

A Customer Satisfaction Evaluation Method of the Power Company Using Sentiment Analysis

WenHao Ou¹, Shi Shen^{2,3,+}, Wei Xia⁴, BinBin Zhao¹, Gang Yang⁵, LinJie Bai⁶, JianGuo Ma⁷

¹ Power transformer engineering research institute, China Electric Power Research Institute, Beijing

² Key Laboratory of Environmental Change and Natural Disaster, Beijing Normal University, Beijing, China

³ Center for Geodata and Analysis, Faculty of Geographical Science, Beijing Normal University, Beijing, China

⁴ Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, Beijing, China

⁵ State Grid Shanxi Electric Power Company, Taiyuan, Shanxi 030001, China

⁶ State Grid Hebei Electric Power Company, Shijiazhuang, Hebei 050021, China

⁷ State Grid Hubei Electric Power Company, Wuhan, Hubei 430077, China

Abstract. This study proposes a method for improving customer satisfaction evaluation of power supply enterprises using sentiment analysis. First, a corpus of comments and posts about power supply enterprise is generated. Second, several machine learning algorithms are used to extract features from the corpus. Finally, the best classifier is used to evaluate the work of a company through the comments and reviews. The experiment shows that Multinomial naive Bayes is more appropriate for clustering the sentiment of Weibo posts. And this approach can benefit the power supply companies to improve their service.

Keywords: customer satisfaction evaluation, sentiment analysis, power supply

1. Introduction

Customer satisfaction (CS) is the direct assessment of the service quality of enterprises whose core value is to provide high-quality service. Several methods that are based on surveys and questionnaires are known and applied studies used to evaluate customer satisfaction. Medjoudj et al. analyzed customer satisfaction and profit making using the analytic hierarchy process (AHP), the cost benefit analysis (CBA), and the economic criteria inspired by the game theory (ECIGT) [1]. Lin et al. applied Kano customer satisfaction model to explore the customer satisfaction of an electric power company [2]. Huo and Li made an empirical analysis of the impact of corporate image and customer expectation on customer satisfaction [3].

However, due to the design of questioners and the unwillingness of customers, it is difficult to timely collect customer satisfaction in order to achieve better service. Moreover, customers are likely to hide their real feelings and opinions in surveys conducted by the power supply companies. Hence, previous methods of evaluating customer satisfactions limit to the time effectiveness of data collection and reliability of customers' assessment.

Meanwhile, social media (e.g., Twitter, Facebook, and Weibo) have become an important platform that converges various information, including customers' opinions and comments. This provides an opportunity to evaluate customer satisfaction of the power supply enterprises from the perspective of customers' real feelings. The crucial problem is analyzing affective aspects of customers' options and attitude which can be done through sentiment analysis (SA).

⁺ Corresponding author.

E-mail address: shens@mail.bnu.edu.cn.

Sentiment analysis, also known as opinion mining (OM), focuses on analyzing opinions, sentiments, and emotions from text [4]. This method has been widely applied in various fields. Bollen et al. investigated the relationship between mood states derived from large-scale tweets and the value of the Dow Jones Industrial Average (DJIA) [5]. Daniel et al. used sentiment analysis of tweets published by the financial community to detect the company event popularity [6]. Li and Wu detect and forecast hotspot of online forums using sentiment analysis and text mining approaches [7].

This study aims to propose a method to evaluate customer satisfaction using sentiment analysis. This method is divided into two stages: emotional customer satisfaction index construction and sentiment analysis based on Naïve Byes and Support Vector Machine (SVM). Comments and reviews of customers are collected from the biggest Chinese social media platform Weibo.

The rest of this paper is structured as follows. Section 2 addressed related work of using sentiment analysis to evaluate customer satisfaction. Section 3 presents the methodology and models. Section 4 introduces and analyses an application of the proposed method. Finally, section 5 summarized this study and supplies conclusion and the proposal of future work.

2. Related work

2.1. Sentiment analysis on customer satisfaction

Websites, social media and mobile phone applications greatly extend data sources and information containing opinions and views. Thus, organizations, companies, and marketers are able to truthfully evaluate the customer satisfaction through the user generated contents. The Miranda and Sassi used sentiment analysis to analyze in an online job search company [8]. Kang and Park combined sentiment analysis and VIKOR to investigate customer reviews for monitoring customer satisfaction with mobile services [9]. Vidya et al. measured mobile phone providers' brand reputation according to customer satisfaction through the sentiment analysis of tweets [10]. Farhadloo et al. used a Bayesian approach modeling the overall customer satisfaction based on the semi-structured opinions which are transformed by aspect-level sentiment analysis [11]. Li et al. simultaneously extracted and groups aspects through a topic model and then calculated sentiment ration based on opinion mining [12]. However, few studies on customer satisfaction of power supply companies using sentiment analysis are conducted.

2.2. Chinese social media platform (Weibo)

Weibo, which is the most popular social media platform in China has attracted the attention in analyzing it content using sentiment analysis. Zhao et al. presented a Social Sentiment Sensor system based on Weibo in order to detect hot topics and public opinions [13]. The relation Weibo moods and emotion states were also used to predict the stock market in China [14, 15]. Customer opinions and views are mined and analyzed based on context Weibo data. For example, Mou and Du evaluate movie reviews sentimental aspects with emotional lexicon and Chinese language features [16]. Zhang et al. proposed an analytic framework to predict the hidden opinion orientations of users according to their relationships with people whose opinions are explicitly extracted by sentiment analysis [17].

3. Method

The method proposed in this studies is mainly composed of three steps: Weibo posts collection and cleansing, text sentiment analysis and customer classification index calculation based on emotion states. Figure 1 depicts the conceptual diagram of the approach.

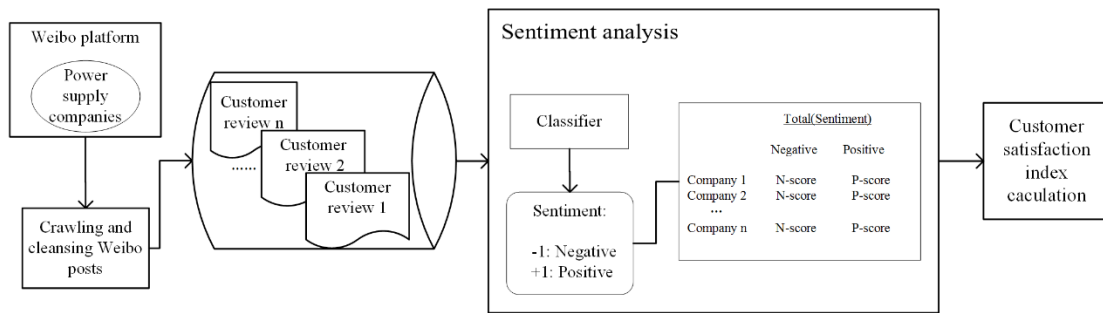


Fig. 1: The diagram of the approach of customer satisfaction evaluation using sentiment analysis

Weibo post collection, that is used to generate customers' reviews and opinions, is retrieved from the Sina Weibo platform. Since the raw data of Weibo posts contain various noisy characters, for example, users' emotion icons, hashtags, it is necessary to cleanse the raw data to prepare for sentiment analysis. On the other hand, a post of Weibo is usually no more than 140 Chinese characters. The information contained in a post is low density and sparse. Hence, how to identify the feelings and emotion users express through Weibo is difficult.

In this study, sentiment analysis is utilized to solve the problem. The challenge of sentiment analysis is to apply the suitable classifier to identify the sentiment of a customer review. The corpus used in this study consist of 10,000 positive posts and 10,000 negative posts which represent common customer reviews and comments. Before training, the developing dataset is randomized. 80% of the corpus is used as developing dataset for training and testing the classifier model. The rest of the corpus is applied for computing the accuracy of the corresponding classifier. The experiment result of the four classifiers is shown in Table 1.

Table 1: Comparison of four classifier

Classifier	Accuracy	Avg Precision	Avg Recall	Avg F-score
Bernoulli naive Bayes(BNB)	0.925	0.93	0.93	0.92
Multinomial naive Bayes(MNB)	0.9375	0.94	0.94	0.94
Logistic Regression(LR)	0.9300	0.93	0.93	0.93
Support Vector Machine(SVM)	0.8900	0.90	0.89	0.89

Table 1 indicates that the Multinomial naïve Bayes classifier has the highest accuracy, average precision, average recall and average f-score. Hence, in this study, the MNB is applied in the following sentiment identification. We examined 67 Weibo posts on discussing the Beijing State Grid Company. Part of the result of the examination is listed in Table 2.

Table 2: Identification of 20 Weibo posts on Beijing state grid company

Probability of negative	Probability of positive	Class Label	Artificial Identification
0.41062	0.58937	Positive	Positive
0.00028	0.99972	Positive	Positive
0.00022	0.99978	Positive	Positive
0.48987	0.51013	Positive	Positive
0.00134	0.99866	Positive	Positive
0.00517	0.99483	Positive	Positive
0.72623	0.27378	Negative	Positive
0.41252	0.58748	Positive	Positive
0.00173	0.99827	Positive	Positive
0.00072	0.99927	Positive	Positive
0.26565	0.73435	Positive	Negative
0.80484	0.19516	Negative	Negative
0.41063	0.58937	Positive	Negative
0.68332	0.31668	Negative	Negative

0.99813	0.00187	Negative	Negative
0.99988	0.00012	Negative	Negative
0.02196	0.97804	Positive	Negative
1	0	Negative	Negative
0.80484	0.19516	Negative	Negative
0.69943	0.30057	Negative	Negative

Overall, the false identification of positive posts is one in 12. In contrast, the false identification of negative posts is 14 in 55. The accuracy of positive posts 0.9167 is approximate to the classifier accuracy. Although the accuracy of negative posts 0.7455 is lower than the classifier accuracy. The results prove this approach is a possible and useful way to improve customer satisfaction evaluation.

4. Discussion

The will of customers delivering a positive Weibo post has not taken into account. Since people have stronger willing to complain, grumble and criticize companies in social media, the weight of positive and negative sentiment should be investigated. Moreover, the negative posts also provide the power supply companies to find out the weakness of their services.

This work presents an approach to improving the customer satisfaction evaluation using sentiment analysis. The experiment of four classifiers indicates that Multinomial naive Bayes model is the best candidate for identifying sentiment of Weibo posts on power supply companies. The examination experiment shows that the accuracy of positive post identification is better than negative. This is ascribed to the lack of enough samples and the low density of information in Weibo posts. Future studies should focus on enriching the corpus of customer reviews on power companies and improve the classifier’s accuracy.

5. Acknowledgements

This work was supported by a grant from the science and technology project of State Grid (Research and application of special geological structure in mining area of transmission line corridor based on small radar; Research on data processing theory and methods of the auxiliary lines selection based on satellite remote sensing image; Research and application on intelligent monitoring and early warning technology of geological hazard for power transmission line based on InSAR)

6. References

- [1] R. Medjoudj, D. Aissani, and K. D. Haim, “Power customer satisfaction and profitability analysis using multi-criteria decision making methods,” *Int. J. Electr. Power Energy Syst.*, vol. 45, no. 1, pp. 331–339, 2013.
- [2] S. Lin and D. Niu, “Empirical study on electric power customer satisfaction based on Kana model,” in *Proceedings - 2009 IITA International Conference on Services Science, Management and Engineering, SSME 2009*, 2009, pp. 136–139.
- [3] Y. Huo and L. Xu, “The impact of corporate image and customer expectation on customer satisfaction: An empirical study in power supply industry,” in *2010 International Conference on Management and Service Science, MASS 2010*, 2010, p. IEEE Wuhan Section; Sichuan University; Wuhan Univ.
- [4] B. Liu, *Sentiment analysis and subjectivity*, vol. 30, no. 36. BOCA RATON: CRC PRESS-TAYLOR & FRANCIS GROUP, 2010.
- [5] J. Bollen, H. Mao, and X. Zeng, “Twitter mood predicts the stock market,” *J. Comput. Sci.*, vol. 2, no. 1, pp. 1–8, 2011.
- [6] M. Daniel, R. F. Neves, and N. Horta, “Company event popularity for financial markets using Twitter and sentiment analysis,” *Expert Syst. Appl.*, vol. 71, pp. 111–124, 2017.
- [7] N. Li and D. D. Wu, “Using text mining and sentiment analysis for online forums hotspot detection and forecast,” *Decis. Support Syst.*, vol. 48, no. 2, pp. 354–368, 2010.
- [8] M. D. Miranda and R. J. Sassi, “Using Sentiment Analysis to Assess Customer Satisfaction in an Online Job Search Company,” in *Business Information Systems Workshops: BIS 2014 International Workshops*, Larnaca,

Cyprus, May 22-23, 2014, Revised Papers, W. Abramowicz and A. Kokkinaki, Eds. Cham: Springer International Publishing, 2014, pp. 17–27.

- [9] D. Kang and Y. Park, “Review-based measurement of customer satisfaction in mobile service: Sentiment analysis and VIKOR approach,” *Expert Syst. Appl.*, vol. 41, no. 4 PART 1, pp. 1041–1050, 2014.
- [10] D. Kang and Y. Park, “Measuring customer satisfaction of service based on an analysis of the user generated contents: Sentiment analysis and aggregating function based MCDM approach,” in *2012 IEEE 6th International Conference on Management of Innovation and Technology, ICMIT 2012*, 2012, pp. 244–249.
- [11] M. Farhadloo, R. A. Patterson, and E. Rolland, “Modeling customer satisfaction from unstructured data using a Bayesian approach,” *Decis. Support Syst.*, vol. 90, pp. 1–11, 2016.
- [12] Z. Li, L. Liu, and C. Li, “Analysis of customer satisfaction from Chinese reviews using opinion mining,” in *Proceedings of the IEEE International Conference on Software Engineering and Service Sciences, ICSESS, 2015*, vol. 2015–November, pp. 95–99.
- [13] Y. Zhao, B. Qin, T. Liu, and D. Tang, “Social sentiment sensor: a visualization system for topic detection and topic sentiment analysis on microblog,” *Multimed. Tools Appl.*, vol. 75, no. 15, pp. 8843–8860, 2016.
- [14] Z. Zhou, J. Zhao, and K. Xu, “Can Online Emotions Predict the Stock Market in China?,” in *Web Information Systems Engineering -- WISE 2016: 17th International Conference, Shanghai, China, November 8-10, 2016, Proceedings, Part I*, W. Cellary, M. F. Mokbel, J. Wang, H. Wang, R. Zhou, and Y. Zhang, Eds. Cham: Springer International Publishing, 2016, pp. 328–342.
- [15] M. ZHU, H. JIANG, and X. Wei, “Weibo moods and propagation factors based stock prices prediction,” *J. SHANDONG Univ. Sci.*, vol. 51, no. 11, p. 12, 2016.
- [16] X. Mou and Y. Du, “Sentiment classification of Chinese movie reviews in micro-blog based on context,” in *2016 IEEE International Conference on Cloud Computing and Big Data Analysis (ICCCBDA)*, 2016, pp. 313–318.
- [17] L. Zhang, H. Yuan, and R. Y. K. Lau, “Predicting and Visualizing Consumer Sentiments in Online Social Media,” in *2016 IEEE 13th International Conference on e-Business Engineering (ICEBE)*, 2016, pp. 92–99.