



# Social media analytics for quality surveillance and safety hazard detection in baby cribs



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## ABSTRACT

Defects in baby cribs and related products can cause injuries and deaths, and they cost manufacturers and distributors millions of dollars in fines and legal fees and even more in losses of sales and brand image. There has been no prior research regarding automated defect discovery from online reviews of baby cribs, and prior safety defect discovery methods designed and calibrated for other industries must be adapted. We aim to determine which words and phrases are indicators of defects in online reviews and whether sentiment analysis is sufficient for automated defect discovery in the baby crib industry. We find that sentiment analysis serves as a useful tool for automated defect discovery in the baby crib industry and create a supplementary set of “smoke terms” that are strong indicators of safety defects in online reviews of baby cribs. Using our term-based scoring method, we observe a 59% improvement in precision and a 60% improvement in recall when compared to the top-performing prior sentiment method. Our findings provide actionable insights into how analysis of online reviews and other social media can improve baby crib quality management techniques. These terms can be used with immediate effect to monitor and more rapidly identify defects and rectify them before injuries or deaths occur.

## 1. Introduction

Baby crib safety and defects are a major concern for families, crib manufacturers and distributors. Regulators and consumers are very sensitive to potential safety risks and therefore even just a few cases of defects or safety hazards can lead to a mass recall, costing companies millions of dollars and causing consumers losses of time, money, and peace of mind. Between 1990 and 2008, an estimated 181,654 children younger than two years of age were treated in emergency departments in the United States for injuries related to cribs, playpens, and bassinets, 83.2% of which involved cribs (Yeh, 2011). Between January and September of 2015, there were 6 separate recalls of baby cribs and crib mattresses cited by the Consumer Product Safety Commission (CPSC), involving more than 300,000 individual units (CPSC, 2015). In 2009, the CPSC recalled 2.1 million “drop-down” cribs made by Stork Craft after it was found that they could trap and sometimes injure or kill children. These cribs were sold by many major retailers, such as Amazon, Target, Sears, and Wal-Mart (Smith and Rooney, 2009). In addition to suffering from a tarnished reputation, the manufacturer was required to provide consumers with free repair kits for the cribs, and

pay for legal fees.

The industry currently attempts to self-regulate to avoid mass recalls such as the Stork Craft example. After the 2009 incident, companies such as Toys R Us phased out drop-down cribs, while other companies started manufacturing different types or tried to improve their designs. Companies also frequently recall their own products due to safety concerns and often offer free repairs or replacements for faulty products.

Prior work in hazard discovery from online reviews has studied other industries, such as motor vehicles (Abrahams et al., 2015; Abrahams et al., 2012) and children's toys (Winkler et al., 2016). Academic research regarding crib defect discovery has been minimal, though companies have likely done their own industrial research into the subject. This paper will attempt to provide a more proactive method for finding baby crib safety concerns by analyzing online consumer reviews. Using this methodology, firms can potentially find possible defects or safety concerns while they are relatively small in magnitude and avoid huge scandals and recalls.

This paper is structured as follows. First, we motivate the need for crib quality management research targeted specifically at defect

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discovery from online reviews. Next, we discuss related work. We describe our contributions and the research questions we aim to address. We lay out our process for quality surveillance in the crib industry through consumer review analysis. We discuss and evaluate the application of our crib defect discovery and classification approach using a large data set of Amazon reviews. Finally, we summarize our conclusions and propose further research.

## 2. Background and related work

In this section, we discuss related work on sentiment analysis, electronic word of mouth, text mining, and quality management. We then review the coverage and limitations of this prior work.

### 2.1. Sentiment analysis

Sentiment analysis is a process that allows users to mine text and find out whether the emotion of the content is positive or negative by, for instance, comparing each word to a lexicon of positive and negative words. Abbasi et al. examined online forum messages to determine their sentiment (positive or negative) (Abbasi et al., 2008). This method can be used to determine which features of a product cause dissatisfaction in customers, which can then be used to identify product defects. Other studies have applied this methodology to financial markets to predict volatility (Antweiler and Frank, 2004).

Some in the sentiment analysis field presume that postings with a high negative valence indicate a defect in the product. However, this is not always the case, as sometimes a posting that is largely negative may merely report a nuisance or poor product design rather than an actual defect in the product. Particularly in the case of baby cribs, parents of young children are often very stressed, and this could lead to a great deal of sentiment polarity in their comments, even if the problem with the product is not a large or generalizable issue outside of their particular context.

Due to these drawbacks, generic sentiment polarity analysis may not yield proper results when applied to baby cribs. A reviewer might post a seemingly more negative comment about a bad assembly manual than a defect with a hinge if it did not directly affect their child. Therefore, defects must be prioritized based on their potential safety threat: a major defect, such as a crib that is prone to collapsing, must be differentiated from a minor defect, such as a squeaky crib door.

### 2.2. Electronic word of mouth

There has been a great deal of research regarding electronic word of mouth and reviews, mostly regarding their effect on sales and marketing. Amblee and Bui investigated the effect of electronic word of mouth (eWOM) in the e-book industry (Amblee and Bui, 2011). Applied specifically to Amazon Shorts e-books, they found that eWOM can affect the reputation of the product (the book), the brand (the author), and the reputation of complementary goods (books in the same or similar category).

Other studies have examined eWOM fragments to identify some linguistic patterns. One study found that the text in online reviews of cameras tends to convey strong emotional arousal, implying that usually only people with very strong feelings, positive or negative, write online reviews for products (Pollach, 2006). The same study also found that online reviews tend to be written in a much more professional and serious manner than most other online communications. These two points are important when applying eWOM analysis to defect discovery because it could imply that small defects that do not arouse strong emotions may not be written about, even if they are latent and potentially dangerous. It also could imply that the defects that are written about could be significant, but because reviewers may attempt to write like unbiased critics, the wording may be less polarizing than in other online written content.

### 2.3. Text mining

Text mining has frequently been applied to e-mails, news articles, online forums, and customer reviews to garner business intelligence, often to support business' decision making. For instance, text mining has been used to classify inbound emails as complaints or non-complaints (Coussement and Van den Poel, 2008). It has also been applied to unstructured consumer generated content to identify consumer issues (Spangler and Kreulen, 2008). Other researchers have used text mining to analyze consumer reviews and forecast box-office success for films (Duan et al., 2008).

Although there have been many studies regarding using text mining to gain competitive business intelligence, these techniques have only recently been applied to product quality and defect discovery (Pan et al., 2014; Vallmuur, 2015). Further exploration is required to extend prior works to new applications and to maximize the performance of the data mining techniques. Abrahams et al. have applied text mining and analytics to defect discovery in the automotive industry (Abrahams et al., 2012) and then subsequently created a framework for defect discovery using text mining across industries (Abrahams et al., 2015). This framework has been adapted to uncover safety hazards in children's toys (Winkler et al., 2016), as well as performance defects in dishwasher appliances (Law et al., 2017). In this study, we attempt to adapt and improve these methods, with specific focus on safety defect discovery in the baby crib industry.

### 2.4. Quality assurance in baby crib manufacturing

Quality assurance in the baby crib manufacturing industry includes techniques focused on both the supply-side and the demand-side. On the supply-side, firms use traditional product testing, and Statistical Process Control (SPC). Product testing consists of stress-testing the product to identify how and why products fail. This aids in future product improvement as well as identifying common areas of failure in the current product. Statistical Process Control (SPC) utilizes statistical analysis to monitor and control quality during the manufacturing process. It primarily relies upon "acceptance sampling, statistical process monitoring and control, design of experiments, and capability analysis" (Woodall and Montgomery, 1999). Acceptance sampling is used to make decisions regarding "lots" (production batches). Firms use statistical process monitoring to detect changes or abnormalities in the manufacturing process. They can also design experiments to identify which factors of the manufacturing process have the largest effect on product quality. Finally, firms can use capability analysis to determine whether a process is capable of meeting producer or consumer quality requirements (Woodall and Montgomery, 1999).

On the demand-side, firms monitor consumer feedback via surveys (such as Consumer Reports consumer surveys) or direct consumer responses (such as complaint call center hotlines or e-mail complaints). These methods are utilized after the products have been produced and are more reactive than the supply-side quality assurance techniques. Using demand-side and supply-side techniques in tandem creates a more holistic analysis for the firm.

### 2.5. Summary

Most prior work in the fields of sentiment analysis, electronic word of mouth analysis, text mining, and social media surveillance has not dealt with their applications specifically to defect discovery. For the few studies that have undertaken defect discovery (Abrahams et al., 2015; Abrahams et al., 2012; Law et al., 2017; Winkler et al., 2016), none have assessed the baby crib industry. We aim to adapt, apply, and verify these techniques of analyzing social media and online reviews for the baby crib industry, where we believe these methods could provide valuable feedback to manufacturers and regulators and also yield safer outcomes for parents and their children.

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