

Analyzing Consumer Satisfaction of Online Grocery Retailing Process Using Consumer Reviews

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This research was motivated by the need to identify relationships between elements of online grocery retailing process and its consumer satisfaction using online consumer reviews. By utilizing text mining analysis, we grouped online consumer reviews into five clusters of word terms that come close to the elements of the online grocery retailing process, i.e., order delivery to consumers, online ordering and service, item variety and availability for ordering, picking and packing of ordered items, and order and delivery price. We also found that these elements can positively or negatively impact consumer satisfaction of the online grocery retailing process. The utilization of text mining and predictive modelling led to the development of a multinomial logistic regression model to predict consumer satisfaction ranking based on word terms identified in online consumer reviews. The results of this research produced several important practical directions for improving consumer satisfaction in online grocery retailing.

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I. INTRODUCTION

Online grocery retailing is an important part of the overall e-tailing. According to the eMarketer report (Droesch, 2024), online grocery purchase will become the largest ecommerce category in 2026, and will increase from 11.7% of the total ecommerce market in 2019 to 19% in 2026. In many respects, this growth was triggered by the COVID-19 pandemic. The prediction results from various sources indicate that the online grocery retailing will continue a fast pace of growth in subsequent years and the proportion of online grocery sales in the total grocery market will increase from 10.6% in 2020 to an estimated 21.5% in 2025 (Mercator Research, 2023).

Consumers shop grocery online through a retailer's website or pure online grocery store, which results in delivery of a grocery order to a consumer's home, as a curb side pickup or in-store pickup. The Oracle Retail (2022) report shows that 51% of consumers ordering grocery online are opting for in-home delivery, 33% of them are choosing to pick up groceries in-store, and 16% are selecting curb side pickup to collect their grocery purchases.

The management of logistical operations that relate to the online food retail business is far more complicated than in any other retail sector (Hübner, Kuhn and Wollenburg 2016; Mkansi et al. 2018), and has unique features and higher than usual complexity in its shopping and delivery process

(Kishore, 2023). This complexity stems from the need for a speedy grocery delivery within several hours, maintaining freshness of produce items (e.g., fruits and vegetables), refrigeration of certain food items (e.g., meats, fish, dairy), and picking of special food categories (organic vs. non-organic, GMO vs. non-GMO foods, etc.). Despite the safety and convenience of online grocery retailing, its complex shopping and delivery process can lead to a number of issues and consequently consumer dissatisfaction of the process. These issues can potentially include the lack of available items or difficulty finding items, getting low-quality grocery that consumers would not have picked themselves, incorrect items in orders, long delivery, and other issues (Ladd, 2020; Mukherjee, 2019; Oracle Retail, 2022).

The extant research has identified many elements pertaining to online grocery retailing process, analyzed their impact on consumers' behavior, and examined intentions of online grocery shopping (Monoarfa et al., 2024). Surprisingly, the existing research has not analyzed consumer satisfaction and related elements of online grocery retailing using consumer reviews posted online in various websites. Typically, these primary data sources would include rich textual information on the factors that influence consumers' satisfaction and dissatisfaction with online grocery retailing. We consider the lack of utilizing online consumer reviews as a major gap in the extant research on online grocery retailing.

The research discussed in this paper was motivated by the need to identify relationships between consumer satisfaction and elements of the online grocery process using online consumer reviews. An important contribution of this research is related to systemizing and clustering consumer reviews into elements of the online grocery retailing process. Another important contribution is associated with identifying polarity and subjectivity of consumer reviews in conjunction with their consumer satisfaction. In this research, the term

“polarity” describes a measurable level of positive or negative consumer reviews and their relations with consumer satisfaction. The term “subjectivity” measures how subjective or factual consumer reviews affect consumer satisfaction (Kautish and Kaur, 2017; Sarkar, 2019). One more important contribution of this research is the development of quantitative relationships between consumer satisfaction ranks and significantly correlated word terms in consumer reviews. Based on these results, our research provides directions on improving existing online grocery retailing processes to achieve better consumer satisfaction.

This paper's structure includes five main sections. After the *Introduction*, the *Literature Review* section analyzes extant research pertaining to online grocery retailing. The *Methodology* section provides a description of the research objectives, data collection, methods and algorithms used in this research. The *Analysis, Results, and Discussion* section presents analytical results and discussion of consumer reviews and their satisfaction in the online grocery retailing process utilizing the text mining, sentiment, and predictive analytics methods and algorithms. The *Conclusions* section provides a summary of this research, its results, and directions for improving consumer satisfaction in online grocery retailing.

II. LITERATURE REVIEW

Online grocery retailing is an interdisciplinary e-service process that includes technology, marketing, quality, operations, and supply chain management disciplines. The proliferation of online grocery retailing, specifically after the start of the COVID-19 pandemic, increased interest in the academic research in this area. We have organized the review of the existing research pertaining to the online grocery retailing process and its consumer satisfaction into the following *four streams*.

The *first stream* includes the articles on the development of online grocery retailing models and the associated challenges. Kishore (2023) identifies four main online grocery models that are: (a) inventory-based model where inventory is bought and stored by an online grocery store (e.g., Amazon Fresh); (b) multi-vendor marketplace model (e.g., Peapod) that aid and enable traditional brick-and-mortar (B&M) retailers to offer online shopping and delivery; (c) hyperlocal grocery model that caters to the needs of consumers within a specific location (e.g., Walmart); and (d) click and collect or buy online pick-up in store model (e.g., Instacart). Abbu et al. (2021) describe how major grocers have been trying to transform their grocery retailing processes to meet the growing demands of online consumers. The authors indicate that: (a) some grocery stores have converted certain stores to process online orders and have redesigned parking lots to handle more curb side pickups, and (b) others have added micro-fulfilment centres to speed up order picking and packing processes.

Hübner, Kuhn, and Wollenburg (2017) indicate that the omni-channel planning can be structured into three back-end-fulfilment concepts (in-store, separate fulfilment centre, and central warehouse) and five last-mile-distribution concepts (attended/unattended home delivery, in-store, attached station, and solitary station). Benner et al. (2020) contrast the traditional purchase model in store with the online grocery model. The authors conclude that the main elements that change the traditional in-store retailing model to the online grocery retailing model are related to online ordering and payment, order fulfilment using specially designated in-store or warehouse shoppers, and order delivery to consumers.

Mkansi et al. (2018) present a content analysis of the e-grocery research published from 2008 to 2017 and indicate that significant body of research focus on e-grocery fulfilment models, e-grocery shopping behavior, and omni-channel or multi-channel perspectives.

They also report a variety of e-grocery challenges, e.g., availability and freshness of products, managing customer expectations, managing competitive delivery window against demand and cost.

Recognizing the importance of online grocery retailing as one of the main current and future grocery models, some authors discuss the issues of these models during and after the end of the coronavirus pandemic. Ladd (2020), states that “Covid-19 has made unattended delivery (no human contact with a delivery driver) a necessity, and this expectation is not going to change.” Fuentes, Samsioe, and Backe (2022) conceptualize and explain how and why online shopping has changed during the COVID-19 pandemic and discuss the stability of this new mode of shopping. The authors conduct ethnographic interviews with 31 Swedish households to analyze how online grocery shopping was performed during the COVID-19 pandemic. They find that consumers had to develop new competencies by interacting with technology and social networks. Conversely, the online grocery platforms also shaped and adapted to the emerging practice during the pandemic, scaling up their capacities, broadening their ranges, and adapting their interfaces and the services they offered. Overall, the analysis of this *first stream* of research thus shows the complexities and challenges the grocers are facing in transforming to the online grocery retailing process.

The *second stream* relates to articles that identify attributes (elements) of the online grocery retailing and how these elements impact consumers’ behavioural intentions/outcomes. Blut et al. (2015) present a conceptualization of e-service quality by reviewing/synthesizing papers that were published over fifteen years (2000-2014). The authors characterize the overall e-service quality model within four underlying attribute dimensions (website design, fulfilment, consumer service, and security/privacy) and three outcomes (consumer satisfaction, repurchase intentions, and

electronic word-of-mouth (eWOM). Singh (2019) developed an integrated framework of online grocery customer experience using an interpretive analysis of 1,004 customer reviews/incidents captured from review sites dedicated to online grocery shopping. This framework contains several attributes, for example, product assortment, delivery, website navigation, price, return and refund, and product quality, which influence the behavioral responses such as “repurchase intention, eWOM and intention to switch.”

Chopra (2023) identified several important features for developing an online grocery application including easy registration, uploaded grocery list, easy to use online cart, text-based list of items, and real-time tracking. Singh and Soderlund (2020) assess antecedents influencing consumers’ online grocery retailing experiences using an online survey with a response rate of 358 respondents. They find that consumer service, website experience, and product option show a significant impact on the online grocery retailing experience, which in turn impacts consumer satisfaction. Kolesova and Singh (2019) analyze the impact of online product display on the behavioral outcomes of online grocery shoppers. They find that an online product display with low visual complexity for a single product will increase purchase intention compared to a product display with high visual complexity for a combination of multiple products.

Benn et al. (2015) suggest that timely delivery, appropriate order packing, technology-driven, and easy-to-use website capabilities are important for consumer switch to online grocery retailing. Strailey (2020) shows that the traditional grocery stores offering online retailing should emphasize price over speed to best play to their strengths in a market-share battle with Amazon. Amorim and Dehoratius (2021) indicate that online consumers value several elements of online grocery retailing, such as delivery speed, delivery precision, and delivery day choice. The

authors recommend retailers to rethink their operations to optimize not only on speed but also on the most appropriate combination of speed, precision, and flexibility. A study by Frank and Peschel (2020) that uses a web-based survey data reveals three distinct segments within the online grocery adopters, i.e.: (a) the price-oriented segment emphasizes product assortment, correct delivery, fast delivery, and price; (b) the time-optimizer segment emphasizes time savings, independent open hours, and choice of ‘best before’ date; and (c) the cautious segment emphasizes personal service, trust mark, and retail chain. Overall, the review of the papers in the *second stream* identifies important elements of the online grocery retailing process such as consumer service, website experience, variety and availability of product items, price, picking and packing of orders, and timely delivery.

The *third stream* includes articles that examine the role of consumer perceptions and subjectivity in adoption of the online grocery retailing model and evaluation of the online grocery services. Mortimer et al. (2016) analyze the relationship among online shopping satisfaction, customer trust, perceived risk, and online purchase intention. Based on the survey of 555 frequent/infrequent online shoppers they find that consumer satisfaction predicts trust, and trust in turn reduces the perceived risk and increases repurchase intentions. Harris et al. (2017), based on a survey data obtained from a sample of 871 UK online and offline shoppers, identify that the choice of whether to shop online or in store may be driven not only by the perceived advantages of one channel vs. the other, but also by the desire to avoid the greater disadvantages of the alternatives.

Kühna, Lichters, and Krey (2020) indicate that online grocery retailers face negative perceptions concerning their products because of consumers’ need-for-touch (NFT) to assess quality concerns. The research’s survey results suggest that for the high NFT products such as grocery, retailers encounter lower

consumer intention to buy and pay. The authors discuss a need to adjust online product display to overcome negative quality perceptions and affective reactions toward produce for the high-NFT consumers. Klepek & Bauerova (2020), using on a web-based survey, identify that those consumers who do not want to buy grocery online prefer to see grocery in person before buying it because they have distrust in e-tailers in terms of choosing the best and freshest grocery. Singh and Söderlund (2022) find that customers' satisfaction with a home where they live is positively associated with an in-home delivery of grocery products purchased online. Overall, the literature review in the *third stream* demonstrates that consumer perception and subjectivity could have a substantial impact on consumer satisfaction in online grocery retailing.

The *fourth and final stream* pertains to the consumer reviews online. With the rapid growth in internet technologies, consumers not only shop online – they also tend to post reviews on online social media and use these reviews to make decisions. These consumer-generated reviews create rich and important information about product and service quality, which is a valuable alternative to the traditional survey-based data. Singh et al. (2017) develop machine learning models that can predict, based on consumer reviews, sentiment features of consumers such as polarity and subjectivity. Wang, Liu, and Fang (2015) indicate that online consumer reviews can be useful to understand consumers' retailing experiences, future purchase intentions, and attributes of products and services that the consumers value. Zhao, Xu, and Wang (2019) utilize online textual reviews from Yelp.com to identify consumer perceptions of influential hotel products and services, and also to extract service quality dimensions in restaurant industry. Tian et al. (2020) propose a methodology that uses text mining and sentiment analysis to help the airline industry assess its service quality. Overall, the literature review in the *fourth stream* reveals the

existing text mining and sentiment analysis research in evaluating consumer reviews in various industries. However, we were not able to identify any research or publication that would do this evaluation for online grocery retailing process and consumer satisfaction.

In summary, we draw several important conclusions from the literature review. *First*, the review of literature sources reveals important attributes (elements) of the online grocery retailing process such as website experience, variety and availability of products, purchase, and delivery price, picking and packing of orders, and timely delivery. *Second*, the existing literature sources recognize complexities and challenges in the online grocery retailing process and consider many e-service elements that impact consumer satisfaction in this process. However, the direction and strength of relationships between elements of the online grocery retailing process and its consumer satisfaction are not analyzed in this literature. *Third*, the literature review demonstrates that consumer perception and subjectivity could have a substantial impact on consumer satisfaction in online grocery retailing. *Finally*, all research articles on the online grocery retailing process and its consumer satisfaction apply consumer survey data. Surprisingly, the extant research has not utilized primary data of consumer reviews posted online in various consumer research and social media websites, to analyze consumer satisfaction and elements of the online grocery retailing process. The lack of utilization of online consumer reviews is a major gap in the existing research on consumer satisfaction in online grocery retailing that will be addressed in this paper.

III. METHODOLOGY

Based on the results of the literature review in the preceding section and, specifically, the identified gap in analyzing online consumer reviews of the online grocery

retailing process, we formulated the following objectives of this research:

- (a) Relate online consumer reviews to elements of the online grocery retailing process.
- (b) Identify relationships between positive and negative consumer satisfaction and these elements of the online grocery retailing process.
- (c) Recognize relationships between polarity and subjectivity sentiments of consumer reviews and associated consumer satisfaction.
- (d) Identify quantitative relationship between consumer satisfaction and word terms in online consumer reviews.

To address the described research objectives, we collected online consumer reviews and their respective consumer satisfaction of the online grocery retailing for the three companies with the largest numbers of online grocery shoppers: Walmart, Amazon Fresh and Amazon Whole Foods (combined), and Instacart. The first two companies are well known for their capabilities in online grocery retailing (Redman, 2021). Instacart is a third-party logistics (3PL) company that provides retailing and delivery from various grocery stores (Huet & Chapman, 2020). These companies are recognized by several sources as one of the best and largest online grocery companies in the U.S.A. (Fisher, 2021; Insider Intelligence, 2021).

The consumer reviews for online grocery retailing from the specified companies are retrieved from the open-source online research, product reviews, and social media websites including *www.consumeraffairs.com*, *www.facebook.com*, *www.sitejabber.com*, *www.trustpilot.com*, and *www.yelp.com*. The data is retrieved for a 5-year period from 2017 through 2021. Each collected data record from these web sources includes the following data parameters:

1. Record date.
2. Grocery delivery company's name, which is one of the described companies.

3. Consumer response textual document describing an online grocery retailing experience.
4. Consumer satisfaction using a numeric ranking of this experience. The ranking is typically associated with a five-star scale, one star being the lowest and five stars – the highest. This star ranking was seamlessly converted into a five-point scale ranking for the consumer satisfaction.

Based on the specified websites, the total of 1896 records were collected, including similar number of records for each online grocery organization: 632 records for Walmart, 654 records for Amazon's Fresh and Whole Foods, and 607 records for Instacart. At the same time, 834 of the consumer records were before the COVID-19 pandemic (in this case, we consider it before 3/1/2020) and 1062 of the records were after the pandemic start, i.e., from 3/1/2020.

To address objectives (a) and (b) from the described set of the research objectives, we applied *text mining* analysis for the collected data set to extract frequent words and phrases, referred to as *terms*, from the online consumer reviews. The extracted terms were stored in a structured format, i.e., *text corpus* and *document-term matrix (DTM)*, and they were cleaned to remove terms and parts of the text not relevant to this research (Bengfort, Bilbro and Ojeda, 2018). Based on DTM, The *Latent Dirichlet Allocation (LDA) topic modelling* (Jelodar et al., 2019) is applied next to cluster consumer reviews in a meaningful number of term topics. Each modelled topic is analyzed to identify its potential connection to an element(s) of the online grocery retailing process. The identified process elements are also analyzed for their association with the positive and negative consumer reviews and associated consumer satisfaction.

In case of the research objective (c), we utilized *text sentiment analysis* (Bengfort, Bilbro and Ojeda, 2018) to examine positive and negative consumer satisfaction in

conjunction with polarity and subjectivity of consumer reviews (Singh et al., 2017; Zhao, Xu, and Wang, 2019). To address the research objective (d), we employed the *bag of words (BoW)*, and *multinomial classification models* (Bengfort, Bilbro and Ojeda, 2018; Sarkar, 2019) to establish quantitative relationships between the consumer satisfaction ranking and text terms from consumer reviews. To fulfil the required in the methodology analysis and for utilizing the described text analytics methods and algorithms, various *Python* software libraries are applied in this research.

III. ANALYSIS, RESULTS, AND DISCUSSION

3.1. Preliminary Analysis

For the initial data exploration, the descriptive statistics measures of consumer satisfaction's numeric ranks (1 to 5) were identified. These measures are considered for the entire dataset, as well as for the periods before and after the start of the COVID-19 pandemic (see Table 1).

TABLE 1. DESCRIPTIVE STATISTICS OF CONSUMER SATISFACTION RANKS.

	<i>All records</i>	<i>Records before 3/1/2020 (start of pandemic)</i>	<i>Records after 3/1/2020 (after start of pandemic)</i>
Count	1896	834	1062
Mean of consumer satisfaction rank	3.149	3.207	3.093
Standard deviation of consumer satisfaction rank	1.738	1.683	1.519
Hypothesized difference of means		0	
T-stat value		1.531	
P-value		0.228	

As can be seen from Table 1, the data for the entire dataset (all records) and for the periods before and after the start of the pandemic shows similar values of the sample means and standard deviations of consumer satisfaction ranks. A hypothesis testing of the population means' difference was done for the respective records before and after the start of the COVID pandemic. For the null hypothesis, the difference of the population means of consumer satisfaction ranks is considered equal to 0 and the alternative hypothesis is that the difference is not equal to 0. The T-statistic's P-value for confidence α of 0.05 is identified as 0.228 (see Table 1), which means that the null hypothesis cannot be rejected. This result indicates that the consumer satisfaction of

online grocery retailing remains the same regardless of the time period prior or after the COVID-19 pandemic. Therefore, this enables us to continue with analysis of consumer satisfaction of the online consumer reviews for the entire dataset as opposed to analyzing it separately before and after the COVID-19 pandemic's start.

The next step in evaluating online consumer reviews is to create a *text corpus* and *document-term matrix (DTM)*, both of which are directly used in text mining analysis. The text corpus is developed as a collection of text words or terms associated with consumer reviews and their respective consumer satisfaction ranks. In addition to numeric designation of these ranks from 1 through 5, a

categorical variable with five classes of consumer satisfaction, Rank1, Rank2, ..., Rank5, respectively, was also added to the text corpus. The DTM is developed for n-gram terms (phrases) including two to four terms in a phrase. The DTM contains frequency of respective n-grams that occur in the dataset of consumers reviews and related to them consumer satisfaction ranks. It is important to point out that the n-gram phrases are clearly more substantive in describing consumer reviews and consumer satisfaction than unigrams (one-word terms), and, therefore, it is more appropriate to apply n-grams in this research. At the same time, the n-grams with more than four words have considerably lower frequencies in DTM and will not be considered further in the analysis of consumer reviews.

The most frequent DTM consumer reviews' terms related to the lowest Rank1 and Rank2 of consumer satisfaction are indicative of consumer issues with the online grocery retailing process, for example, "slow delivery," "waste time," "order missing," "item unavailable," "food quality poor," "call customer service," and "limited availability." Contrary to that, the highest Rank4 and Rank5 are related to positive terms toward the online grocery retailing process, e.g., "available online," "fast delivery," "great online service," "good customer service," "extremely

convenient," "quality grocery," and "low fee." Overall, the smaller the consumer satisfaction rank number the less positive and more negative consumer reviews' terms are being used, and vice versa for a higher rank.

3.2. Consumer Reviews and Elements of Online Grocery Retailing

To address the first objective (a) on relating online consumer reviews to elements of the online grocery retailing process, we used in this research the *Latent Dirichlet Allocation (LDA)* topic modelling. LDA allows grouping the DTM n-gram terms into a small number of topics (combination of the DTM n-grams) that describe the consumer reviews' textual documents. After analyzing scenarios with different number of topics between 2 and 10, it is identified that the scenario with five topics makes the most sense for describing consumer reviews of retailing groceries online (Figure 1).

The LDA topic modelling results in Figure 1 show that each topic is presented by a number ranging from 1 to 5 and incorporates 10 different n-gram terms (two or three words in each term) with their respective numeric weights (in descending order) describing that topic. As can also be observed for each topic, the terms are not homogeneous, and describe both positive and negative consumer reviews.

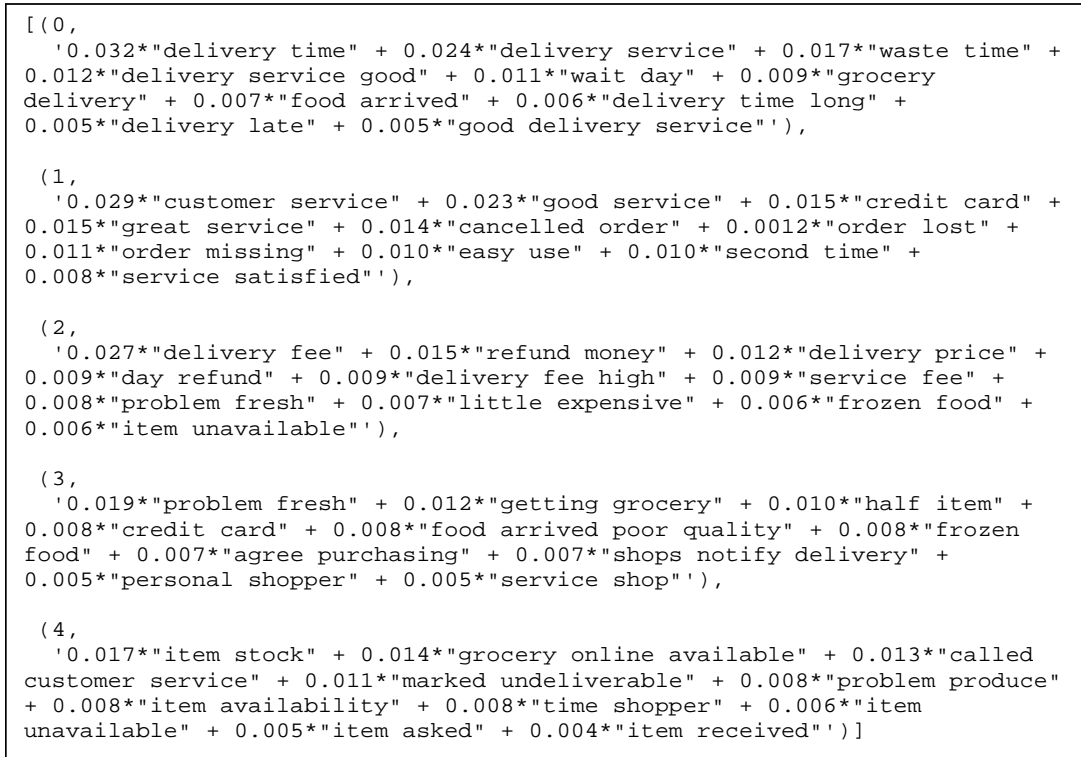


FIGURE 1. RESULTS OF LDA TOPIC MODELING.

Summarizing the terms for each topic, we created five labels to describe the respective topics as follows:

- Topic 1: Order delivery to consumers.
- Topic 2: Online ordering and service.
- Topic 3: Item variety and availability for ordering.
- Topic 4: Picking and packing of ordered items.
- Topic 5: Order and delivery price.

The LDA topics of consumer reviews and respective labels come remarkably close to many elements (attributes) of the online grocery retailing process discussed in the paper's *Literature Review* (the second stream). These results also demonstrate that each consumer review can be related to the specific elements/topics of the online grocery retailing process.

3.3. Positive and Negative Consumer Satisfaction

The LDA topic modelling is also used to analyze the research objective (b) on identifying relationships between positive and negative consumer satisfaction and the recognized five elements of the online grocery retailing process. As already discussed in this section, Rank4 and Rank5 of consumer satisfaction are associated with the mostly positive reviews, and Rank1 and Rank2 – with the mostly negative ones. Relations with Rank3 are not considered as it is regarded as a neutral rank. The LDA topic modelling enables to identify frequency of topics for positive and negative consumer satisfaction ranks that are presented in Table 2. For better visualization of the LDA results, the number of asterisks in Table 2 represents the frequency of each topic in a positive or negative rank, ranging from the five asterisks ‘*****’ for the highest frequency of a topic in a particular

rank to a single asterisk ‘*’ representing the lowest frequency of the topic in a rank.

TABLE 2. FREQUENCY OF TOPICS FOR POSITIVE AND NEGATIVE CONSUMER SATISFACTION RANKS.

Topic #	Topic Label	Negative Ranks		Positive Ranks	
		Rank 1	Rank 2	Rank 4	Rank 5
1	Order delivery to consumers	*****	*****	****	****
2	Online ordering and service	**	*	*****	*****
3	Item variety and availability for ordering	****	****	*	*
4	Picking and packing of ordered items	***	***	***	***
5	Order and delivery price	*	**	**	**

As can be seen from Table 2, the three most related topics for the positive Rank4 and Rank5 are (in descending order): “Topic 2. Online ordering and service,” “Topic 1. Order delivery to consumers,” and “Topic 4. Picking and packing of ordered items.” This leads to an important conclusion that the positive consumer satisfaction of online grocery retailing is typically associated with online ordering and service, order delivery to consumers, and picking and packing of ordered items.

For the negative Rank1 and Rank2, the three most frequent topics (in descending order) are: “Topic 1. Order delivery to consumers,” “Topic 3. Items variety and availability for ordering,” and “Topic 4. Picking and packing of ordered items.” This result indicates that negative consumer reviews and their low consumer satisfaction rankings are associated with order delivery to consumers and picking/packing of ordered items as well as with items variety and availability for ordering. Surprisingly, from the standpoint of consumer satisfaction, the order and delivery price topic appeared to be the least important among the five main topics in the analyzed consumer reviews.

3.4. Polarity and Subjectivity of Consumer Reviews and Their Consumer Satisfaction

The third objective (c) of this research is to recognize relationships between polarity and subjectivity of consumer reviews and associated

consumer satisfaction. For this, we applied *text sentiment analysis*, which is a method of capturing the sentiment (feeling or opinion) of people towards a specific topic (Kautish and Kaur 2017). The *TextBlob* technique of sentiment analysis is utilized for the two sentiment labels of polarity and subjectivity, which are common labels to analyze consumer opinions and emotions. In Python’s TextBlob algorithm, the polarity score is measured between -1 and 1, where -1 defines a completely negative sentiment, and 1 represents a completely positive sentiment. The subjectivity score is measured between 0 and 1; the value of 0 means that it is a fact, and the value of 1 is considered a pure opinion (Sarkar 2019).

Using the previously developed text data corpus, polarity and subjectivity was identified for each consumer satisfaction rank and then plotted in a chart presented in Figure 2. The chart’s x-axis represents the sentiment’s polarity level in terms of the “Negative – Positive” consumer perception. The y-axis describes the subjectivity level using the “Facts – Opinions” scale for consumer reviews.

As can be seen from Figure 2, the sentiment analysis confirms that the lower the polarity (more “negative”) of consumer reviews the lower the consumer satisfaction rank. At the same time, the higher the polarity (more “positive”) of consumer reviews the higher the consumer satisfaction rank will be. This result is quite intuitive and logical, but it is worth noting that neither Rank1 nor Rank5 represents

close to pure negative (-1) or pure positive (+1) sentiment, respectively. It may be due to some negative comments that are absorbed into overall positive consumer reviews. On the

contrary, the negative consumer reviews may still contain some positive consumer comments.

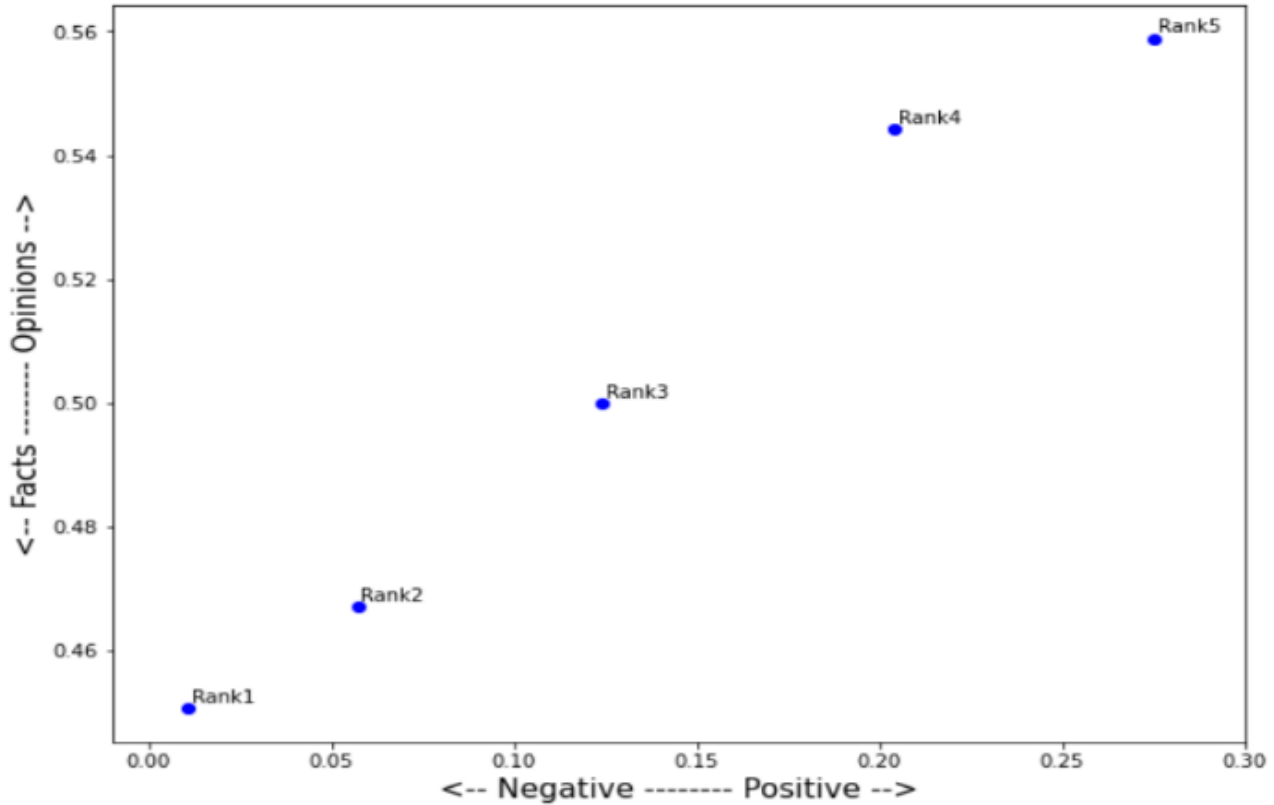


FIGURE 2. SENTIMENT ANALYSIS FOR CONSUMER SATISFACTION RANKS.

The result of analyzing consumer subjectivity versus consumer satisfaction (see Figure 2) demonstrates that more subjective or “opinionated” consumer reviews have a higher consumer satisfaction rank. Contrary to that, the less subjective or more “factual” consumer reviews have a lower consumer satisfaction rank. This research result, which is rather counterintuitive, clearly indicates that reviews with the low consumer satisfaction ranks (Rank1 and Rank2) are more factual (have lower subjectivity) in terms of describing the actual performance of an online grocery retailing process as opposed to the reviews with the high ranks (Rank4 and Rank5).

3.5. Predictive Modelling of Consumer Satisfaction

To analyze relationships between consumer satisfaction and word terms from consumer reviews (objective (d) of this research), we utilized the *Bag of Words (BoW)* method. BoW is a method of text modelling where for each text document the presence of terms is taken into consideration, but the order in which they occur is ignored. The BoW model also incorporates text vectorization by *Term Frequency-Inverse Document Frequency (TF-IDF)* method that produces more reliable BoW by weighing more relevant and less relevant terms in each document (Sarkar 2019). As previously discussed in this section, the n-grams

word terms, i.e., bigrams, trigrams, and quadrigrams, are considered. For the developed BoW with TF-IDF, the *chi2* test (χ^2 -test) is applied to identify word terms (n-grams) that are mostly associated with each of the consumer satisfaction ranks.

Examples of five mostly correlated two-word (bigram) and three-word (trigram) terms in descending order for each consumer satisfaction rank are presented in Table 3. As can be viewed from the table, the bigram and

trigram terms associated with Rank1 are indicative of consumer issues with the online grocery retailing process, e.g., “slow delivery” and “problem fresh” (problem with food freshness) for bigram terms, and “delivery time long” and “call customer service” for trigram terms. Similar types of bigrams and trigrams can be viewed for Rank2 as well.

TABLE 3. EXAMPLES OF FIVE N-GRAM TERMS MOSTLY ASSOCIATED WITH CONSUMER SATISFACTION RANKS (IN DESCENDING ORDER).

##	Rank1 Terms	Rank2 Terms	Rank3 Terms	Rank4 Terms	Rank5 Terms
Bigrams					
1	slow delivery	item unavailable	product availability	fast delivery	order online
2	problem fresh	wait day	credit card	online great	quality grocery
3	order missing	problem produce	mark unavailable	available online	low fee
4	waste time	item lost	frozen food	refund money	extremely convenient
5	arrive late	limited availability	notify delivery	delivery price	item available
Trigrams					
1	delivery time long	call customer service	easy use website	good customer service	great online service
2	call customer service	order arrive late	good customer service	same day refund	easy use website
3	food quality poor	incorrect item pack	food quality poor	good delivery service	items receive fast
4	second time order	frozen food issue	item expensive delivery	half item available	notify delivery quick
5	item never ask	customer service time	item available online	low delivery fee	service fee low

Contrary to Rank1 and Rank2, the highest Rank5 and Rank4 in Table 3 are related to bigrams and trigrams with positive reviews toward the online grocery retailing process. For Rank5, these will be, for example, “order online” (ability to order online) and “quality

grocery” for bigrams, and “great online service” and “easy use website” for trigrams. There were no quadrigrams that significantly correlate with the ranks. Therefore, they are not shown in Table 3, and will not be used in further analysis.

The identified in Table 3 significantly correlated terms (bigrams and trigrams) in consumer reviews are used as *predictor variables* in a classification model that establishes their relationships with the consumer satisfaction rank as the *response variable*. The categorical response variable of consumer satisfaction contains five outcome classes, Rank1 through Rank5, and thus a

multinomial classification model should be applied. In this research, several models are considered – naïve bayes, logistic regression, and random forest – to identify which model gives the highest level of accuracy. The modelling accuracy results of each model are presented in Table 4.

TABLE 4. ACCURACY OF MULTINOMIAL CLASSIFICATION MODELS.

<i>Accuracy Measure</i>	<i>Multinomial Classification Models</i>		
	<i>Naïve Bayes</i>	<i>Logistic Regression</i>	<i>Random Forest</i>
Mean	0.603	0.612	0.483
Standard deviation	0.117	0.152	0.111
Lower level of 95% confidence interval	0.365	0.308	0.263
Upper level of 95% confidence interval	0.833	0.918	0.703

As can be seen from Table 4, the highest average accuracy of 0.612 is with the multinomial logistic regression model, followed by the multinomial naïve bayes (average accuracy of 0.603) and random forest (average accuracy of 0.483) models. The accuracy levels of these models clearly demonstrate the existence of significant relationships between consumer satisfaction ranks and specific terms in consumer reviews. To model such relationships, the multinomial logistic regression model, with the highest average accuracy level, may be utilized. As an alternative, the multinomial naïve bayes model may also be considered in this case.

IV. CONCLUSIONS

Our main objectives of this research were to identify relationships between consumer reviews of online grocery retailing, including positive and negative reviews, and elements of the online grocery retailing process. The main objectives also included finding associations between polarity and subjectivity of these consumer reviews and related

consumer satisfaction, and, in addition, identifying quantitative relations between consumer satisfaction and the textual terms in consumer reviews.

Through literature review we revealed important attributes (elements) of the online grocery retailing process such as website experience, variety and availability of products, price values, picking and packing of orders, and timely delivery. Through reviewing the extant literature sources, we identified complexities and challenges in the online grocery retailing process. However, the direction and the strength of relationships between the online grocery process and consumer satisfaction of this process are not analyzed in these studies. The literature review also demonstrated that consumer perception and subjectivity could have a substantial impact on consumer satisfaction in online grocery retailing. All research articles on online grocery retailing and its consumer satisfaction have utilized consumer survey data. We also identified that, surprisingly, online consumer reviews posted on various consumer research and social media websites are not employed in analyzing

consumer satisfaction in online grocery retailing. We consider the lack of utilization of online consumer reviews as a major gap in the existing research on consumer satisfaction in online grocery retailing that was addressed in this paper.

Our research methodology was based on the four objectives stated in the *Methodology* section of this paper. They include: (a) relating online consumer reviews to elements of the online grocery retailing process; (b) identifying relationships between positive and negative consumer satisfaction and these elements of the online grocery retailing process; (c) recognizing relationships between polarity and subjectivity sentiments of consumer reviews and consumer satisfaction; and (d) identifying quantitative relationship between consumer satisfaction and word terms in online consumer reviews. The data collection of online consumer reviews and consumer satisfaction was done for Walmart, Amazon, and Instacart, the three largest online grocery retailing companies. The consumer reviews of the online grocery retailing from the specified companies were retrieved from the open-source online research, product reviews, and social media websites for a 5-year period from 2017 through 2021. For addressing the research objectives, several methods and algorithms of text mining analytics, sentiment analysis, and predictive analytics were applied using a variety of Python-based software libraries.

By utilizing the research methodology with the specified methods and software, we achieved several important results in this research that contribute to the theory and practice of the online grocery retailing process and its consumer satisfaction. *First*, we identified that online consumer reviews can be grouped into five clusters of word terms (bigrams and trigrams) that can clearly relate consumer reviews to the specific elements of the online grocery retailing process, i.e., (1) order delivery to consumers; (2) online ordering and service; (3) item variety and availability for

ordering; (4) picking and packing of ordered items; and (5) order and delivery price. *Second*, for the positive consumer satisfaction in online consumer reviews, the most related and influential elements of the online grocery retailing process were (in descending order): online ordering and service, order delivery to consumers, and picking and packing of ordered items. *Third*, we also identified that for the negative consumer satisfaction in online consumer reviews, the most related and influential elements of the online grocery relating process were (in descending order): order delivery to consumers, item variety and availability for ordering, and picking and packing of ordered items. In addition, the order and delivery price, as an element of the online grocery retailing, appeared to be the least important among the five main retailing elements for the analyzed positive and negative consumer satisfaction in online consumer reviews.

Fourth, we recognized that the higher the polarity of consumer reviews, the higher the consumer satisfaction will be. In addition, the overall polarity sentiment cannot be pure negative or pure positive for an online grocery retailing process due to the negative consumer reviews that may include some positive comments, and vice versa, the positive consumer reviews that may contain some negative comments. *Fifth*, we identified that online consumer reviews with low consumer satisfaction are less subjective and thus more factual in describing the actual performance of an online grocery retailing process than the reviews with high consumer satisfaction. *Finally*, we developed the multinomial logistic regression model to identify consumer satisfaction ranks based on significantly correlated word terms (bigrams and trigrams) identified in online consumer reviews.

Based on the results of this research, we produced several important practical directions for managing and improving consumer satisfaction in online grocery retailing. *First*, to

increase consumer satisfaction, managers should initially concentrate on improving the most negative to consumers elements of the online grocery retailing process, i.e., order delivery to consumers, items variety and availability for online ordering, and picking and packing of ordered items. *Second*, in improving consumer experience with an online grocery retailing process, managers need to pay more attention on negative consumer reviews with a low consumer satisfaction as they tend to be more factual (credible) than the reviews with a high satisfaction. *Third*, a consumer satisfaction ranking for an online grocery retailing review, if not available, can be predicted by utilizing a multinomial logistic regression model that connects consumer satisfaction ranks with most correlated word terms associated with online consumer reviews.

Despite an extensive number of contributions and practical results achieved in this research, it still contains some limitations. In particular, this research does not involve the comparison of online grocery retailing processes and consumer satisfaction using different supply chain models, i.e., pure-play retailers like Amazon Fresh, third-party logistics like Instacart, and traditional brick-and-mortar retailers, e.g., Walmart. In addition, the replication of this research with different samples of consumer reviews is necessary to further ascertain and confirm the finding of this study. These limitations can potentially become the basis for future expansion of the research provided in this paper.

REFERENCES

- Abbu, H., Fleischmann, D., and Gopalakrishna, P., 'The Case of Digital Transformation in Grocery Business: A Conceptual Model of Digital Grocery Ecosystem', *2021 IEEE International Conference on Engineering, Technology and Innovation*, 2021, 1-9.
- Amorim, P. and Dehoratius, N., "Online Shoppers Don't Always Care About Faster Delivery", *MIT Sloan Management Review*, Fall, 2021, 12-14, <https://sloanreview.mit.edu/article/online-shoppers-dont-always-care-about-faster-delivery/> (accessed December 13, 2022).
- Bengfort, B., Bilbro, R., and Ojeda, T., *Applied Text Analysis with Python*, O'Riley Media, Inc., 2018.
- Benn, Y., Webb, T.L., Chang, B.P.I., and Reidy, J., "What information do consumers consider, and how do they look for it, when shopping for groceries online?", *Appetite*, 89, 2015, 265-273.
- Benner, C., Mason, S., Carré, F., and Tilly, C., "Delivering Insecurity: E-commerce and the Future of Work in Food Retail", *Berkeley: UC Berkeley Labor Center and Working Partnerships USA*, 2020, <https://laborcenter.berkeley.edu/delivering-insecurity/> (accessed October 21, 2023).
- Blut, M., Chowdhry, N., Mittal, V., and Brock, C., "E-Service Quality: A Meta-Analytic Review", *Journal of Retailing*, 91(4), 2015, 679-700.
- Chopra, H., "Key Features To Consider While Developing An Online Grocery App", 2023, <https://www.uengage.in/spotlight/features-of-grocery-app> (accessed May 24, 2024).
- Droesch, B., "US Digital Grocery 2024: On Pace to Become the Largest Ecommerce Category", *eMarketer*, 2024, <https://www.emarketer.com/content/us-digital-grocery-2024#page-report> (accessed June 1, 2024).
- Fisher, S. "The 8 Best Online Grocery Shopping Sites in 2021", 2021, <https://www.lifewire.com/groceries->

- online-3482646 (accessed February 13, 2023).
- Frank, D.A. and Peschel, A.O., “Sweetening the Deal: The Ingredients that Drive Consumer Adoption of Online Grocery Shopping”, *Journal of Food Products Marketing* 26(8), 2020, 535-544.
- Fuentes, C., Samsioe, E., and Backe, J.Ö., “Online food shopping reinvented: developing digitally enabled coping strategies in times of crisis”, *The International Review of Retail, Distribution and Consumer Research*, 32(2), 2022, 130-150.
- Harris, P., Riley, F.D., Riley, D., and Hand, C., “Online and store patronage: a typology of grocery shoppers”, *International Journal of Retail & Distribution Management*, 45(4), 2017, 419-445.
- Hübner, A., Kuhn, H., and Wollenburg, J., “Last mile fulfilment and distribution in omni-channel grocery retailing”, *International Journal of Retail & Distribution Management*, 44(3), 2017, 228-247.
- Huet, E. and Chapman, L., “Instacart’s Frantic Dash from Grocery App to Essential Service”, 2020, <https://www.bloomberg.com/news/features/2020-05-06/instacart-was-overwhelmed-by-coronavirus-overnight> (accessed October 25, 2022).
- Insider Intelligence, “The 5 best online grocery delivery stores for 2021”, 2021, <https://www.insiderintelligence.com/insights/best-online-grocery-stores/>, (accessed June 24, 2023).
- Jelodar, H., Wang, Y., Yuan, C., Feng, X., Jiang, X., Li, Y., and Zhao, L., “Latent Dirichlet allocation (LDA) and topic modeling: models, applications, a survey”, *Multimedia Tools and Applications*, 78, 2019, 15169-15211.
- Kautish, S. and Kaur, R., *Sentiment Analysis – From Theory to Practice*, LAP LAMBERT Academic Publishing, 2017.
- Kishore, G., “eGrocery Business Models to Lunch a Grocery Business”, 2023, <https://www.fatbit.com/fab/different-business-models-to-launch-online-grocery-business/> (accessed May 22, 2024).
- Klepek, M. and Bauerová, R., “Why Do Retail Customers Hesitate for Shopping Grocery Online?”, *Technological and Economic Development of Economy*, 26(6), 2020, 1444-1462.
- Kolesova, S. and Singh., R., “One Vs. Many: who wins? An empirical investigation of online product display”, *The International Review of Retail, Distribution and Consumer Research*, 29(3), 2019, 285-305.
- Kühna, F., Lichters M., and Krey, N., “The touchy issue of produce: Need for touch in online grocery retailing”, *Journal of Business Research*, 117, 2020, 244-255.
- Ladd, B., “How Grocery Retailers Can ‘Win the Porch’ for Online Grocery Delivery”, *Forbes*, 2020, <https://www.forbes.com/sites/forbescommunicationscouncil/2020/12/17/how-grocery-retailers-can-win-the-porch-for-online-grocery-delivery/?sh=3841aae25e31> (accessed November 2, 2022).
- Mercator Research, “Online Grocery: Grocers Meet the Challenge of Digital Demand, but Can They Do It at a Reasonable Cost?”, 2023, https://www.mercatoradvisorygroup.com/Reports/Online-Grocery--Grocers-Meet-the-Challenge-of-Digital-Demand_-but-Can-They-Do-It-at-a-Reasonable-Cost_ / (accessed May 2, 2023).
- Mkansi, M., Eresia-Eke C., Emmanuel-Ebikake, O., and Liu, S., “E-grocery challenges and remedies: Global

- market leaders perspective”, *Cogent Business & Management*, 5, 2018, 1-28.
- Monoarfa, T. A., Sumarwan, U., Suroso, A. I., and Wulandari, R., “Uncover the trends, gaps, and main topics on online grocery shopping: Bibliometric analysis”, *Helion*, 10(4), 2024, 1-18.
- Mortimer, G., Hasan, S. F. E., Andrews, L., and Martin, J., 2016. “Online grocery shopping: The impact of shopping frequency on perceived risk”, *The International Review of Retail, Distribution and Consumer Research*, 26(2), 2016, 202–223.
- Mukherjee, S., “Top roadblocks in the online grocery shopping journey”, 2019, <https://www.digitalcommerce360.com/2019/05/29/top-roadblocks-in-the-online-grocery-shopping-journey/> (accessed July 19, 2022).
- Oracle Retail, “Retail Shopper Outlook: Consumer Research 2022”, <https://www.oracle.com/a/ocom/docs/industries/retail/retail-consumer-research-2022.pdf> (accessed May 28, 2024).
- Redman, R., “Amazon tops H-E-B, Trader Joe’s on dunnhumby grocery retailer index”, 2021, <https://www.supermarketnews.com/retail-financial/amazon-tops-h-e-b-trader-joe-s-dunnhumby-grocery-retailer-index> (accessed November 10, 2022).
- Sarkar, D., *Text Analytics with Python: A practitioner’s Guide to Natural Language Processing*, Second edition, Apress Publisher, 2019.
- Singh, J.P., Irani, S., Rana, N. P., Dwivedi, Y. K. and Saumya, S., “Predicting the "helpfulness" of online consumer reviews”, *Journal of Business Research*, 70, 2017, 346-355.
- Singh, R., “Why do online grocery shoppers switch or stay? An exploratory analysis of consumer’ response to online grocery shopping experience”, *International Journal of Retail & Distribution Management*, 47(12), 2019, 1300-1317.
- Singh, R. and Soderlund, M., “Extending the experience construct: an examination of online grocery shopping”, *European Journal of Marketing*, 54(10), 2020, 2419-2446.
- Singh, R. and Söderlund, M., “There is no place like home: home satisfaction and customer satisfaction in online grocery retailing”, *The International Review of Retail, Distribution and Consumer Research*, 32(4), 2022, 370-387.
- Strailey, J., “Price Trumps Speed in Online Grocery, New Study Shows”, 2020, <https://www.winsightgrocerybusiness.com/retailers/price-trumps-speed-online-grocery-new-study-shows> (accessed December 16, 2023).
- Tian, X., He, W., Tang, C., Li, L., and Xu, H., “A new approach of social media analytics to predict service quality: evidence from the airline industry”, *Journal of Enterprise Information Management*, 34(1), 2020, 51-70.
- Wang, F., Liu, X., and Fang, E., “User Reviews Variance, Critic Reviews Variance, and Product Sales: An Exploration of Customer Breadth and Depth Effects”, *Journal of Retailing*, 91(3), 2015, 372-389.
- Zhao, Y., Xu, X., and Wang, M., “Predicting overall customer satisfaction: Big data evidence from hotel online textual reviews”, *International Journal of Hospitality Management*, 76(Part A), 2019, 111-121.