User complaint analysis on Twitter: assessing the usability of complaints for innovation on Nestlé Consumer Care's Twitter page

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ABSTRACT,
Social media offers an opportunity for companies to bring data analysis quicker to a higher level than previously. The challenge is the vast amount of data generated: the number of posts can get in the tens of thousands. Twitter, as a free, global, open service, can be a compelling solution to reduce the cost of collecting text data. This paper examines the usability of social media, in particular Twitter, for identifying user complaints and if those complaints could be linked to innovation types. The relationship between social media and innovation has seen an increase in research but is still limited. We aim to fill this gap. In this study, 14,630 tweets are collected, filtered, and labelled from Nestlé's Twitter page 'Nestlé Consumer Care'. During data labelling, the Valence Aware Dictionary and sEntiment Reasoner (VADER) sentiment analysis is applied to identify negative, neutral, and positive sentiment. Subsequently, the tweets are coded according to six innovation types. The results acknowledge that user complaints can be used to identify innovation topics. The dataset of Nestlé's Consumer Care Twitter page reveal that the largest innovation type category is product, followed by process, social, organization, marketing and lastly technology innovation. The findings have practical implications as they show that Twitter can be effective in identifying a firm's shortcomings, which can drive innovation.

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Social Media, Twitter, Innovation, Sentiment analysis, VADER, Complaint analysis.

1. INTRODUCTION

Currently data generation floods the world with data every second of every day. The amount of data is continuing to grow (Barlatier & Mention, 2020). Social media is a valuable source to collect customer data on a wide range of topics. Customers increasingly use social media for complaining and businesses use it for responding to those complaints (Alcántara, 2020; Golmohammadi et al., 2021; Sigurdsson et al., 2021). These complaints can help identify genuine customer needs in the pre-usage, usage, and post-usage stages (Joung et al., 2019).

However, the number of posts can get into the tens of thousands, otherwise described as Big Data, and this can become costly to analyze. Business intelligence and analytics (BI&A) and Big Data analytics are fields that have seen an increase in importance for analyzing Big Data to acquire insights (Chen et al., 2012). Data analysis is becoming a key resource and helps to bring competitive advantage. The cloud computing options social media offers, for Big Data management, brings an opportunity for companies to bring data analysis quicker to a higher level than previously, even those scarce by financial and organizational resources. (Del Vecchio et al., 2018)

The data generated by social media represent one of the greatest riches for data-driven innovation. The current challenge is to learn to benefit from social media for innovation purposes. Social media is both a driver and enabler of innovation. The relationship between social media and innovation has seen an increase in research, but is still limited. (Bhimani et al., 2019)

One social medium to collect information from and enable innovation is Twitter. Twitter's purpose is to serve the public conversation via a free, global, open service that constitutes of diverse people, perspective, ideas, and information (Twitter, n.d.-b). People and companies can post text, pictures, GIFs, videos, and links, although Twitter primarily focusses on text. A tweet is a post with a maximum of 280 characters. (Twitter, n.d.-a) Due to these properties, Twitter can be a compelling solution to reduce the cost of collecting text data and create insights for the innovation process. The challenge of filtering Big Data remains, however.

This paper examines the usability of social media, in particular Twitter, for identifying user complaints and if those complaints could be linked to innovation types. The paper aims to assess if complaints can create valuable input for innovation. To assess the usability, the text of a dataset of 14,630 tweets collected in 2022 from Nestlé's Twitter page 'Nestlé Consumer Care' are retrieved, filtered, manually coded, and assessed. This research aims to contribute to expanding the limited knowledge on the relation between social media and innovation, by analyzing customer data on Twitter, specifically on user complaints in relation to six innovation types. Additionally, it aims to develop practical guidance for firms on how to benefit from complaints on social media for innovation. For instance, complaints could generate product ideas, diagnose technology failures, enhance reputation, or develop better marketing strategies. It is interesting for firms as it helps to identify unknown issues or prioritize issues in different departments of the organization or innovation stages.

This paper is structured as follows: In the subsequent section the relevant literature is discussed. The paper continues with discussing methodology. Accordingly, the results are presented and discussed. Then the theoretical and practical implications will be given, followed by research limitations and recommendations. In the last section, the conclusion is given.

2. LITERATURE

Big Data analytics and Social Media Analytics have seen an increase in importance as a way to analyze Big (Social) Data. An approach to Big Data and Social Media Analytics is text analysis. Specifically, Sentiment Analysis can categorize text in negative, neutral, or positive sentiment. Negative sentiment or complaint analysis can be linked to innovation via social media. This section will describe these concepts.

2.1 Big Data

In an era where vast amounts of data are created every day Big Data is becoming increasingly relevant. According to Del Vecchio et al. (2018) "Big Data refers to any set of data that, with traditional systems, would require large capabilities of storage space and time to be analysed" (p. 6). Two components led to the Big Data era. Firstly, the arrival of social media platforms such as Facebook and Twitter and the increased socialization on these platforms, combined with the introduction of smart devices. Secondly, the possibility of cloud computing, in which data and programs are stored and accessed online. Big Data can help all companies in a cheap and effortless way, at any time and on any device. (Del Vecchio et al., 2018)

The comprehension and management of the Big Data paradigm can be discussed via the 6V's: volume, velocity, variety, veracity, variability, and value. *Volume* relates to the storage space required by servers and databases. *Velocity* classifies as the speed of creation, sharing and storage. *Variety* refers to the diversity of types of data available, such as text, images, videos, and audio. *Veracity* reviews if data is interpreted reliably and confidently. *Variability* relates to the continuous updating of data and the perspectives of interpretation adopted, and how business should manage these. Lastly, *value* discusses the usability of data for decision making and improvement in business performance. It concerns the heterogeneity, accuracy and scalability of unstructured data and its integration. To combine these six elements into an insightful analysis, companies are required to analyze data sets and have analytical techniques in applications that are so large and complex, that they need advanced and unique data storage, data management, data analysis and visualization technologies. (Del Vecchio et al., 2018)

2.2 Big social data & social media analytics

The growth of and increased access to social media and social media networks have facilitated interest in Big Social Data. It encompasses large-scale datasets from popular online social networking platforms such as Twitter and Facebook, but also other platforms for mass collaboration and self-organization such as weblogs and wikis, which generate a rich and dynamic set of data. (Stieglitz et al., 2014) Zeng et al. (2011) define social media in a broad sense as "a conversational, distributed mode of content generation, dissemination, and communication among communities" (p.13). Social media is a valuable source for user-generated information. Recent studies have showed that there is an emerging need to monitor, analyze, collect, summarize, and visualize relevant information from social interactions and user generated content. (Stieglitz et al., 2014) Comparable to Big Data, Big Social Data faces the challenges of being a very enriched and dynamic set of data which makes it difficult to treat systematically. However, in the last few years, a new research area has emerged called Social Media Analytics (SMA) that addresses these issues. In business, it can be seen as a subset of Business Intelligence (BI). SMA concerns itself with developing methodologies, processes, architectures, and technologies to transform raw data extracted from social media, into meaningful information for business purposes. In this context, there are three methods of analysis: text analysis/mining, social network analysis, and trend analysis. (Stieglitz et al., 2014)

2.3 Text & sentiment analysis

Twitter produces a vast amount of unstructured text in tweets every day. Recent progress in text mining makes it possible to analyze such unstructured text data (Joung et al., 2019). The text analysis techniques predominantly focus on processing, searching, or analyzing the factual, objective data (Kharde & Sonawane, 2016). A subfield of text analysis is Sentiment Analysis (SA) which Stieglitz et al. (2014) describe as the study of "people's opinions in terms of views, attitudes, appraisals, and emotions toward entities, individuals, issues, events, topics, and their attributions in a more thorough way" (p. 92). Other terms for Sentiment Analysis include subjectivity analysis, opinion mining and appraisal extraction (Kharde & Sonawane, 2016). The classification of text can be accomplished via a lexicon, a machine learning and linguistic-based approach (Kharde & Sonawane, 2016; Stieglitz et al., 2014; Zhang et al., 2018). For example, Sentiment Analysis can be applied to solve social or business problems (Zhang et al., 2018). Thus, Sentiment Analysis is applicable to analyze unstructured text from Twitter.

Sentiment is divided into explicit or implicit opinions, and by polarity, strength, and target. An opinion is explicit if directly expressed and implicit if implied. An opinion can be objective or subjective. Frequently, researchers characterize sentiment as being of negative, neutral, or positive polarity. It can also be analyzed as a range. There is a distinction between polarity and strength: someone can strongly feel about a product being bad or weakly about a product being good. Another part of sentiment is target – which can be anything: e.g., an object, a concept, or a person. There are challenges with Sentiment Analysis. For instance, the informal nature of social media text, e.g., emoticons, acronyms, amplifications, slang, sarcasm, and irony, makes interpretation difficult. Furthermore, different contexts or domains challenge the accurate classification of texts in general. These challenges provide even more difficulty in the machine learning approach. (Stieglitz et al., 2014) Hence, characteristics of sentiment can have an effect on data analysis.

2.4 Social media & innovation

Innovation in literature has different conceptualizations. Barlatier and Mention (2020) define it as "a process that involves the creation and use of knowledge for the conceptualisation, development and implementation of a new product, service or practice" (p. 11). Additionally, it extends to other business areas, e.g., entering markets, improving positions in markets, or improving existing business processes. Big Data analysis and innovation strategies can sustain or increase overall business value and improve efficiency and intelligence. (Del Vecchio et al., 2018) It is a challenging task as analytics should be seamlessly integrated into the innovation process (George & Lin, 2017). Furthermore, innovation must be placed in the context of collaboration and interaction with the external environment (Joung et al., 2019; Schilling, 2017). For example, there has been an increase in stakeholder involvement in the firm's innovation process. Innovation should therefore be considered as being part of the internal and external processes of a firm.

An enabler of internal and external interaction is social media. Social media foster communication and connectivity between people and therefore provides a way of generating customer insights, accessing knowledge, co-creating with users, and support product introductions. The challenge is to leverage social media in organizational settings and its interaction with the innovation process. (Bhimani et al., 2019) For instance, customer's suggestions, feedback, and complaints can help generate ideas to determine product concepts in the innovation process, but also increase the number of novel ideas and thereby improve the quality of innovation (Joung et al., 2019). Thus, social media and innovation are closely related.

Social media has a dual role in innovation: driving the innovation process (social media for innovation) and enabling innovation (social media in innovation). Social media allows companies to create knowledge by involving internal and external stakeholders at various stages of the innovation process. Social media for innovation has two main strategies. At a basic level, companies mobilize social media for improving and developing products/services. At an advanced level, companies apply social media platforms internally, e.g., building internal social media networks for interaction. Social media in innovation includes types of innovation and the stages of the innovation process. The innovation process extends from conceptualization, generation, adoption, diffusion, to analysis of its impact. (Bhimani et al., 2019) Hence, social media can be applied in and for innovation, in all stages of the innovation process.

2.5 Innovation types

In literature multiple ways to typologize innovation are described. Innovation types are characterized as being radical or incremental, competence-enhancing or competence-destroying and architectural or component innovation. (Schilling, 2017) Furthermore, innovation is distinguished by six innovation types. The traditional four are product/service, process, organization, and marketing innovation. Recently, technology and social innovation has been added to provide a more comprehensive picture that is adjusted to the current technological and sustainable focus of society. (Barlatier & Mention, 2020; Bhimani et al., 2019)

Research suggests the following definitions of the six innovation types. *Product* or *service innovations* are changes to an organization's goods, services, or hybrid versions. It can be adding new ones or changing a function or feature. (Boddy, 2014; Rowley et al., 2011) *Process innovations* describe how an organization conducts and delivers its business, such as the techniques of producing their products or services. It improves effectiveness and efficiency. (Rowley et al., 2011; Schilling, 2017) Process innovations can be applied to administrative, technical, production, organizational, management, and business system aspects. *Organization innovations* are changes to how an organization operates. In other words, changes to its social structure, including people, and administration. Examples include changes in training policies; allocation of resources; or structuring of tasks, authority, and reward. Shared typologies are administrative and business system innovation. *Marketing innovations* are also described as commercial or position innovation. It describes the introduction of an innovation to the customer; changes on how a product/service is introduced; and how new customer bases and markets are exploited, characteristics of them or their change and how new ones are created. It aims to change a customer's view or understanding of the product/service. (Rowley et al., 2011) *Technology innovations* value the role of technology in innovation (Kusiak, 2009). Technical innovations refer to the assessment of products, processes, or services via a technological viewpoint. This type relates more to the technical system of the organization and its general activities. Technological innovations are those innovations initiated by the adoption or advancement of technologies in an organization (Rowley et al., 2011). *Social innovations* change social mobilization and its accompanying values, processes, and impacts. Stimulating a change in behavior in networks of people is of its essence. For instance, it relates to the societal challenge of sustainability and climate change. (Repo & Matschoss, 2019) All in all, the six innovation types give a comprehensive overview of innovation in a firm.

2.6 Social media & complaints

Complaint analysis can benefit from social media. Consumers and firms are increasingly using social media for complaining and responding to complaints (Einwiller & Steilen, 2015; Golmohammadi et al., 2021; Sigurdsson et al., 2021; Stevens et al., 2018). This is because social media makes it easy and effortless to complain (Einwiller & Steilen, 2015). Einwiller and Steilen (2015) define a complaint as "an expression of dissatisfaction for the purpose of drawing attention to a perceived misconduct by an organization and for achieving personal or collective goals" (p. 196). Collectively, the complaints fall into the electronic word-of-mouth (eWOM) category and can be positive, negative, or neutral statements related to any kind of business conduct (see Section 2.3). Complaints are a specific form of negative WOM and are voiced to achieve a certain goal. Reasons for complaining can be divided into personal goals, e.g., vengeance, or collective goals, e.g., helping others. (Einwiller & Steilen, 2015). Often, complaints are viewed as having an adverse impact on organizations, however through social dialogue firms can extract opinions and knowledge, allowing firms to identify existing problems (Stevens et al., 2018). Hence, complaints on social media can provide a valuable input for businesses.

3. METHODOLOGY

This paper followed a three-step classification methodology as presented in Figure 1. This approach is based on the needmining approach by Kühl et al. (2016) who demonstrate "that the small share of relevant tweets can be identified with remarkable precision or recall results" (p. 1). Needmining is like customer review analysis, including Sentiment Analysis (Kühl, 2016). First, 14,630 tweets were collected from the 'Nestlé Consumer Care' Twitter account (*data retrieval*). Second, irrelevant data were excluded (*data filtering*). Third and last, the tweets were categorized on whether it has positive, neutral, or negative sentiment by applying a sentiment analysis tool. The negative and neutral sentiment were manually classified in relation to the innovation types (*data labelling*).

Figure 1. Methodology steps adopted from Kühl et al. (2016)

An implication of this method is that an appropriate quantity of relevant keywords must be used. This means that a balance between having countless irrelevant results and limited overly specific results needs to be achieved. Additionally, a large dataset should be constructed and analyzed.

Kühl et al. (2016) mention three limitations of this approach: the use of keywords to search for data; the use of a limited data set compared to the number of tweets available; and the application to one domain. Moreover, they used their method for needmining, which covers an easy yes/no decision if it contains a need or not, which is simpler than deciding between six innovation categories in this research.

3.1 Data retrieval

As this paper is a graduation paper for a Bachelor Thesis of International Business Administration, the examiner executed the data retrieval. The Twitter data was retrieved via the University of Twente as a researcher has free access to the Application Programming Interface (API) (Twitter, 2022). Twitter's API allows researchers to extract real-time, public, unrestricted, free-of-charge data that matches pre-defined keywords (Kühl et al., 2016).

3.2 Data filtering

Data filtering increases the percentage of complaints in the dataset. The examiner filtered on using English as the main language. In addition, tweets under fifty characters and duplicate tweets were removed. This resulted in a dataset of 14,630 tweets. However, the data still contained non-English tweets. Those were deleted to give a total number of 14,556 tweets. The examiner did not use keywords or a stop-word list in the data extraction as originally done by Kühl et al. (2016). This was because the initial screening of 'Nestlé Consumer Care' Twitter page revealed that first, almost no promotions, sales or deals were promoted. Second, as the research focused on one Twitter page and sentiment analysis, all results were relevant.

3.3 Data labelling

After filtering, the remaining tweets were classified according to whether it contains positive, neutral, or negative sentiment. The publicly accessible Valence Aware Dictionary and sEntiment Reasoner (VADER) sentiment analysis was used for this. This is a sentiment tool that is both lexicon and rule-based and specifically attuned to microblog-like social media. The authors developed a human-validated gold standard sentiment lexicon that includes both sentiment intensity and polarity. The sentiment polarity is negatively rated with a negative number, rated zero if neutral, and rated positive with a positive number. The sentiment intensity is expressed between -1 and +1. The authors showed that VADER outperformed both human raters matching ground truth (r *correlation coefficient* = 0.881 and 0.888 respectively) as well as in the accurate classification of the sentiment of tweets (F1 *classification accuracy* = 0.96 and 0.84 respectively). In other words, VADER outperformed the human raters and other sentiment analysis lexicons in the social media domain, making it an appropriate choice. (Hutto & Gilbert, 2014) Figure 2 summarizes the results of the VADER sentiment filtering.

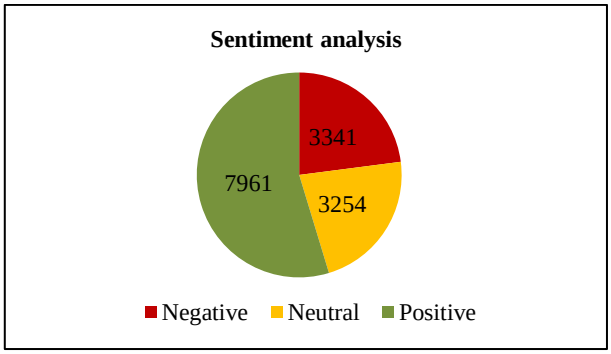

Figure 2. Pie diagram of sentiment analysis

This research focusses on consumer complaints (negative sentiment) and how they could improve innovation for Nestlé. Positive sentiment was assumed to discuss satisfactory practices of Nestlé and was therefore excluded from this research. Neutral sentiment was included as it was expected to include improvement topics. This reduced the total number of tweets to 6,595 that needed to be manually classified according to the innovation types of product/service, process, organization, marketing, technology, and social innovation. An extra category 'other' was added for tweets that could not be placed in one of the innovation type categories. Table 3 in Appendix A describe the coding decisions.

4. RESULTS

After coding, around 59% of the negative and neutral tweets is assigned one of the six innovation type categories, while the other 41% is put into the category 'other'. The product and service innovation type constitutes the largest innovation type

category with 1,219 tweets (see Figure 3). The second largest category is process innovation with 838 tweets, closely followed by social innovation with 814 tweets. Sequentially, the organization innovation type includes 590 tweets, marketing innovation 315 tweets and technology innovation 115 tweets.

Noticeably, more than double the tweets are put in the 'other' category for neutral sentiment compared to negative sentiment. Similarly, for each innovation type category the negative sentiment includes more tweets, except for technology innovation which has one less tweet.

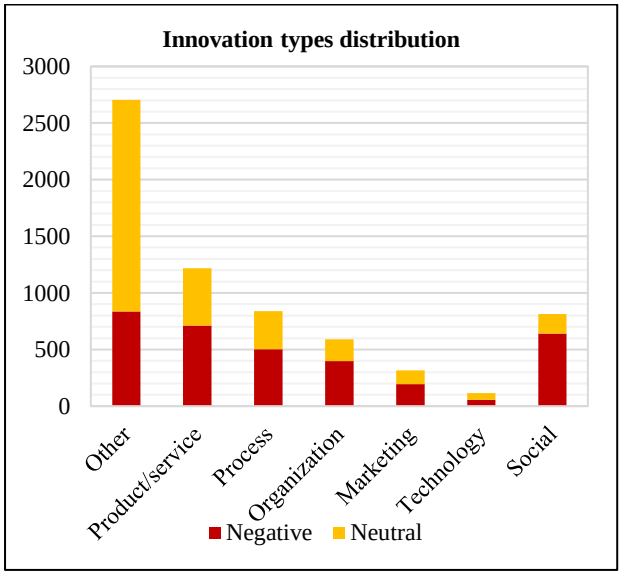

Figure 3. Categorization of innovation types

For further specification, the respective topic of each tweet is analyzed. Table 1 presents the number of topics established per innovation type with their respective code. Irrelevant tweets are one of the topics in the 'other' innovation type category.

Table 1. Number of topics per innovation type

Code	Innovation type	Topic count
0	Other	2
1	Product/service	85
2	Process	51
3	Organization	7
4	Marketing	9
5	Technology	10
6	Social	17
	Total	**181**

Table 2 includes the top twenty of most mentioned topics which account for almost 43% of the total topic count. A list with all the topics and the corresponding results is given in Appendix B. The topics of tweets that are in the 'other' innovation category that belong to a topic of one of the six innovation types, is counted as being part of the respective innovation category.

Next to certain topics, specific products also show importance. Table 4 in Appendix B reveals that KitKat, Milo, and Quality Street are products Nestlé should pay close attention to. The most mentioned product in the dataset is KitKat. Alongside complaints about the size and content reduction (e.g., using less chocolate to cover the biscuit), a considerable number of consumers have reported missing the wafer inside and thus having a solid chocolate bar. Furthermore, people complain about the packaging and quantities inside KitKats. The second most mentioned product is Milo. Topics of discussion are the change in Milo consistency due to fortification by Nestlé, packaging issues, safety issues and finding extraneous materials. The third most mentioned product is Quality Street. People complain about inconsistencies in product mix, the removing or adding of certain flavors, and the chocolate wrapping.

Table 2. Top twenty of topics

Code	Topic	Count	Percentage
6	Russian invasion Ukraine	518	7.8544%
2	Supply to a particular location	280	4.2456%
3	No response	251	3.8059%
3	Bad customer service	205	3.1084%
1	Unknown product	197	2.9871%
1	Reducing product size/content	154	2.3351%
4	Text, terminology, and images present on the product	144	2.1835%
1	One-time mentions: product/service	132	2.0015%
1	Unknown product discontinued	125	1.8954%
3	Storing the product/packaging	101	1.5315%
2	Extraneous materials	99	1.5011%
2	Unknown product production failure	89	1.3495%
2	KitKat production failure	83	1.2585%
4	Advertisement	75	1.1372%
1	Product idea	74	1.1221%
2	One-time mentions: process	61	0.9249%
5	Customer service unreachable	58	0.8795%
6	Social reputation	50	0.7582%
6	Plastics	49	0.7430%
6	Stealing water	45	0.6823%
6	Unethical practices	45	0.6823%

5. DISCUSSION

This section discusses the results of the previous section and its application to theory and practice.

5.1 Analysis of results

First, the general approach of sentiment analysis reveals interesting results. Negative sentiment tweets have a higher number of tweets categorized into one of the six innovation types compared to neutral tweets. Assumably, positive tweets could have even less relevant results. Therefore, doing a sentiment analysis prior to coding, could improve the relevancy of the results within the innovation subject area.

Second, the dataset reveals a significant contribution of social innovation. Nestlé continuing to do business with Russia after they invaded Ukraine has stirred commotion, being the highest

ranked topic. Consumers have reported that they will boycott Nestlé if they continue supporting Russia. On top of that, five of the seventeen social innovation topics scored in the top twenty (see Table 2), whilst an extra four scored in the top forty (see Table 4). This supports the importance of social responsibility aspects in business.

Third, although *supply to a particular location*, *unknown product*, *one-time mentions: product/ service*, *unknown product discontinued*, *unknown product production failure*, and *one-time mentions: process* score within the top twenty of topics, they fail to mention a target (see Section 2.3). In general, people become dissatisfied if a product is out of stock or is not supplied to their location of residence. Furthermore, production failures or product disapproval are likely to happen. Thus, tweets without a target provide unclear innovation possibilities.

Fourth, consumers disapprove of *misleading text, terminology, and images present on the product* as this topic scores seventh. In relation to this, people voiced their concern about misleading advertising in the *advertisement* topic category. For example, they complained that products advertise recyclability whilst it cannot. Individuals also complained that for specific products packaging is too similar. This is especially the case for Walnut Whip and vanilla Whip. People find it unclear and complain about missing the Walnut on the Whip. Hence, Nestlé should be more honest and transparent.

Fifth, the topic of *extraneous materials* is mentioned frequently. Like the previous paragraph, this topic contains more than one product, but five products are mentioned more than five times: Milo, Maggi Noodles, Nobbly Bobbly, Toll House Cookie Dough and Cerelac. Consumers finding extraneous materials should be avoided as it makes them reluctant to buy again. Thus, it is advised to review those five product's production processes.

Sixth, consumers voiced annoyances with the customer service and handling policies of Nestlé. The topics *no response*, *bad customer service* and *storing the product/packaging* of the organization innovation category and *customer service unreachable* of the technology innovation category supports this, as they are listed in the top twenty. Organization innovation only includes seven topics, so having three of them ranked high supports the significance. The way companies react to customer feedback on social media is influential, as seen in the academic field of complaint handling.

Seventh, the topic of *reducing product size/content* has not come unnoticed by customers. A considerable number of consumers want the old size despite if it means a price increase. For example, they claim that KitKat Chunky is not chunky anymore: the part of the product that makes it distinct from competitors. Additionally, customers state that with this size they will stop buying Nestlé products. This signifies that reducing product size and/or content can lower commodity costs, but also could cost Nestlé their customer sales and loyalty.

Eight, Nestlé should pay close attention to KitKat, Milo and Quality Street as these products are mentioned most frequently. Nestlé should aim to satisfy those customer complaints to improve sales, customer loyalty and positive eWOM.

Ninth and last, the dataset can function as a source for product ideas with 74 mentions of the topic *product idea*. Product idea examples are, e.g., having more white chocolate products as people want more of those or introducing a limited edition all year round. Another interesting mention in the marketing innovation category is marketing the BabyRuth candy bar as 'Ruth Bader Ginsberg' candy bars, after the famous American female judge the 'notorious RBG' passed away in 2020. Twitter revealed that the idea gets enough support.

These points can help Nestlé assess their current state and improve on various aspects of their business. Nestlé can adapt their products to customer complaints and product ideas, improving sales and customer loyalty. On top of that, improved honesty and transparency is needed. Furthermore, customers can identify failures in production, which can be directed as input for quality control. In addition, the feedback can help Nestlé increase customer satisfaction on their customer service and advertising. Lastly, customers can provide guidance regarding social and environmental responsibility practices, which can be used to improve Nestlé's social reputation and win customers back.

5.2 Theoretical & practical implications

This paper contributes to theory as social media is a new academic research field. Research on social media and innovation is limited, especially in relation to the six innovation types. The results show that more than fifty percent can be categorized into an innovation category. In addition, this paper reveals that negative sentiment can achieve higher categorization than neutral sentiment tweets. Therefore, sentiment analysis could be applied to improve the relevancy of the results. Furthermore, the findings show that like businesses, consumers primarily focus on product and/or service and process innovation. In relation to this, this study highlighted that, as stated in literature, there can be an overlap between product and process innovation. It also finds that there can be an overlap between product and social innovation, as the packaging design and materials impacts the perceived environmental contribution of Nestlé. Interestingly, the new social innovation category scores high, signifying its added contribution to the innovation literature. The other recent technology innovation category is mentioned infrequently. This is logical as Nestlé is not technology-based. Thus, this study makes a purposeful contribution to the literature by supporting the notion that Twitter is a useful medium for examining innovation types.

This research provides an example how a firm's Twitter customer support account can assess a firm's current state and extract areas to focus on. Numerous innovation topics were identified. A study like this can reveal customer product, service, social and environmental responsibility preferences. It can identify production and technological failures. It can improve advertisements, organizational processes, and social media management. A restriction is that a study like this is limited to large companies with substantial Twitter accounts to retrieve meaningful insights. In conclusion, a study as this can help analyze the current business state and what type of innovation is preferred by the customer.

6. LIMITATIONS & FUTURE RESEARCH DIRECTIONS

This research has its limitations and recommendations. First, only the researcher coded the tweets and gave them a topic. This gives way for a larger human error possibility. It is advised to have more people categorize the same data. Second, the VADER sentiment analysis achieves a F1 = 0.96 classification accuracy, implying that not all sentiment is incorrectly labelled. As it is the best sentiment analysis to date, this cannot be avoided. Third, this research only reviewed negative and neutral sentiment. Future research could also look at positive sentiment. It would be interesting to investigate if the relevancy of tweets for innovation is highest for negative, then neutral, and last positive sentiment. Fourth, this research covers a large company in the food and beverages industry. For future research it can be interesting to focus on other companies and determine if company size matters. Additionally, generalizability over industries could be examined. Fifth and last, the product and process, and product and social innovation categories shared overlap on certain topics. Other

academics could improve the distinction between or adding more innovation types. In relation to this, a future research topic can be to develop a list of in- and excluded topics per innovation type that can be generalizable over the food and beverages industry, or even over other industries.

7. CONCLUSION

In this paper, a three-step classification methodology based on the needmining approach by Kühl et al. (2016) was applied to retrieve, filter, and label 14,630 tweets of 'Nestlé Consumer Care' Twitter page. For labelling, the VADER sentiment analysis was applied to categorize the tweets into negative, neutral, and positive sentiment. The 6,595 negative and neutral sentiment tweets were further categorized into 'other' or one of the six innovation type categories of product/service, process, organization, marketing, technology or social. Lastly, respective topics were analyzed.

In general, this paper showed that user complaints can be linked to innovation types. Negative sentiment achieved a higher categorization in an innovation type compared to neutral sentiment. Thus, doing a sentiment analysis prior to coding, could improve the relevancy of the results for innovation.

More specifically, the dataset of Nestlé's Twitter page revealed that the largest innovation type category is product, followed by process, social, organization, marketing and lastly technology innovation. It also revealed that this type of research can help Nestlé and other firms to assess their current state and to improve on various aspects (or topics) of their business.

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APPENDIX A

Based on Section 2.5, the innovation types are coded according to its definition, see Table 3. If a tweet more strongly leans toward one type of innovation, that innovation type will be selected instead of putting it into the 'other' category. If necessary, URLs will be investigated. In addition, Table 3 gives an explanation to further specify what is included in a category.

Table 3. Coding of innovation types

Code	Innovation	Definition	Included
0	**Other**	Tweets that cannot be classified or fall into more than one category	Tweets that are cut off and therefore difficult to interpret. (Partial) non-English messages. Tweets not aimed at Nestlé. Brand protection.
1	**Product/ service**	Goods, services, or hybrid versions a firm offers, e.g., its function or feature.	The text/terminology on the packaging required about its contents. Delivery service. Discontinuation of products. Packaging design of products. Product design failures.
2	**Process**	How an organization conducts and delivers its business, such as the techniques of producing their products or services.	The location of Nestlé companies. The allocation or supply of products to stores. Finding extraneous materials in products. Product production failures. Products gone off (before the expiration date).
3	**Organization**	How an organization operates, or in other words, changes to its social structure, including people, and administration.	Customer support handling policies. Employee management. Distributors. Selling off part of company.
4	**Marketing**	It describes the introduction of an innovation to the customer; the changes on how a product/service is introduced; and, how new customer bases and markets are exploited, characteristics of them or their change and how new ones are created. It aims to change a customer's view or understanding of the product/service.	The marketing text/terminology and images present on the packaging of a product. Pricing decisions. Recipes produced by Nestlé. Social media account portfolio. Contest and promotional campaign problems. Grammar and spelling errors. Advertisement.
5	**Technology**	Technical innovations refer to the assessment of new products, processes, or services via a technological viewpoint. Technological innovations are those innovations initiated by the adoption or advancement of technologies in an organization	DMs that are blocked on Nestlé social media accounts. Issues related to Nestlé website or technology part of customer service.
6	**Social**	Social mobilization and its accompanying values, processes, and impacts. Stimulating a change in behavior in networks of people.	Social responsibility aspects and reputation. Unethical practices. Irresponsible product ingredients. Sourcing decisions. Environmentally responsibility. Animal wellbeing.

APPENDIX B

Table 4. Topics ranked from highest to lowest count

Code	Topic	Count	Percentage
6	Russian invasion Ukraine	518	7.8544%
2	Supply to a particular location	280	4.2456%
3	No response	251	3.8059%
3	Bad customer service	205	3.1084%
1	Unknown product	197	2.9871%
1	Reducing product size/content	154	2.3351%
4	Text, terminology, and images present on the product	144	2.1835%
1	One-time mentions: Product/service	132	2.0015%
1	Unknown product discontinued	125	1.8954%
3	Storing the product/packaging	101	1.5315%
2	Extraneous materials	99	1.5011%
2	Unknown product production failure	89	1.3495%
2	KitKat production failure	83	1.2585%
4	Advertisement	75	1.1372%
1	Product idea	74	1.1221%
2	One-time mentions: Process	61	0.9249%
5	Customer service unreachable	58	0.8795%
6	Social reputation	50	0.7582%
6	Plastics	49	0.7430%
6	Stealing water	45	0.6823%
6	Unethical practices	45	0.6823%
1	Allergy	39	0.5914%
1	Milo	39	0.5914%
6	TerraCycle	30	0.4549%
4	Pricing	27	0.4094%
6	Human rights violation	27	0.4094%
1	Drifter discontinued	26	0.3942%
6	Recyclability of packaging	25	0.3791%
2	Unknown product mix	24	0.3639%
2	Quality Street product mix	24	0.3639%
1	Quality street	23	0.3487%
1	Water delivery service	22	0.3336%
5	Form is broken	22	0.3336%
3	Employee management	21	0.3184%
4	Sexism	21	0.3184%
6	Palm oil	21	0.3184%
1	Tooty Frooties discontinued	20	0.3033%
1	Vegan/vegetarian	20	0.3033%
1	Nestea discontinued	19	0.2881%
1	MilkyBar	18	0.2729%
1	KitKat	16	0.2426%
1	Sugar	15	0.2274%

Table 4. Continued

Code	Topic	Count	Percentage
0	Brand protection	14	0.2123%
4	Social media portfolio	14	0.2123%
4	Contests	14	0.2123%
1	Fat	13	0.1971%
1	MilkyBar Choo discontinued	13	0.1971%
2	Quality Street production failure	13	0.1971%
4	Social media posts	13	0.1971%
2	Water production failure	12	0.1820%
2	Munchies production failure	12	0.1820%
1	Rowntrees Secret discontinued	11	0.1668%
1	Sugar tax	11	0.1668%
2	Milo production failure	11	0.1668%
3	Selling off part of company	11	0.1668%
1	Easter egg	10	0.1516%
1	Halal	10	0.1516%
1	Coffee mate	9	0.1365%
2	Easter egg production failure	9	0.1365%
2	Drumstick production failure	9	0.1365%
5	Automated responses	9	0.1365%
1	Yorkie	8	0.1213%
1	Corn syrup	8	0.1213%
1	Pops discontinued	8	0.1213%
1	Wonka Bar discontinued	8	0.1213%
1	Butterfinger BB's discontinued	8	0.1213%
2	Smarties production failure	8	0.1213%
3	Distributors	8	0.1213%
4	Grammar and spelling errors	8	0.1213%
5	Link is broken	8	0.1213%
6	Environmental responsibility	8	0.1213%
1	Walnut Whip	7	0.1061%
1	Dibs discontinued	7	0.1061%
3	Blocking of people	7	0.1061%
5	Website	7	0.1061%
1	Honey Shreddies discontinued	6	0.0910%
1	Chamyto discontinued	6	0.0910%
1	Unknown service	6	0.0910%
2	Fruit pastilles product mix	6	0.0910%
2	After Eight production failure	6	0.0910%
5	Order handling system	6	0.0910%
1	SMA	5	0.0758%
1	Maggi Noodles	5	0.0758%
2	Sanpellegrino production failure	5	0.0758%
5	Store locator	5	0.0758%

Table 4. Continued

Code	Topic	Count	Percentage
6	Hiding supplies in Lebanon	5	0.0758%
1	Caramac Buttons discontinued	4	0.0607%
1	Caramac Buttons	4	0.0607%
1	Lean Pockets discontinued	4	0.0607%
1	Water	4	0.0607%
1	Peel-a-pop discontinued	4	0.0607%
1	Bugz discontinued	4	0.0607%
2	Rolo production failure	4	0.0607%
2	Maggi noodles production failure	4	0.0607%
2	Toll House vanilla chocolate chip cookie sandwiches production failure	4	0.0607%
2	Polo production failure	4	0.0607%
6	Animal wellbeing	4	0.0607%
6	Fairtrade	4	0.0607%
1	Unknown product info	3	0.0455%
1	Yorkie Duo	3	0.0455%
1	Chocolate Log discontinued	3	0.0455%
1	Drumstick	3	0.0455%
1	SanPellegrino	3	0.0455%
1	Golden Grahams discontinued	3	0.0455%
1	Raisinets	3	0.0455%
1	Vittel discontinued	3	0.0455%
1	Clusters discontinued	3	0.0455%
1	Maxibon/Tandem discontinued	3	0.0455%
1	Runts discontinued	3	0.0455%
2	Fab production failure	3	0.0455%
2	Matchmakers production failure	3	0.0455%
2	Coffee mate production failure	3	0.0455%
2	Maggi Tastemaker production failure	3	0.0455%
2	Fruit Gums production failure	3	0.0455%
2	Aero milk production failure	3	0.0455%
2	Classic rich milk chocolate production failure	3	0.0455%
2	Advent calendar production failure	3	0.0455%
5	Not user-friendly website	3	0.0455%
6	WHO code violation	3	0.0455%
1	Cheerios	2	0.0303%
1	Dibs	2	0.0303%
1	Butterfinger Peanut Butter Cups discontinued	2	0.0303%
1	Nerds Rope discontinued	2	0.0303%
1	Yorkie Buttons discontinued	2	0.0303%
1	Fruit pastilles	2	0.0303%
1	After Eight	2	0.0303%
1	Club discontinued	2	0.0303%
1	DiGiorno Croissant Crust Pizza	2	0.0303%

Table 4. Continued

Code	Topic	Count	Percentage
1	SweeTarts	2	0.0303%
1	DiGiorno Rising Crust	2	0.0303%
1	Nesquik Classic	2	0.0303%
1	SanPellegrino Fantasia discontinued	2	0.0303%
1	MilkyBar Munchies discontinued	2	0.0303%
1	Toll House Butterscotch Morsels	2	0.0303%
1	Splash	2	0.0303%
1	E-numbers	2	0.0303%
1	Dolce Gusto	2	0.0303%
1	Giant Smarties discontinued	2	0.0303%
1	Colorings	2	0.0303%
1	Frog Family discontinued	2	0.0303%
1	Whip	2	0.0303%
1	Yorkie Peanut discontinued	2	0.0303%
1	Fruit Screamers discontinued	2	0.0303%
1	ToffeeCrisp	2	0.0303%
1	Advent calendar	2	0.0303%
1	Nescafe Gold Cappuccino	2	0.0303%
1	Double Cream discontinued	2	0.0303%
1	KitKat Senses discontinued	2	0.0303%
1	Pure Life water	2	0.0303%
1	Vice Versas discontinued	2	0.0303%
1	Carnation breakfast bar discontinued	2	0.0303%
1	Nescafe Café con Leche discontinued	2	0.0303%
2	Rowntrees product mix	2	0.0303%
2	Extreme Ice Cream Cone production failure	2	0.0303%
2	Box bowls production failure	2	0.0303%
2	Blue Riband production failure	2	0.0303%
2	Caramac bar production failure	2	0.0303%
2	Butterfinger production failure	2	0.0303%
2	Jelly Tots production failure	2	0.0303%
2	Toll House chocolate chip cookie dough production failure	2	0.0303%
2	Nerds production failure	2	0.0303%
2	Fruit Gums product mix	2	0.0303%
2	Nobbly Bobbly production failure	2	0.0303%
2	Yorkie Raisin & Biscuit chocolate bar production failure	2	0.0303%
2	Milkybar buttons production failure	2	0.0303%
2	ToffeeCrisp production failure	2	0.0303%
2	Ideal original production failure	2	0.0303%
2	Drifter production failure	2	0.0303%
2	Rowntrees Pick & Mix product mix	2	0.0303%
2	Aero Mini Milk Chocolate production failure	2	0.0303%
2	Aero Bubbles production failure	2	0.0303%

Table 4. Continued

Code	Topic	Count	Percentage
2	Smarties product mix	2	0.0303%
2	LinDahls Kvarg production failure	2	0.0303%
2	Aero mousse production failure	2	0.0303%
6	Israel	2	0.0303%
6	Sourcing	2	0.0303%
4	Audience	1	0.0152%
5	Warranty not valid	1	0.0152%
5	Algorithm	1	0.0152%
6	Racism	1	0.0152%