

Causal Inference in Sustainable Fashion Concern: Anomaly Detection and Explanation Discovery with Big Data

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Introduction and Literature Review

In today's evolving landscape, the fashion industry is witnessing a pivotal shift towards sustainability awareness. This transition is driven by not only changing consumer preferences but also a global industrial imperative to adopt more ethical practices. Alongside this, the advent of big data analytics in the textile and apparel sector is revolutionizing the way trends are analyzed, consumer behavior is understood, and innovation is fostered (Vasilopoulou et al., 2023). Despite a growing interest in sustainable fashion, there remains a notable challenge in fully comprehending the dynamics of consumer attitudes and engagement as well as the factors that contribute to shifts in public interest. This research aims to address these challenges by using complex system theory, which explores how components within a system influence collective behavior and interact with the environment (Espinosa & Porter, 2011). This approach is relevant to studying sustainable fashion, as it examines how consumer attention to sustainability is influenced by interconnected factors like social, economic, and political events, and natural disasters. Complex system theory underscores the interdependence of system elements and feedback loops, aiding in a comprehensive understanding of anomalies in consumer attention toward sustainable fashion (Higgins, 2014). By integrating complex system theory, our analysis aims not only to track sustainable fashion discourse but also to reveal intricate interactions between consumer behavior, social environment, and sustainable fashion trends. This perspective promises a nuanced understanding of the dynamics at play, fostering a more informed approach to promoting sustainability in the fashion industry. This comprehensive study lays a crucial foundation for future research, providing a strong methodological approach and theoretical basis for exploring the complex relationship between fashion sustainability and consumer dynamics in the digital age.

Methodology

This research integrated advanced statistical techniques with extensive X/Twitter data analysis to explore anomalies in consumer attention towards sustainable fashion. Utilizing the `tsoutliers` package in R, we detected outliers in time series data, considering various types such as Additive Outliers, Level Shifts, Temporary Changes, Innovational Outliers, and Seasonal Level Shifts (Chen & Liu, 1993; Kaiser Remiro & Maravall, 1999). Following this, we employed abductive reasoning to interpret these observed anomalies, delving into the underlying causes through an analysis informed by the complex system theory. Data collection focused on X/Twitter posts that were posted within the United States of America in English, spanning nearly a decade (05/01/2013-04/01/2023) and filtered for relevance to sustainable fashion discourse (with hashtag #sustainablefashion and/or #ecofashion). Cleaning steps included the exclusion of promotions, retweets, and organizational posts, resulting in a dataset of 54,031 tweets. This

analysis aims to uncover anomalous shifts in consumer interest and further investigate their underlying causes, contributing to a deeper understanding of sustainable fashion dynamics.

Results

In this research, the `tsoutliers` package in R was employed to conduct a comprehensive analysis of large-scale X/Twitter data, successfully identifying three main types of anomalies in consumer attention towards sustainable fashion: six Level Shifts (LS), one Additive Outlier (AO), and one Innovational Outlier (IO) (See Figure 1 & Table 1). The detection of these anomalies not only revealed patterns of consumer attention changes related to significant events such as political events, social movements, and disasters but also provided deep insights into the complex causal relationships behind these changes. Specifically, LS reflects sustained changes in consumer attention often associated with long-term societal shifts; AO indicates short-term deviations in attention caused by specific events; while IO signifies structural changes that could alter the pattern of attention fluctuations. Compared to traditional anomaly detection methods, this approach demonstrates unique advantages, including the ability to perform more complex and granular analysis of time series data, explore the causality behind anomalies, and adapt to large-scale datasets. This comprehensive analysis not only deepens the understanding of the dynamics of consumer attention in sustainable fashion but also offers valuable insights for further advancing the field.

Conclusion and Future Research

The conclusion of this study on sustainable fashion and anomaly detection highlights the intricate dynamics of consumer engagement influenced by external stimuli and the evolving digital landscape. The analysis successfully identifies and categorizes anomalies, enhancing our understanding of consumer behavior shifts. For future research, suggests diving deeper into the causality behind these shifts, employing a complex system theory framework, and exploring cross-cultural consumer behavior toward sustainable fashion. The study opens avenues for integrating advanced analytics with socio-economic theories to further unravel the complexities of sustainable fashion consumption.

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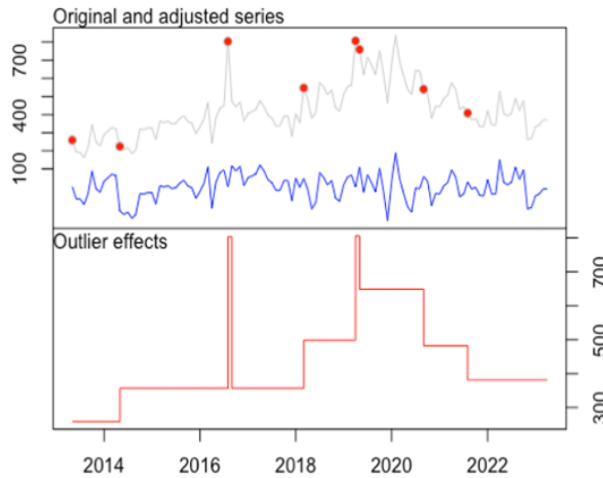


Figure 1. Detected Outliers in Time Series Data

Table 1. Summary of Detected Outliers

Time of Outliers	Type of Outliers	Abductive Reasoning	Time of Event	Complex system Theory
2013.5	LS	Rana Plaza collapse	2013.4.24	Disasters
2014.5	LS	First Fashion Revolution Movement	2014.4.24	Social movements
2016.8	AO	G20 summit: China and the United States jointly ratify the Paris climate change agreement	2016.9.3	Political events
2018.3	LS	“Fashion and the SDGs: what role for the UN?” conference	2018.3.1	Political events
2019.4	IO	UN Alliance for Sustainable Fashion launched	2019.3.14	Political events
		First Global Climate Strike	2019.3.15	Social movements
2019.5	LS	Second Global Climate Strike	2019.5.24	Social movements
2020.9	LS ^a	The first known case of COVID-19 reinfection reported in the US	2020.8.28	Disasters
		US rejects WHO global COVID-19 vaccine effort	2020.9.1	Political events
2021.8	LS ^a	US Meets Biden’s Vaccine Goal 1	2021.8.3	Political events
		Sixth Assessment Report of IPCC	2021.8.9	Political events