

Sales Optimization in Fashion Retailing Using Personalized Subscription Boxes

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Abstract:- Modern technology and changing consumer preferences drive a dramatic transition in the fashion retail sector. Personalized subscription boxes have become dominant among cutting-edge trends, offering expertly curated collections of trendy products catered to interests and preferences. This study investigates how personalized subscription boxes can be strategically used to boost sales in the retail fashion industry. The study encompasses various objectives, including assessing the impact of personalized subscription boxes on sales and customer engagement, developing novel algorithms to curate precisely tailored assortments, exploring the role of continuous customer feedback, and devising efficient inventory management methods. The study's conclusions highlight the potential of personalized subscription boxes to transform the retail footwear industry by offering consumers highly tailored shopping excursions with a significant emotional impact. These modern algorithms increase customer satisfaction and loyalty by ensuring that the products in subscription boxes precisely match each client's preferences. Data-driven insights enable more targeted marketing initiatives, and ongoing client feedback helps personalization techniques get better. Effective inventory management protects against stockouts and enhances supply chain operations under predictive demand forecasting. In conclusion, this study presents a convincing vision of how personalized subscription boxes might transform the retail environment for fashion, empowering fashion merchants to succeed in a constantly changing sector by implementing data-driven strategies and customer-centric insights.

Keywords: *Footwear Retail, Personalization, Review Processing, Sales Optimization, Subscription Box*

1. Introduction

The landscape of fashion retail has experienced profound shifts in recent years, driven by the convergence of consumer preferences, technological advancements, and innovative business strategies. As the fashion industry seeks novel ways to engage customers and optimize sales, the concept of personalized subscription boxes has emerged as a disruptive force. Tailored to individual tastes and preferences, these curated assortments of fashion products offer a modern solution to the challenges of traditional retail models.

In fashion retail, understanding consumer behavior and predicting trends have been existing challenges. Previous researches have explored various methods of sales optimization, including forecasting models, customer segmentation, and inventory management techniques. However, integrating personalized subscription boxes introduces a novel approach capitalizing on the growing demand for personalized shopping experiences.

The core problem addressed in this research is how to effectively optimize sales in the fashion retail sector through the strategic implementation of personalized subscription boxes. This study recognizes the need for a comprehensive understanding of the impact of personalized subscription boxes on sales, customer engagement, and overall business performance.

The significance of this research stems from its potential to reshape the fashion retail landscape. By diving into the dynamics of personalized subscription boxes, this study aims to contribute to understanding how fashion retailers can leverage data-driven insights and advanced algorithms to enhance sales optimization strategies. The practical implications of this research extend to industry practitioners seeking innovative methods to increase customer satisfaction and revenue generation.

Although sales optimization has been studied in detail, insufficient attention has been paid to using subscription boxes for sales optimization. This research pursues the following objectives:

- To assess the impact of personalized subscription boxes on sales and customer engagement.
- To develop and evaluate novel algorithms for curating personalized assortments within subscription boxes.
- To enhance customer segmentation through the utilization of subscription box data.
- To investigate the role of continuous customer feedback in refining personalization strategies.
- To devise methods for maintaining efficient inventory levels through predictive demand forecasting.

To achieve these objectives, the study addresses the following research questions:

- How does the integration of personalized subscription boxes impact sales and customer engagement in fashion retailing?
- What novel algorithms can be designed to curate personalized assortments within subscription boxes, aligning with individual customer preferences?
- How can continuous customer feedback through a review system further enhance personalization?

The subsequent sections of this paper are structured to address these research objectives and questions comprehensively. Section II presents a thorough literature review, highlighting relevant theories, concepts, and previous research related to sales optimization in fashion retail and the emergence of personalized subscription box models. Section III outlines the methodology employed in data collection, preprocessing, and algorithmic implementation. The results of the research are detailed in Section IV, followed by a discussion of the findings in Section V. The paper concludes Section VI by summarizing key insights and implications derived from the study.

2. Related Work

Research conducted on Sales Optimization in the Fashion Retail [1] introduces a novel approach to sales optimization in the fashion retail sector. The authors address the unique challenges faced by fashion retailers and propose an innovative solution, which is a comprehensive sales optimization strategy by focusing on leveraging advancements in computing and data analysis. Key findings from this study reveal the potential of data-driven approaches in enhancing sales and operational efficiency within the fashion retail domain. The paper offers insights into the development and implementation of a solution tailored to the specific needs of the fashion retail industry. At the end of the paper, the researchers mentioned that rather than targeted marketing as the next step, personalized marketing will have more potential in the near future.

Another study by S. A. Erdogan¹, A. Gundogdu Senturk¹, and J. Balasingham [2] examines the difficulties subscription box businesses confront in terms of resource allocation and operational effectiveness. The study examines how resources are distributed in the context of subscription box services, including inventory, labor, and logistics. The importance of effective resource allocation in raising service quality, cutting costs, and increasing customer happiness is highlighted through key findings. The article presents optimization models and tactics that can help subscription box companies improve their business processes. These observations help to understand personalized subscription boxes in the footwear retail industry better because they highlight how crucial resource optimization is in providing specialized and effective subscription services, which aids in comprehending how crucial re-order points are. The reasons and expectations of consumers using e-commerce subscription services are clarified by Chen's incisive examination of the preferences and behaviors of e-commerce customers [3]. The study investigates many aspects of subscription commerce, highlighting its expanding significance in the e-commerce environment. The appeal of subscription models for customers, including ease, product discovery, and customization, is highlighted by key findings. The paper goes into detail on the elements that affect consumer adoption of subscription boxes, including perceived value, pricing policies, and brand trust. It also looks at consumer retention and satisfaction in subscription-based online shopping, offering light on what motivates continued memberships. These report's key takeaways support the inquiry into personalized subscription boxes in the footwear retail industry since they stress how crucial ease, customization, and trust-building are to the subscription commerce model.

The research by Lee, Sadachar, and Manchiraju [4] offers a thorough examination of beauty subscription box services. This study explores the complex interactions of beauty subscription boxes, illuminating their varied functions in the retail industry. The beauty and cosmetics business is the main area of attention for the authors as they carefully look into the distinctive qualities and services of beauty subscription boxes. The study's key findings provide light on how factors like product quality, brand trust, and personalization affect consumer engagement in beauty subscription box services. The study also highlights the importance of subscription boxes in encouraging brand loyalty and looks at member satisfaction rates. These observations are especially pertinent because they offer a detailed knowledge of how tailored subscription box services operate in the retail market for cosmetics and beauty products. The study's conclusions offer insightful information that is relevant to the investigation of personalized subscription boxes in the footwear retail industry because they stress the significance of product quality, personalization, and consumer loyalty in the context of subscription-based retail services.

A comprehensive analysis of the subscription box industry's dynamic landscape may be found in [5]. This study emphasizes its rapid expansion and diversification, underscoring its significance in contemporary retail. The writers explore the numerous subscription box options available across different businesses. The report also identifies and analyzes the main difficulties subscription box companies face, including competitiveness, user acquisition, personalization, and logistics. Notably, the report highlights the crucial success aspects, such as the use of data analytics, personalization, customer involvement, and successful marketing tactics, that enable these organizations to succeed. A pivotal theme throughout the paper is the adoption of a customer-centric approach, where understanding and catering to individual customer preferences play a central role. The writers also talk about how technology, especially data analytics and algorithms, can be used to customize subscription products. They also emphasize the value of consumer feedback loops and customer happiness in enhancing subscription box services. The research concludes by projecting future growth opportunities for the industry in growing markets and new product categories. This report offers important new perspectives on the subscription box market and how it fits into the changing retail environment. In order to make comparisons and distinctions relevant to this particular study area, [5] serves as a fundamental source that contextualizes the larger subscription box market.

The drivers of consumer behavior in the adoption of subscription boxes have been the subject of research to understand better the elements that influence consumers' continuing intention to use subscription boxes [6]. The study looks into a number of factors, such as perceived value, service quality, perceived risk, and satisfaction, and how they affect consumers' plans to continue using subscription boxes. The main conclusions of this study shed light on the importance of perceived value and service quality in encouraging consumers' positive continuation intentions. It also discusses the importance of perceived risk and satisfaction in determining whether or not customers continue to use subscription box services. These findings underscore the significance of value, quality, risk mitigation, and customer happiness in generating sustained engagement with subscription-based services, making them extremely pertinent to the investigation of personalized subscription boxes in the footwear retail sector.

A study done by Bischof, Boettger, and Rudolph [7] offers a theoretical framework for curated subscription commerce. Even though it is not specifically focused on fashion retail, it offers insightful information about the conceptual foundations of subscription box models, such as curation. This theoretical viewpoint can help to grasp the guiding ideas and theories behind this sales optimization technique as it applies to this study of personalized subscription boxes in the fashion retail industry.

By utilizing client product ratings, Cheung (2003) [8] explores the world of personalized marketing in their work that was published in the journal *Decision Support Systems*. The study investigates how product reviews and consumer input might be used to improve and customize marketing campaigns. In the context of e-commerce, the writers stress how crucial it is to comprehend unique customer preferences and wants. To learn more about consumer behavior and preferences, the article presents techniques for mining and evaluating user reviews and ratings. This includes methods for spotting trends, correlations, and patterns in the data. The study highlights the opportunity for companies to personalize their marketing strategies in light of this insightful feedback. Ultimately, the research contributes to the advancement of personalized marketing strategies, underscoring the role of data analytics in enhancing customer engagement and satisfaction. Additionally, [8] is a key source for this study in

the fashion retail industry since it emphasizes the value of comprehending customer preferences and utilizing data analytics to raise customer engagement and satisfaction. The ideas presented in this study are relevant to the investigation of personalized subscription boxes because they emphasize the value of customizing services to meet the needs and preferences of each individual client. This source serves as a core guide that helps to understand how to use customer input and data analytics best to curate personalized subscription boxes that closely match what customers want and expect. The information from [8] provides a strong framework for increasing customer involvement and satisfaction in the context of fashion retail, which makes a substantial contribution to this research.

This research on personalized subscription boxes in the fashion retail industry is consistent with Songpan's study on opinion mining techniques [9], which focuses on assessing and forecasting consumer review ratings. The work of Songpan highlights the significance of sentiment analysis, review rating prediction, and accuracy evaluation in comprehending and influencing customer opinions. Similar sentiment analysis techniques can be used in this research to evaluate customer comments on personalized subscription boxes. This study can help to determine customer satisfaction levels and identify areas for development so that the offerings are more in line with what customers want, eventually maximizing loyalty and revenue in the fashion retail industry.

The study of personalized subscription boxes in the fashion retail industry is closely relevant to Lazhar and Yamina's research [10]. Their research explores the extraction of both explicit and implicit opinions from internet reviews, tackling the challenges of understanding the customer sentiments revealed in these reviews. Although their study looks at a wider range of online reviews, the essential ideas behind sentiment analysis, feature extraction, opinion mining, and contextual analysis are all directly relevant to this study. The understanding of customer feedback analysis, a crucial component of the study, has been greatly improved by Lazhar and Yamina's [10] work. The objective is to extract insightful information from the feedback of customers of personalized subscription boxes in order to improve the entire shopping experience for fashion retailers.

3. Methodology

This section outlines the methodology, which focuses on developing and implementing a personalized shoe recommendation system using the k-Nearest Neighbors (KNN) algorithm. The research encompasses data collection, preprocessing, model training, validation, and integration of an intelligent re-order logic system for shoe inventory management.

a) Data Collection and Dataset Description: The provided dataset served as the fundamental resource for this study. It included information about various shoes, comprising attributes such as Brand, Model, Type, Gender, Size, Color, Material, Price in USD, Sentiment Analysis Scores, and Re-order Points. The dataset consisted of more than 1,500 shoe products, offering a diverse representation of shoe brands, types, and styles, which was vital for understanding customer preferences.

b) Data Preprocessing Techniques: Before training the KNN recommendation model, several data preprocessing techniques were applied to ensure data quality and model suitability. These techniques encompassed,

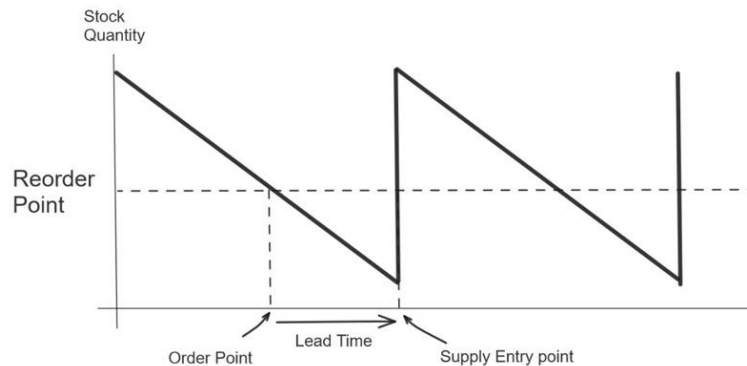
1. Data Cleaning: Remove erroneous or redundant entries to enhance data integrity.
2. Standardization and Normalization: Bringing numerical attributes (e.g., shoe size and price) to a consistent scale to prevent any disproportionate influence on the model.
3. Encoding of Categorical Variables: Transformation of categorical attributes (Brand, Type, Gender, Color, and Material) into numerical values using methods such as one-hot encoding or label encoding.
4. Handling Missing Values: Management of missing data by removing incomplete entries or imputing reasonable values.
5. Duplicate Removal and Outlier Detection: Eliminating duplicate records and identifying and handling outliers to ensure data quality.

c) Feature Engineering: In addition to the existing attributes, two new features, Sentiment Analysis Scores

and Re-order Points, were engineered. Sentiment Analysis Scores provided insight into customer sentiment toward specific shoe products, offering a deeper understanding of user preferences. Re-order Point defined the threshold at which inventory should be replenished based on historical demand, preventing stockouts. Fig. 1 provides visual representation of how the re-order point is calculated.

Fig. 1 How reorder point is calculated

d) *KNN Model Training*: The recommendation model was trained using the k-nearest Neighbors (KNN)



algorithm. The following steps were undertaken:

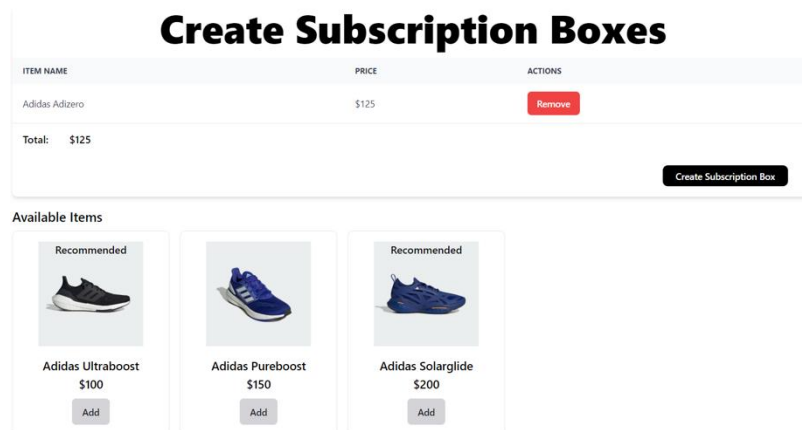
1. **Choosing K Value**: The value of K was selected to determine the number of nearest neighbours used for predictions. This choice was crucial and depended on the dataset size; the square root of the number of training examples was adopted as a starting point.
2. **Calculating similarity**: Similarity between each pair of training examples was computed, employing metrics like cosine similarity to quantify the likeness between data points.
3. **Model Training**: The KNN model was trained by storing training examples and their similarity scores in memory.

e) *Recommendation Generation*: In brief, to generate personalized shoe recommendations based on user preferences for Brand, Type, Gender, Color, Material, Sentiment Analysis Scores, and Re-order Points, the trained KNN model calculates the similarity between the user's input and training examples. Recommendations were made by identifying the K most similar training examples, and products rated highly by these similar users were suggested to the current user. In brief, to generate personalized shoe recommendations based on user preferences for Brand, Type, Gender, Color, Material, Sentiment Analysis Scores, and Re-order Points, the trained KNN model calculated the similarity between the user's input and training examples. Recommendations were made by identifying the K most similar training examples, and products rated highly by these similar users were suggested to the current user. Fig. 2 provides a visual representation of the shoe recommendation process for creating a subscription box. It emphasises the interaction between the user's preferences and the recommendation algorithm, which is responsible for recommending appropriate items.

f) *Review processing*: Customer feedback is gathered from various sources, including online reviews and surveys administered to subscribers of personalized subscription boxes in the footwear segment. This comprehensive data collection process includes the examination of publicly available online feedback and direct engagement with subscribers to elicit their opinions. Once the feedback is collected, advanced data analytics techniques are employed to extract meaningful insights. This analysis encompasses sentiment analysis to determine the positivity, negativity, or neutrality of the feedback. The feedback analysis offers valuable insights into how customers perceive and interact with personalized subscription boxes. Preliminary findings suggest that customers highly appreciate the customization and convenience offered by these boxes, often citing these factors as influential in their purchase decisions. A notable positive sentiment is directed towards the tailored product selection and the sense of novelty that each subscription box brings. However, the analysis also reveals areas for potential improvement. Negative feedback primarily centres on issues related to the initial set of products recommendations, including concerns about sizing accuracy and style alignment. These findings echo prior

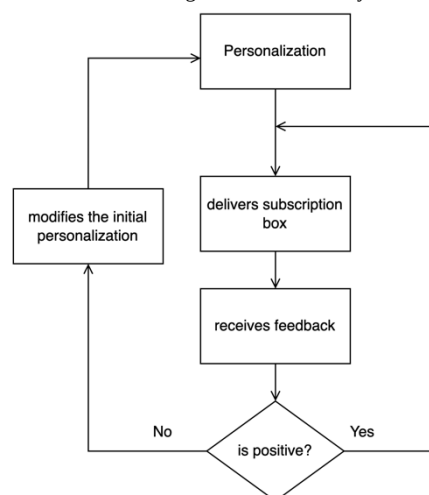
research on challenges encountered by subscription box businesses, underscoring the importance of addressing such issues to enhance overall customer satisfaction.

Fig. 2. Item Recommendations



Building upon the insights gained from this analysis, the system intends to propose practical recommendations for subscription box providers. These recommendations will be tailored to address specific issues highlighted in the feedback, with the goal of optimizing sales and enhancing the overall customer experience. Fig. 3 provides a visual representation of how the feedback analysis contributes to the system to cater more personalized footwears to customers

Fig. 3. Feedback Analysis



g) Validation and Inventory Management: A validation step was incorporated to ensure that recommended items were present in the dataset. If a recommended item was found, it was tagged with an "isRecommend" attribute set to true; otherwise, it was set to false. Fig. 4 provides a clear visual representation of how different modules within the system interact and collaborate to support the purchase, sale, and management of products, with a strong emphasis on data flow and database integration.

This methodology combines data pre-processing, KNN model training, recommendation generation, review processing, and inventory management to create a comprehensive approach to building a personalized shoe recommendation system while optimizing inventory control. Additionally, this research employs Sentiment Analysis for review analysis.

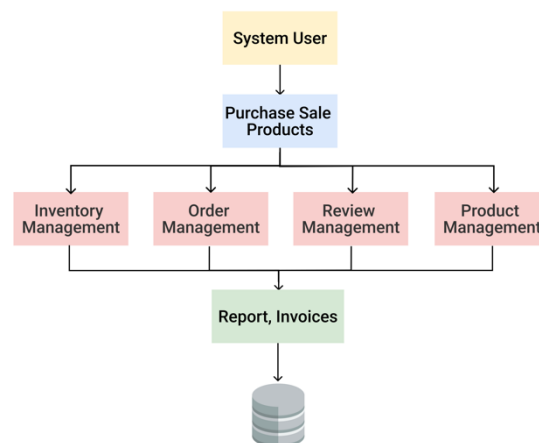


Fig. 4. High Level Overview

4. Results and Discussion

- Model Training and Recommendation Generation
 - The personalized shoe recommendation system was developed using the k-Nearest Neighbours (KNN) algorithm. The training of the KNN model involved crucial steps, starting with selecting the value of K. The square root of the number of training examples was chosen as the initial value for K. Next, the similarity between each pair of training examples was calculated using metrics such as cosine similarity to quantify the likeness between data points. This information was used to train the KNN model by storing training examples and their similarity scores in memory.
 - Recommendations were generated based on user preferences for Brand, Type, Gender, Color, Material, Sentiment Analysis Scores, and Re-order Points. The KNN model calculated the similarity between the user's input and training examples. Recommendations were made by identifying the K most similar training examples, and products highly rated by these similar users were suggested to the current user.
- Validation and Inventory Management
 - To ensure the validity of the recommendations, a validation step was integrated into the system. Recommended items were checked against the dataset, and if a recommended item was present, it was tagged with an "isRecommend" attribute set to true. Otherwise, it was set to false.
- Inventory Control
 - Additionally, an intelligent re-order logic system for shoe inventory management was integrated into the methodology. The "Re-order Point" feature was engineered to define the threshold at which inventory should be replenished based on historical demand patterns. This proactive approach aimed to prevent stockouts and ensure a seamless shopping experience for customers.
- Feature Engineering and Sentiment Analysis
 - Feature engineering played a crucial role in enhancing the recommendation system. Two new features, sentiment analysis scores, and re-order points, were introduced. Sentiment analysis scores provided valuable insights into customer sentiment towards specific shoe products, enabling a deeper understanding of user preferences. Re-order point, on the other hand, helped optimize inventory control by setting thresholds for restocking based on historical demand trends.
 - The methodology presented in this study provides a comprehensive approach to building a personalized shoe recommendation system while optimizing inventory control. By combining data pre-processing, KNN model training, recommendation generation, and inventory management, the system ensures a comprehensive approach to enhancing the shopping experience for customers.

- Sentiment analysis adds an extra layer of insight into customer preferences, allowing the system to recommend products not only based on attributes but also on user sentiments. This feature can significantly enhance the quality of recommendations, leading to increased customer satisfaction and potentially higher sales.
- Inventory management is critical in the retail industry, and introducing the Re-order Point feature helps strike a balance between maintaining stock levels and preventing overstocking or stockouts. This proactive approach to inventory control aligns with modern retail practices, where efficient supply chain management is vital.
- Overall, the methodology described here offers a practical solution for personalized recommendations and efficient inventory management in the shoe retail industry. It can serve as a foundation for further research and implementation in the broader e-commerce domain.

5. Conclusion

This study embarked on a journey to explore the integration of personalized subscription boxes as a novel approach to optimize sales in the fashion retail sector. The research addressed several critical questions and objectives, leading to valuable insights and findings, and assessed the profound impact of personalized subscription boxes on sales and customer engagement in the fashion retail industry.

The findings underscored the potential of this approach to revolutionize the retail landscape by offering tailored shopping experiences. To curate personalized assortments within subscription boxes, novel algorithms were developed and evaluated. These algorithms align with individual customer preferences, enhancing the value and relevance of the products offered in subscription boxes.

The utilization of subscription box data was explored to enhance predictive analysis. This data-driven approach provides a deeper understanding of customer behaviours and preferences, enabling more targeted marketing strategies.

The role of continuous customer feedback through a review system was investigated. This feedback loop plays a vital role in refining personalization strategies, ensuring that subscription boxes continue to meet customer expectations.

Efficient inventory management is crucial in retail. This study delved into methods for maintaining efficient stock levels through predictive demand forecasting, preventing stockouts, and optimizing supply chain operations.

In conclusion, this research sheds light on the potential of personalized subscription boxes as a disruptive force in fashion retail. It highlights the importance of data-driven insights, algorithmic personalization, and customer-centric strategies. The findings suggest that by embracing these approaches, fashion retailers can enhance customer satisfaction, increase revenue, and stay competitive in an evolving retail landscape.

As personalized subscription boxes continue to gain momentum, this research serves as a valuable foundation for both academics and industry practitioners seeking innovative ways to optimize sales and provide exceptional shopping experiences. By staying attuned to customer preferences and leveraging data-driven strategies, fashion retailers can navigate the ever-changing retail terrain with confidence and success.

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