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Hybrid Recommendation System in E-Commerce

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A B S T R A C T

This study explores hybrid recommendation systems in e-commerce, which combine content-based and collaborative filtering to overcome limitations such as cold-start and data sparsity. Through a Systematic Literature Review of 15 selected papers, it identifies key hybrid types—Weighted, Switching, and Cascade Hybridization—and analyzes trends in their adoption. Weighted Hybridization is found to be the most frequently used due to its effectiveness in improving recommendation accuracy. The study also discusses the strengths of hybrid systems in providing personalized and adaptive suggestions, along with challenges like system complexity and computational cost. Overall, hybrid approaches offer promising improvements for user experience in e-commerce recommendation systems.

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INTRODUCTION

In recent years, technology has transformed the way people carry out their daily activities, particularly in the context of shopping. E-commerce platforms have emerged as a technological advancement that enables consumers to shop online, whether through websites or mobile applications. These platforms have revolutionized commerce by offering a wide variety of products, personalized recommendations, and seamless transactions (Zhu, 2024). As the number of available products and user preferences increases, recommendation systems have become an essential component of e-commerce—not only for maximizing platform profits but also for assisting consumers in making informed purchasing decisions.

Recommendation systems implemented in e-commerce include Collaborative Filtering, Content-Based Filtering, Hybrid Filtering, and various machine learning models such as Neural Networks. Each of these methods has its own strengths and limitations depending on the type of data, the implementation context, and the specific objectives of the e-commerce platform. However, both Content-Based and Collaborative Filtering methods face common challenges such as the cold-start problem, real-time personalization, and scalability issues (Ko et al., 2022). Hybrid Filtering has emerged to overcome these limitations by combining the strengths of both approaches, making it particularly valuable in the e-commerce domain.

Given these challenges, a systematic review is needed to evaluate the methods used for implementing hybrid recommendation systems on e-commerce platforms (University Durham, n.d.). In recent years, research on hybrid filtering in the e-commerce domain has shown significant growth. However, there is still a lack of systematic reviews that compile and compare the various hybrid approaches that have been proposed. Therefore, this study aims to conduct a Systematic Literature Review (SLR) to evaluate the development, techniques used, and challenges in implementing hybrid filtering in e-commerce. The reviewed studies were selected from several digital libraries using keywords such as "recommender system," "recommendation system," "e-commerce," and "hybrid filtering."

METHODOLOGY

The process of identifying, evaluating, and interpreting all available research relevant to a specific research question, topic, or phenomenon is known as a Systematic Literature Review (SLR). SLR is commonly used in medical research and is also widely applied in software engineering studies. This study adopts a systematic approach to understanding the literature on recommendation systems, particularly in the e-commerce domain, based on the guidelines proposed by (University Durham, n.d.)

A. Research Question

The purpose of this Systematic Literature Review (SLR) is to analyze the trends, methods, and challenges involved in developing recommendation systems. To ensure that the study remains focused and aligned with its objectives, the authors have formulated the following research questions:

Table 1. List of Research Question

ID	Research Question	Motivasion
RQ1	What hybrid filtering approaches have been applied in e-commerce recommendation systems?	Identify the hybrid filtering approaches that have been implemented in e-commerce recommendation systems.
RQ2	Which hybrid approaches are most commonly combined in hybrid methods?	Identify the algorithms that are most frequently used in hybrid filtering methods.
RQ3	How does the performance of hybrid methods compare to single methods (pure CF or CB)?	Identify the performance of hybrid methods in comparison to single methods.
RQ4	What are the challenges and solutions in implementing hybrid filtering in e-commerce?	Identify the challenges and solutions associated with implementing hybrid filtering in e-commerce.

B. Study Selection

The studies related to this SLR are limited to those published in both Indonesian and English. The criteria for inclusion and exclusion of studies are presented in the following table.

Table 2. List of Study Selection

Inclusion	Exclusion
The studies focus on hybrid recommendation systems in the e-commerce domain.	Non-peer-reviewed studies.
The studies are published up to the year 2025.	Studies that do not mention the integration of two or more filtering techniques.
The studies explain the methods, experiments, and results.	Studies outside the context of e-commerce.

The research journals included in this Systematic Literature Review (SLR) were published up to the year 2025. Before retrieving articles, it is essential to choose reliable research databases to ensure the relevance of the collected literature. The authors conducted their search through databases such as IEEE Xplore, ScienceDirect, and Springer. The studies were collected using keywords such as “hybrid recommender system” or “hybrid recommendation system” to broadly capture research on recommendation systems. Additionally, the keyword “e-commerce” was used to specifically find studies related to recommendation systems in the e-commerce domain.

The search process and the number of studies identified at each stage are illustrated in the following figure. The study selection was carried out in two

phases: the first based on titles and abstracts, and the second through a thorough reading and understanding of the full papers.

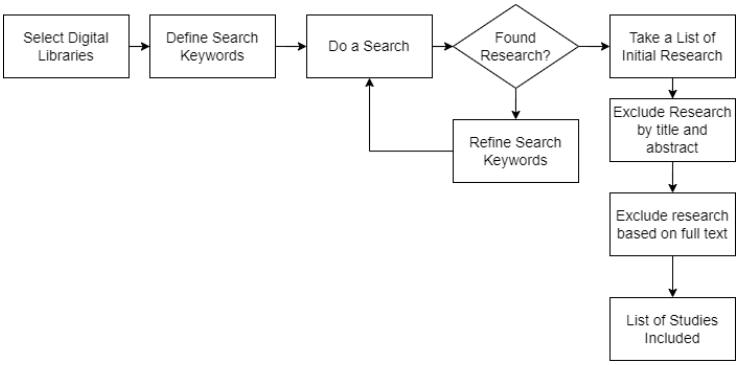

Figure 1. Flow of Research Search and Selection

RESEARCH RESULT AND DISCUSSION

Recommendation systems are filtering systems that provide personalized recommendations based on users, capable of storing and processing various types of data. These systems leverage multiple sources of information to predict preferences that are likely to be favored by the user (Zhao et al., 2025). Recommendation systems have been implemented in various fields such as movies, music, e-commerce, tourism, etc. (Zamanzadeh Darban & Valipour, 2022). This recommendation technology can have a positive impact on e-commerce because it can understand user behavior and preferences, which in turn enhances the user experience and improves e-commerce operations [1]. There are several techniques in recommendation systems, including Content-Based Filtering, Collaborative Filtering, and Hybrid Filtering.

Content-Based Filtering (CB) is a recommendation technique that compares items similar to those previously chosen by the user. CB is the most basic recommendation method and was widely used in its early days (Ko et al., 2022). However, CB has limitations such as the cold start problem, which refers to the inability to recommend items to new users, and sometimes overspecialization, where the system recommends items that are too specific (Zamanzadeh Darban & Valipour, 2022), (Zhang et al., 2021). The second technique is Collaborative Filtering (CF), which is a model that predicts user preferences based on previous evaluation data to recommend items. The prediction results are then presented as recommendations (Ko et al., 2022). Collaborative Filtering can be classified into two categories: User-Based CF, which identifies similar preferences between users, and Item-Based CF, which analyzes the relationships between items (Priya et al., 2022).

Hybrid Filtering is a method that combines Content-Based and Collaborative Filtering to address the limitations of both techniques. There are seven types of Hybrid Filtering, including Weighted Hybridization, Switching Hybridization, Cascade Hybridization, Mixed Hybridization, Feature-Combination, Feature-Augmentation, and Meta-level.

After understanding recommendation systems, a review of several literatures shows that hybrid recommendation systems in the e-commerce

domain have experienced significant development over the past decade. The increasing need for more accurate personalization and the limitations of single methods have encouraged many researchers to adopt hybrid approaches.

A. Tren for Hybrid Filtering

A key trend in the development of hybrid recommendation systems is the combination of Collaborative Filtering (CF) and Content-Based Filtering (CB). This combination is considered effective in overcoming the weaknesses of each method, such as the cold-start and sparsity problems in CF, and the content limitations in CB.

In the study by (Rizki & Rianto, 2024), the hybrid method used is Switching Hybridization to select the appropriate attributes. The algorithm used is a combination of Term Frequency – Inverse Document Frequency (TF-IDF) and K-Nearest Neighbor. The highest accuracy achieved was 83.62% for the switching method with the target variable "product category", followed by 74.9% for the switching method with the target variable "rating".

In the study by (Elahi et al., 2023), the hybrid method used is Weighted Hybridization, which combines the scores from Collaborative Filtering (CF) and sentiment analysis using a weighted combination. The final score is obtained by combining the prediction scores from CF and the sentiment scores from product reviews. The algorithms used include Singular Value Decomposition (SVD) for CF, Valence Aware Dictionary and Sentiment Reasoner (VADER) for sentiment analysis of review texts, and a technique called Hybrid Fusion Technique to combine both scores.

In the study by (Bagga et al., 2023), the hybrid method used is Weighted Hybridization, marked by adaptive fusion from several recommendation sources (click-through rate, new item recommendation, item popularity). This process assigns different weights to each recommendation source based on user context and historical preferences. This can be categorized as Weighted Hybridization because it combines scores from several algorithms with a specific method. Additionally, there is some Feature-Augmentation Hybridization, marked by a transfer learning approach and feature fusion, where new item representations are enhanced using historical embeddings through a generator-discriminator architecture. The algorithms used include Adaptive Fusion Layer to dynamically combine features from source and target domains using adaptive weights, Transfer Learning, and a Base Recommendation Model using Matrix Factorization.

In the study by (Romero et al., 2023), Weighted Hybridization is used, combining the scores from CB and CF using specific weights based on data availability and item similarity, calculated using a weighted linear combination. The algorithms used in this study include Item-Based CF, CB based on item attribute vectors, and the Interest-Aware Epidemic Routing Algorithm.

In the study by (Li et al., 2021), Cascade Hybridization is used, where two or more recommendation techniques are combined sequentially, with the output from the first method becoming the input or filter for the next method [2]. The first stage uses a CNN-BiLSTM model to filter helpful and non-helpful reviews,

which acts as a preprocessing or filtering layer. In the second stage, only the filtered helpful reviews are used to form a user profile, which is then processed using CF-based algorithms like UBCF, SVD, and NCF.

In the study by [13], Hybrid Collaborative Filtering, combining User-Based CF and Item-Based CF, is used. The results from this approach are calculated using adjustable weights to improve system performance. Weighted Hybridization is employed in this study because it uses scores from two methods calculated with specific weights.

In the study by (Mustafa et al., 2024), a combination of Content-Based and Ontology-Based methods is used, classified under Cascade Hybridization. The algorithms used include Ontology construction using OWL, user profiling based on historical and explicit data, and a matching algorithm based on calculating the closeness between user profiles and products in the ontology using semantic similarity metrics.

B. Identified Hybrid Method

Table 3. List of Identified Hybridization

Hybrid Type	Definition	Related Studies
Weighted Hybridization	Combining the scores from multiple recommendation methods using weighted averaging. [13].	(Bagga et al., 2023; Chornous et al., 2021; Elahi et al., 2023; Romero et al., 2023)
Switching Hybridization	The system selects the most appropriate recommendation method depending on the context. [2].	(Rizki & Rianto, 2024)
Cascade Hybridization	Sequential or stage-wise approach. One recommender is used first to generate a candidate list, and another is used to refine or re-rank the results	(Li et al., 2021), (Mustafa et al., 2024)
Feature-Augmentation	Feature-level integration approach. It uses the output or intermediate features from one system as input features for another	(Bagga et al., 2023)

C. Advantage and Disadvantage of identified Hybrid Method

Although the hybrid approach in recommendation systems has proven to offer significant advantages compared to single-method approaches, several challenges still need to be addressed.

On the positive side, the hybrid approach generally improves the accuracy of recommendation results. By combining information from various sources—such as user preferences (Collaborative Filtering) and product descriptions (Content-Based Filtering)—the system can generate more relevant and

personalized recommendations (Elahi et al., 2023; Geng et al., 2023). Additionally, the hybrid approach is considered more flexible and adaptive to different types of data and application contexts, making it suitable for implementation across various e-commerce platforms with diverse needs (Chornous et al., 2021; Elahi et al., 2023).

Another advantage is its ability to address the cold-start problem, especially for new users. By combining demographic data or item content information, the hybrid system can still provide reasonably good recommendations even when a user has limited historical interactions. This is an important added value in the dynamic and competitive e-commerce environment.

However, despite these advantages, there are several weaknesses that cannot be overlooked. One of the main issues is the increased system complexity, both in terms of architecture and data processing. The integration of multiple algorithms requires parameter adjustments, cross-validation, and more intensive tuning processes to achieve optimal performance. Additionally, not all method combinations provide synergistic results—in some cases, the integration of algorithms may result in minimal or even decreased performance if not designed correctly. This complexity also impacts computational load, which can be a constraint in large-scale systems with real-time requirements. Therefore, selecting and implementing hybrid methods must carefully balance the benefits and available resources.

CONCLUSIONS AND RECOMMENDATIONS

This Systematic Literature Review aims to identify and analyze trends, methods, and algorithms used in hybrid recommendation systems for e-commerce. We searched in three digital libraries—IEEE Xplore, Springer, and Science Direct—with the keywords "hybrid recommender system" or "hybrid recommendation system," which are general keywords for finding research on recommendation systems. The next keyword is "e-commerce," which helps locate studies on recommendation systems used in e-commerce. Around 15 studies were included based on inclusion and exclusion criteria. This systematic literature review is defined as the process of identifying, understanding, and interpreting all available research evidence to provide answers to the research questions.

After analysis, it was found that hybrid recommendation systems combine Content-Based Filtering and Collaborative Filtering to address the limitations of the two previously mentioned methods. Hybrid recommendation systems have seven types: Weighted Hybridization, Switching Hybridization, Cascade Hybridization, Mixed Hybridization, Feature-Combination, Feature-Augmentation, and Meta-level.

From the eight studies reviewed, the most commonly used hybrid recommendation type is Weighted Hybridization. This method calculates weight scores based on the results from two or more methods, whether from Content-Based or Collaborative Filtering. Twelve algorithms were used in the studies to build hybrid recommendation systems.

Furthermore, the hybrid approach has proven to address various weaknesses of single methods like Collaborative Filtering (CF) and Content-Based Filtering (CB). The combination of these methods, particularly in the form of weighted hybrid and user-item CF hybrid, is the most widely adopted approach due to its ability to improve accuracy, reduce the cold-start problem, and provide more personalized recommendations. However, challenges such as system complexity, parameter tuning requirements, and data limitations still pose significant concerns. Effective implementation of hybrid methods requires careful design to ensure that the strengths of each algorithm are synergistically utilized. Additionally, there is a lack of consistent quantitative evaluation in many studies, limiting the ability to make direct comparisons between approaches. For future research, it is recommended to focus more on exploring hybrid approaches that integrate new techniques, such as graph-based models (Graph Neural Networks) and natural language processing (Transformer-based models), to enhance understanding of user and product context. Moreover, more experiments with real-world and open datasets are needed to allow for replicable and objective comparisons.

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