Customer Segmentation Based on Return Behaviour: A Prototype for E-Commerce Platforms

Degree programme: BSc in Industrial Engineering and Management Science
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Thesis advisor: Moritz Maier
Expert: Jörg Grimm
Industrial partner: Bern University of Applied Sciences, Management Science and Industrial Engineering, Biel

E-commerce platforms face increasing tension between offering competitive return policies and maintaining operational sustainability. Lenient conditions can drive loyalty but also incentivise behaviours like bracketing and over-ordering. This project presents a cross-platform prototype that aggregates behavioural data to enable smarter and fairer return policies, identifying patterns that single platforms may not detect alone.

Objectives

This thesis explores the technical and business feasibility of implementing behaviour-based customer segmentation across multiple e-commerce platforms to support adaptive return policy management. The work is guided by three main research questions: (1) Can customer return behaviour be reliably classified using behavioural data shared across platforms while complying with GDPR? (2) Which machine learning techniques are best suited to segment customers based on return behaviour patterns? (3) To what extent can behaviour-based return policies reduce operational costs compared to flat policies, without compromising fairness? These questions reflect the growing need for e-commerce platforms to personalise operational strategies and reduce return-related costs without undermining customer trust.

Research Design

The project follows a five-phase methodology combining legal analysis, technical development, economic impact, and business validation. A hybrid machine learning approach is applied: K-means is used to uncover behavioural segments, which then serve as training labels for a K-Nearest Neighbours classifier, enabling the classification of new users by comparing them to previously clustered ones. To ensure GDPR compliance and experimentation flexibility, The prototype was built entirely on a synthetic dataset simulating realistic return behaviour across four distinct e-commerce platforms. It includes variables such as return ratio, product variant and discount usage. In practice, customer identifiers would likely need to be pseudonymised to support lawful cross-platform linkage. This modular system enables scalable integration across retailers and supports real-time decision-making based on customer behaviour profiles.

Results

While based entirely on synthetic data, the model identified five distinct customer profiles: responsible buyers, impulsive returners, bracketers, strategic abusers, and low-activity users. These were derived through K-Means clustering on behavioural indicators. The dataset was visualised using PCA; Figure 1 shows clear separation between segments and underlying behavioural diversity. Simulations based on synthetic transaction data and estimated return handling expenses suggest potential cost reductions of 8% to 15% when stricter return conditions are applied to high risk groups, compared to flat policies, depending on the customer segment and policy configuration.

Implicantions and Recommendations

The research presents a framework for cross-platform behavioural segmentation showing that differentiated return policies can increase cost-efficiency without penalising low-risk customers. Still, the reliance on synthetic data limits the generalisability of results. Future work should validate the model with real transactions and assess customer responses to policy differentiation. The system architecture also includes a mechanism for cross-platform customer identification using shared email identifiers, which could enable the classification of first-time customers based on prior activity on other platforms. Despite the current limitations, the prototype offers a solid basis for responsible and efficient return management in e-commerce.

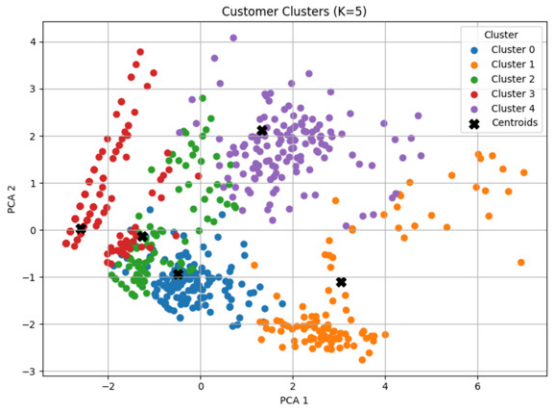

Figure 1: Groups obtained with the K-means method

Maria Vives Ferrer
mariavivesf@gmail.com