

Chapter 2

Development and Application of Machine Learning Algorithms for Sentiment Analysis in Digital Manufacturing: A Pathway for Enhanced Customer Feedback

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ABSTRACT

Customer input has increased as digital manufacturing and smart factories advance. However, standard analysis methods struggle to turn this feedback into useful insights. This research study examined the use of machine learning (ML) sentiment analysis algorithms to improve digital manufacturing customer feedback interpretation. Machine learning, sentiment analysis, and digital industrialization theories underpin the research. Sentiment analysis may reveal nuanced consumer feedback insights that traditional methods miss, according to customer experience management and complex data analytics theories. A specially constructed ML system for sentiment analysis was used to real-world customer feedback data from numerous digital manufacturing enterprises in a case study. This method classified feedback sentiment using natural language processing. The program picked up small changes in client emotions that previous methods missed. These findings imply that machine learning-based sentiment analysis improves digital manufacturing customer feedback interpretation.

DOI: 10.4018/979-8-3693-0920-9.ch002

INTRODUCTION

The advent of digital manufacturing and the subsequent development of smart factories have irrevocably altered the dynamics of the modern industrial landscape. These transformative shifts in manufacturing technologies have not only streamlined operational efficiencies but also have brought about a paradigm change in customer engagement (Schwab, 2016). As customer interaction becomes increasingly digital, the sheer volume of feedback that organizations receive has seen an unprecedented surge. Given the centrality of customer feedback for continuous improvement and innovation in products and services, it is crucial for organizations to adopt sophisticated analytical tools that can decipher this feedback into actionable insights (Baines et al., 2017). Unfortunately, the conventional methods employed for customer feedback interpretation in digital manufacturing are not adequately equipped to handle this burgeoning volume of data. These methods—ranging from simple surveys to manual content coding—are inherently limited in their scope and granularity (Smith & Osborne, 2007). The results derived from these techniques often suffer from bias, incompleteness, and a lack of nuance, thereby failing to represent the complexity of customer sentiment in the era of smart factories (Kelle, 2006).

Consequently, there is a growing consensus among scholars and practitioners alike about the necessity for more advanced analytical tools (Liu, 2012). One promising avenue that has emerged in this context is the application of machine learning algorithms for sentiment analysis. Originally a subfield within Natural Language Processing (NLP), sentiment analysis has proven to be remarkably effective in various domains for analyzing textual data to gauge the underlying sentiment or emotion (Pang & Lee, 2008). Research in the domains of finance, healthcare, and retail has already demonstrated the robustness of machine learning-based sentiment analysis in capturing nuanced emotions and sentiments (Mao et al., 2014; Denecke & Nejd, 2009). Intriguingly, despite the promising potential, the convergence of machine learning, sentiment analysis, and digital manufacturing remains a relatively unexplored frontier. A handful of studies have attempted to touch upon this intersection, but they have largely been isolated in their focus, either emphasizing solely on the technical aspects of machine learning algorithms or dwelling on the managerial implications of customer feedback (Kusiak, 2018; Lemon & Verhoef, 2016). The broader interdisciplinary dialogue that situates machine learning-based sentiment analysis within the operational and strategic imperatives of digital manufacturing is notably absent.

Thus, the purpose of this research is to rigorously investigate the development and application of machine learning algorithms for sentiment analysis in the specific context of digital manufacturing. The objective is not merely to add another computational tool to the analytical toolkit of digital manufacturing firms but to fundamentally question and enrich our understanding of customer feedback interpretation in this digital age. Guided by theories of digital industrialization, customer experience management, and complex data analytics, this research posits that machine learning-based sentiment analysis could potentially unearth granular, nuanced insights from customer feedback, which are often overlooked by conventional methods (Porter & Heppelmann, 2014; Meyer & Schwager, 2007; Chen et al., 2012). The ensuing research will adopt a case study approach, incorporating both qualitative and quantitative data from real-world digital manufacturing companies. By applying a specially designed machine learning algorithm for sentiment analysis to this data, this research aims to offer an empirical validation of the algorithm's efficacy in capturing customer sentiments. In doing so, it endeavors to provide a comprehensive, multi-dimensional view that integrates technical proficiency with strategic insight, thereby contributing to a richer, more informed discourse on customer-centric approaches in digital manufacturing and smart factories.

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