computer becomes a dynamic, problem-solving collaborator in design tasks. Generative design is frequently used in tasks where a balance between aesthetics and performance is sought. A further example of its use case is, custom-built wheelchairs that perfectly suit the owner and are lightweight and sturdy (Marshall, 2021).

Due to the quantitative nature of generative design input, which is mainly about finding solutions to functional engineering problems, it will be discussed after the results of the first research question whether social media sentiment, with its qualitative nature, can be used as an input to arrive at machine-generated product design iterations.

2.5 Emotional responses towards design

According to the American design researcher, Don Norman, there are three levels of brain processing: 1) Visceral: The rapid judgment humans make in response to fear or if something is dangerous or harmless. Here, pleasure and an improved self-image arise if one conquers his or her own fears and does something others are afraid of. For example, experiencing the adrenaline and thrill of a roller-coaster. Note that such events cannot easily be compared to past occurrences and generally stay in sharp contrast to our genetically programmed desires for protection and safety as they trigger deeply rooted fears of heights, unexpected, intense sensations (e.g., loud noises), etc. 2) Behavioural: The pleasure that arises from accomplishing one's tasks or professions (Can happen unconscious e.g., while driving a car on a familiar route, or conscious e.g., while preparing a new meal). 3) Reflective: The pleasure that arrives when reflecting and interpreting a complicated work of literature or art. (Norman, 2002)

Norman further relates these three brain processes to their according three levels of design. In his book, Emotional Design (2005) he explains that the visceral response is instantaneous. Beauty, ugliness, or sudden danger triggers an immediate and instinctive response towards an object's design. The behavioural response to good design arises from the pleasure and effectiveness of using e.g., a sharp, well-balanced knife that has been optically appealing already in the first (visceral) processing phase of the object. Furthermore, the object is functional and intuitively understandable. According to Norman, good design satisfies all three levels.

The aforementioned levels of processing must be combined to create a good design that is appealing, effective, pleasurable, and memorable (Mehra, 2016)

3. METHODOLOGY

Following Kuehl's (et al., 2016) approach for "Needmining", four steps of their five-step methodology will solve the first research question. Firstly, the needed data must be collected. The gathered data then needs to be filtered, labeled, and pre-processed to gain insight into customer needs (The coding step is skipped).

Figure 1: "Needmining" Steps (Kuehl et al., 2016)

3.1 Data Retrieval

The qualitative feedback data from customers from the iPhone customers will be collected through the Twitter API (Application Program Interface) which is free of charge for researchers. The readily available datasets are permanently updated and are mainly written in English, making it ideal for international companies to consider them to get closer to their customer in the pursuit of competitive advantage.

To retrieve data that is useful and in the context of a specific product, search terms need to be identified. In the case of Apple's iPhone, different generations of the iPhone correspond to different search terms, which lets us group different models with similar, or different search terms. However, it would not be feasible to consider all 29 generations, even though older iPhone models still are in use. This research will explore the feedback for variations of the search term "iPhone" (4. SEARCH TERMS) of the year 2019 - 2020, as these are the newest models with contemporary needs. Further iPhone models in that can be expected to be in the dataset are the models from 2017- 2018:

2017	iPhone 8
2017	iPhone 8 Plus
2017	iPhone X
2018	iPhone XS
2018	iPhone XS Max
2018	iPhone XR
2019	**iPhone 11**
2019	**iPhone 11 Pro**
2019	**iPhone 11 Pro Max**
2020	**iPhone SE (2nd gen.)**
2020	**iPhone 12 mini**
2020	**iPhone 12**
2020	**iPhone 12 Pro**
2020	**iPhone 12 Pro Max**

Table 1. Anticipated iPhone models

The search terms corresponding with the items in the table above (Table 1) will be whitelisted, meaning that only Twitter posts containing these words will be gathered for the analysis (Kuehl, 2016). This research will be conducted with a focus on the past two years of iPhone models (11, 12 and SE gen. 2 series). It is also impossible to know with certainty that the collected data will contain only the anticipated iPhone models, as people usually do not state explicitly which model they use or base their feedback on. Thus, it needs to be expected that older models will be contained in the dataset. Nonetheless, those can still offer insights as people may state what features they miss from the older models in newer models.

3.2 Data Filtering

Even though most Twitter posts are written in English, posts in other languages will be excluded by Twitter's built-in search function to only gather English feedback. Also, retweets (republishing a post to e.g., amplify its message) will be excluded to prevent doublings in the data set. Further cleaning of the data includes: 1) Removing tweets that are shorter than 50 characters, as it is empirically observed that they are unlikely to contain valuable information. 2) Eliminating duplicated tweets and posts that contain URLs due to their low probability of containing or expressing a customer need (Kuehl et al., 2016). 3) Filtering out scam posts that contain spam trigger-words such as "deal", "100% free", "Cash bonus", "Fast Cash"," Make Money", etc. Since strict filtering increases the loss of information, it needs to be considered to make exceptions. For example, if posts containing less than 50 characters still contain words such as "need", "should", they should be put in a separate list and checked manually if they indeed express customer needs.

A simple example of how Apple could use the feedback: If many people write that they are unhappy with the battery life, then Apple should consider improving their iPhone's batteries.

3.3 Data Labeling

After the data has been collected and filtered, it needs to be labeled by adding information to it, so that a machine can put it into context. This is the practice in supervised learning to train a machine-learning algorithm to make the correct decisions when it compares an input to an output. The first step is to let a human judge the needs or complaints in each post. For example, if a Twitter user is very unhappy about the camera quality of the iPhone, the human would label this post as a need to improve the camera quality so that the machine can map a given input text to the labeled need categories in the future. There is no need to label "positive" or "negative" text, as the algorithm is already pre-trained to conduct the sentiment analysis. The labeling will be a "1" for an expressed need and a "0" in case no need was expressed. If a post gives too much room for the personal interpretation of the researcher and is thus prone to bias, the label will be set as "0".

3.4 Data Pre-processing

To analyse the data necessary to answer the first research question, Natural Language Processing (NLP) will be used due to the nature of the customer feedback that humans write for other humans to perceive and interpret. Natural Language Processing is a branch of Artificial Intelligence that analyses text data of languages that evolved naturally over time. This means that it is used as a communication medium between humans, with no intention of communicating with machines, for which programming languages would be used. Since natural language, as found on Twitter, is meant for humans to communicate, the Bidirectional Encoder Representations from Transformers (BERT) Neural Network is used to receive the anticipated insights into customer needs. BERT can better understand language like we humans do than previous NLP methods. It learns on an entire set of words in a sentence (Bidirectional) instead of approaching a query, or problem, from left to right (e.g., as Google search processes search inquiries). Thus, it can learn from the context based on surrounding words, rather than the words that follow one another. In traditional NLP stop-words such as "The", "A", "to" as well as punctuations, are removed in the pre-processing, as they have no meaning to a machine. However, in the case of BERT, the model learns from the context these words create when they are used in sentences. Thus, stop words will not be removed for this research, to receive insights into customer needs with a close emphasis on what the customers mean regarding context, metaphors, slang, and other stylistic devices. There are massive datasets available on the iPhone as it is a very popular product. This ensures that BERT will be utilised with 10.000 Twitter posts, of which 6666 are used to train the model and 3334 to conduct the testing. The programming language to research with is Python.

3.5 Explaining the research setting, sample size, and input & output variables

This research is unobtrusive in nature as there is no interaction between the researcher and the test subjects. The subjects do not know that they are being used as a measurement for product satisfaction and their Twitter posts are thus undistorted.

The input for this research is the given models of the past four years iPhones, which influence the satisfaction or dissatisfaction and feedback in general with their properties. Thus, the feedback of the Twitter users is the according output. Taking the aggregated feedback and insights into customer needs for future product development, turns the feedback into the input to design a future output (Figure 2). This approach can continue repeatedly, which resembles the anticipated Build-Measure-Learn process (Ries, 2011).

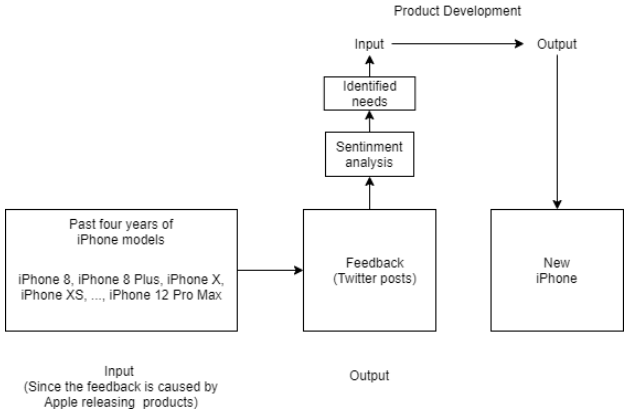

Figure 2. Resembling the Build-Measure-Learn loop on feedback aggregation

It also needs to be considered that there are going to be other variables that may influence the feedback that people give towards the product. This could be peer pressure or the need to "show off" the purchase of a new iPhone in the form of an exaggerated positive review. There may also be moderator variables that influence the strength and direction of a relationship. For example, if Apple caused a scandal that negatively influences people's opinion on their iPhone experience, even though they liked it (Figure 3). This would mean missing out on positive or negative (generally constructive) feedback due to a product unrelated, negative event.

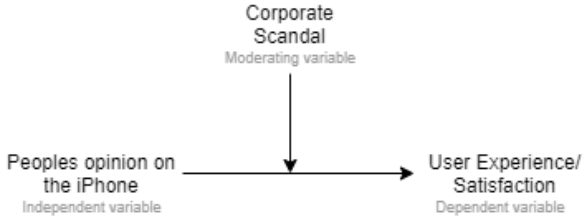

Figure 3. Possible moderator variables

4. SEARCH TERMS

The search terms that were used to mine the Twitter posts were:

"*iPhone", "IPhone", "iphone", "Iphone"*

5. RESULTS

The analysis of the qualitative Twitter sentiment showed that the posts indeed contain statements about the user's needs, wants, likes, and dislikes about the iPhone. Posts from the users that were identified as such contained a reasonable and logical statement such as "I dislike feature X because of Y". Analyzing data that followed a structure in which a reason e.g., a like or dislike was given is fundamentally essential to answer the research question how Twitter sentiment can be used to arrive at product innovation.

The BERT model was utilised with the processed data of which 107 out of 10,000 (0.017) were identified as needs by the researcher. The model had a low Precision (0.118), which means that a large amount of the as 'need' classified Twitter posts, actually did not express needs. The Recall of the model is low as well (0.053). The harmonic mean between the Recall and the Precision of the model is the f_score (0.072). This means that the model did not capture a lot of actual needs from the posts it identified as needs.

From the sentiment, it was generally observable that people have various similar and sometimes unique needs of a product. For example, several Twitter users mentioned that they are displeased that the iPhone's Face ID is unusable when the user is wearing a face mask. In addition to the reason why people are unhappy about this particular feature, solutions to this problem were stated. People explained that the outdated Touch ID, which was removed in 2017 with the iPhone X, is "…*more relevant than ever these days*…". Reasonable statements about this feature of the iPhone were so (relatively) frequent, that it is one of the significant observations from the dataset. This was a post from a user that wants Apple to become innovative and find a solution to this problem: "*I'm actually half expecting iPhone 12 to have Face ID that works with masks on. Mainly because valuable use cases that are hard to engineer are precisely the kind of problems Apple loves to solve".*

It was also frequently observed that people were disappointed by apple not including, or updating, their lightning cable into a USB-C cable: *"The only disappointment so far with the iPhone 12 is lack of USB-C. #AppleEvent", "@Apple I'll switch from Android to Apple if the new iPhone 12 has USB-C ?"* etc.

Another frequent observation was the dislikes on Apple not including a charging block in the packaging of the iPhone 12 (A lightning cable is included). However, those Twitter users mocked Apple for not include the charging brick rather than giving a reason on why they are disappointed, or what Apple could do differently: *"The iPhone 12 Will Come In Bubble Wrapping Nothing Else, No Charger, Nothing ?", "Wait the iPhone 12 doesn't come with a charger LMFAOOOO", etc.*

While most needs were expressed in the form of dislikes, people also posted statements about things they did like. However, those statements, while important to know what is going well, contain little explicit needs. Some of them are reasoned and follow a structure like: 'I like feature L because of K', some are without a reason for the expressed statement e.g. 'I like M'. A prominent observation is a sentiment collected on the design of the iPhone 12 series. For several people it reminded them of the design of the iPhone 5 due to its flat edges design: "*idc i love the new iphone 12 design. i always thought the iphone 5 design was bomb as h anyway*", "*Just finished watching #AppleEvent and I think the iPhone 12 pro looks very nice, love the polished edge, always was a fan of the more square edge design* ". Regarding the design, several people also stated their resentment towards the iPhone 12 but in a less reasoned way: "*okay but the iphone 12 kinda ugly*", "*the iphone 12 is so ugly oh my god ew?*". While important, such posts are not helpful to learn about those people's

needs since they do not express what could have been done better instead.

Contrary to those contemporarily results, there are a few older statements from the iPhone 11 period that express the wish, or need, for an iPhone in the color purple. For example: "*A New Dream: I wish i could get the iphone 11 in purple*". Notable for the color-related need, apple actually introduced the iPhone 12 and iPhone 12 mini in purple. Some people posted recently: "*I told myself I didn't want the iPhone 12 because they didn't have the purple color and NOW THEY ARE COMING OUT WITH A PURPLE COLOR. IT'S LIKE THEY ARE PURPOSELY TEMPTING ME."*

The other two categories of frequent observations are regarding the camera and battery life of the iPhone: „*No jokes, the iPhone 12 Pro max pictures are absolutely lovely*.", „ *In love with iPhone 12 camera*", "*The battery life on the iPhone 11 Pro Max is crazy good*", "*I love the battery life on the iPhone 12* ". Also, little to no reasons for why people like those attributes of the device were given here.

Due to the qualitative, subjective nature of the identified needs, they cannot serve as direct input to generative design algorithms, which require numerical input to define goals and constraints.

6. DISCUSSION

The first problem that this research paper aims to solve is how the identified needs and complaints could be used to create new and innovative products. From the results above it becomes apparent that posts on social media can indeed be used to analyse what customers think of a product to improve the experience and value that it provides.

Briefly summarising the results, it can be stated that 1) Customers want an updated version of Face ID, want Touch ID as an (additional) alternative back, or want a solution to unlocking their phone seamlessly while wearing a mask. 2) Customers want a USB-C charging cable instead of a lightning charging cable. 3) Customers want a charging block included in their purchase of an iPhone. 4) Customers want purple-colored iPhones.

Those results (and less frequent, uniquely expressed needs) are meaningful because they indicate the satisfaction or dissatisfaction of the customers with a product and their demands towards it. However, the low reliability of the BERT model poses a problem. If this model, trained with the processed data from this research, would be used to identify needs in other datasets, there won't be many needs to discover. Further elaboration can be found in the Limitations section of this paper.

Face ID issues

Firstly, the expressed needs towards the issues with Face ID during the corona pandemic indicate a change in customer needs due to environmental factors. Recalling Zeithaml (1988), it can be said that the frame of reference of customers changed and thus their needs with it. The corona pandemic can also be seen as one of the factors influencing customers' needs aligning with the research of Y.Chong and C.Chen (2009) and McCarthy (1960). As humanity is actively fighting the coronavirus, it is expected that, when it is over, Face ID will be usable again. This need can be assumed to disappear once it is not necessary anymore to wear masks. Thus, it must be considered if such temporary needs, created by changes in frames of reference are worth solving. Nonetheless, this need can still be expected to live on for quite some time, and an alternative device unlocking with e.g., Touch ID, would solve a frequent customer need.

USB-C need

Next, considering the needs identified regarding the demand for a USB-C charger, where people wrote that they would switch from android to iPhone, clearly indicate a possible gain of customers if Apple gives in to such requests. Recalling Shah (2006), where he argued that all decisions start with the customer to identify promising opportunities, a gain of potential customers should not be ignored. While the iPhone's lightning cable gives Apple control over its ecosystem and incurs licensing payments through its MFi program (Made for iPhone/iPod/iPad), interoperability with other devices could be enhanced by switching to the open standard USB-C that is finding more and more adaption. The iPhone Pro models could be a valuable case to change to USB-C, as those devices are favored by tech-savvy people that require such interoperability e.g., with the PC hardware market (A reason why the MacBooks from 2015 onwards use USB-C).

Charging Block need

Thirdly, customers are somewhat disappointed about the lack of a charging block when purchasing a high-end smartphone like the iPhone. To reduce waste and be more sustainable, Apple encourages people to reuse their old charging blocks, which comes at the expense of new iPhone customers that must pay more, to be able to charge their devices. Referring to the Kano model, it could be argued that the capability to charge a smartphone should be included with the purchase of such a device, which is a basic need. In general, disappointing customers is not a healthy base to create loyalty, which was pointed out as necessary for business growth and profitability by Kumar and Shah (2004).

Purple color demand

Interesting about this last major need is that the sentiment for this demand stems from before the purple iPhone was released with the latest iPhone 12 models. It is not known where Apple had the idea from to release a purple model. Whether they conducted market research (maybe even sentiment analysis) on their own, or whether it was a natural move to add more colors to their selection to increase individuality to suit their "Think different" slogan.

The interpretations of the results are not trying to pose a solution to the customer's needs and merely serve as an example of how the identified needs can be interpreted.

Sentiment regarding the battery and camera of the device, while frequent, did not offer insights into what could be done better to provide additional value. General technological progress in camera and battery technology can be expected to increase customer satisfaction in such areas.

The findings of this research are in line with the insights from other studies in terms that companies indeed can gain valuable insights into their customer's demand If they continuously (or continually) analyse their environment. Furthermore, the reality that such needs exist in the external environment can be seen as an advantage for those companies that are aware and try to make use of them.

Those insights can then be used to arrive at better versions of the product that reflect more accurately what customers demand and provide them with more value that satisfies their needs. Answering the first research question, Twitter posts can be used to arrive at improved products by analyzing their sentiment and looking out for reasoned statements on why something is perceived as good or bad. It is imperative to note that not all the identified needs will be relevant or are an opportunity that a

company is capable or willing to take. It is thus out of the scope of this research to investigate which of the insights gained from need mining will be relevant to a business and which not. The rationale behind this is that it is fundamentally impossible to meet every customer's need and it must be clear which needs of which customer to focus on, which requires in-depth knowledge of a company and its strategy (Porter, 2018).

Using the gathered sentiment to arrive at product innovation, or completely new and technologically advanced products must be denied from the insights gathered in this research with the iPhone as the object to collect the data on. As the iPhone is a rather mainstream product with many young people as customers and users, there is much noise in the generally huge data set. For example, bragging about social status and being emotional in expressing views, made it difficult to collect many reasoned insights.

While every human design can be improved somehow, this research could not find a way to incorporate the gathered sentiment into generative design algorithms due to its qualitative nature. However, relating the insights of Lobo's four design supporting characteristics it can be said that: 1) If user needs could be defined in specific technical dimensions, which would require a lot of effort. Then they could yield a solution that could have been spotted easily from the gathered needs right away. For example, the need for a USB-C charger could be implemented right away without even utilizing a generative design solution space. 2) If customers have a reasoned need, they are specific about it. It would be infeasible to generate numerous design iterations that are indistinguishable from human perception. 3) It would be a huge strength if designers could let the machine interpret qualitative feedback to come up with product iterations. The main challenge would be to translate nominative, qualitative feedback into data objects that describe them in quantitative ways. (For example, turning a customer's "I wish that button Z would be lower" into measurable input will be difficult) However, the aggregation of needs in this could lead to entirely new design iterations unimaginable to human creativeness as a machine interprets the world differently. 4) The computer will become a collaborator, but the final decision lies with the designer and many other business functions.

Creativeness could be taken to new, modern heights if a way can be found to let machines interpret qualitative input from a design perspective. In essence, the qualitative information would need to be translated into a quantitative input to the machine, which then outputs new qualitative characteristics or design features of a product. The APA dictionary defines quantitative data as expressed only in the form of numbers, while qualitative data is descriptive and expressed without numbers (American Psychological Association, n.d). Interestingly, this would turn qualitative data into quantitative, to be output as something, qualitatively new (Figure 4). Hypothetically, the computer would have added its own meaning to the numerical input and thus have generated information de-novo, out of nowhere (Jochen, 2016) for human perception. Adjustments to specific numerical dimensions could be based on sentiment, such as "waaay tooooo largeee" (Intensifier words), which would decrease a size more than if it was just "too large" etc. Unimaginable new ways of design could appear through the computer adding its own meaning to it.

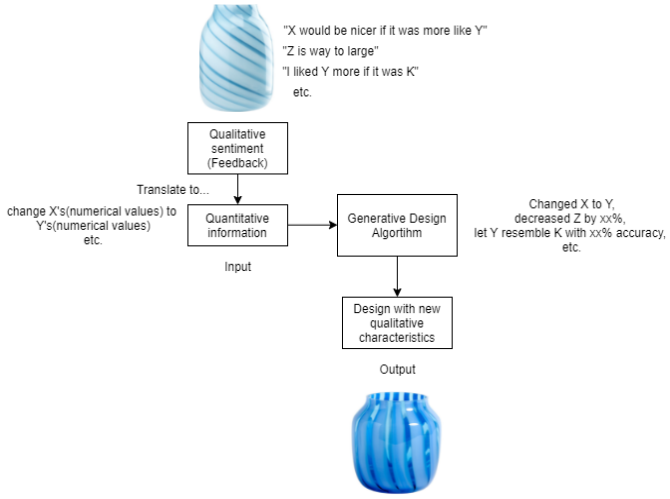

Figure 4. Hypothetical sentiment based design generation

(Note that "Design with new qualitative characteristics" is qualitative, because of the different people's emotional, subjective responses towards it. For example, due to their effects on the visceral, behavioural and reflective perception which then turn into new sentiment feedback)

Relating this hypothesis to Norman's literature, it comes to mind that the visceral level of processing might be the most stimulated level when perceiving such a design. Since generative design objects would not spawn from the human thought process, they may be thrilling due to the "fear of the unknown". The familiar concepts of beauty would be replaced by the logic of a design algorithm, which certainly would make them memorable and even stimulating for the reflective thought process towards design.

7. CONCLUSION

There are valuable insights to gain from analyzing Twitter posts regarding what customers like, dislike, and need of a product. Those can be used to improve products as a cost-efficient alternative to conducting surveys and other means of market research. The iPhone was not an ideal object to collect reasoned sentiment on which was reflected in a misaligned model. Nonetheless, many insights on current needs on the product were identified, which should be an incentive to any company that wants to use a customer-centric approach to improve the value provided by their products, if they are technologically capable of conducting such an analysis. Furthermore, their organizational structure must be capable of handling the pressure of constantly adapting to changes in the environment.

As a mass-produced mainstream product, the iPhone was not a suitable object for the second research question. While design always played an important role for Apple products, the technology inside it would not wholly adapt to the design of the outside, but the other way around. Customized objects like furniture would be ideal use cases for typology optimization as their attributes and functionalities can be explained by measurable dimensions and categorical materials. In contrast only the iPhone casing could be subject to design, while the hardware inside remains the way engineers created it. It is safe to say that generative design will find more and more applications to help designers create satisfying products, both functional and optically. Humans have been creative for several thousand years to survive, express themselves, etc. Computers are better at logical tasks that need massive amounts of calculation power, but

humans are (as of now) better at creating visions and ideas that often incarnate in the form of products, which is what the buyer values. Or as Simon Sinek (2009) wrote in his book, Start With Why: "*…People don't buy what you do; they buy why you do it*…", which is arguably a difficult thing for a machine to emphasize.

8. LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

8.1 Limitations of the Model

Future research should investigate if a model could learn better by mining data about products that contain more reasoned explanations on the user's or customer's need. A helpful guideline for this could be the customer decision-making process by Dewey (1910) (Need recognition, Search for Information, Evaluation of alternatives, Purchase decision, Post-purchase decision). Customers that follow such a decision-making process are likely to do so when confronted with making an investment or major purchase decision. Mining such posts and training BERT on this type of sentiment may lead to a better model because it would be taught by the rational decision-making of the customers. During the bachelor thesis cycle, one of my colleagues trained a well-working model based on sentiment on Amazon's Ring doorbell, which is a home security video system. Such a product is bought for home security, which is a rational concern for homeowners, making them reasonable and logical towards their product. Future research should thus try to train a need mining model based on products that are bought with a clear reason, as needs towards it can be expected to be expressed more equitable.

Back to this dataset's posts, some valuable insights were addressing the Twitter accounts *@AppleSupport* and *@tim_cook*. It is suggested for future research to consciously focus and have a considerable share of company-addressed posts included in their training sets. This could ensure that the model has a higher success in analyzing social media tweets and discover many high-quality, reasoned needs. However, a fair share of random samples of posts should still be in the dataset, as company-addressed posts may be from very technology-savvy people who would not reflect the actual population. Another recommendation is to consider e.g., Amazon reviews as there are clear guidelines on how to write a helpful Amazon review. For example, Amazon's official guidelines state that a review should be relevant and based on own opinions and experiences (Amazon.com Help: Community Guidelines). This is an explicit request for the reviewer to be rational about the product, which distinct from Twitter's freedom when it comes to product reviews. However, mining reviews on Amazon may exclusively expose to buyers that made their purchase on Amazon, while Twitter posts can be from a much broader population of buyers (including Amazon, eBay, etc.). Due to Amazon's request to be rational, it is recommended to utilise a considerable amount of Amazon reviews in the model to train it based on their rationality. Yet, this could be a lot of work as serious reviews can be very lengthy (up to 5000 words) and contain multitudes of needs that must be labeled appropriately, making the preprocessing more complex and thus more prone to error. In any case, it is recommended to conduct the labeling with more than one person to have a more heterogenous evaluation of needs.

8.2 Limitations in the design approach

Because of a lack of technical skill, it was not realizable to create a generative design model for the iPhone. For future research that tries to use sentiment to arrive at generative product iterations, it is recommended to investigate if a way of translating qualitative sentiment into quantitative, machine-interpretable, specifically for generative design, can be found. Further exploring this field, it should be emphasized that the resulting complexity of variables for the design process may be overwhelming, considering that some customer's dislikes may be beloved by others. This may be made more complicated, but very interesting for businesses when referring back to Porter's (2018) cross-section of external opportunity and internal capability. If all the available or necessary resources are introduced into the generative design, they could serve as limiting factors to maximizing the external opportunity, or the customer's needs.

8.3 Being cautious of side effects

Next to exploring in further detail, with better models, how social media sentiment could be used to arrive at better products, researchers and business managers should actively be concerned about where such a constant supply to ever-changing customer needs would lead to. Regardless of the importance of increasing the benefits of a company's products, there should be concerns about what that means for society and the resources of Earth. For example, will a constant stream of changing needs increase throw-away because ravenous customer's permanently shifting needs are always satisfied? Will products which features, and design are based on quickly changing trends only remind customers that they never have the latest features and make them buy more? Or will businesses lose repeat customers over time because they create exactly what a customer wants and snuffs the need to purchase new goods, which might force companies to make use of planned obsolescence (Veritasium, 2021)? These are questions that came to my mind during this study, and I deem them as crucial. I hope they serve as waypoints to continue this field of research in a woke and responsible way.

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