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Original Article

AI-Powered Cross-Platform E-Commerce Search and Ranking Platform Using Agentic AI

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Abstract

The proposed AI-powered cross-platform e-commerce search and ranking platform uses Agentic AI to coordinate multiple autonomous agents for user-intent interpretation, real-time data aggregation, product comparison, sentiment analysis, dynamic ranking, and personalized recommendation. The system is designed to support seamless interaction among AI agents, heterogeneous e-commerce data sources, and end-user interfaces through a modular, scalable, and performance-aware architecture. The platform emphasizes real-time responsiveness, adaptive ranking models, continuous learning from user behavior, and efficient inter-agent coordination to improve relevance, transparency, and decision quality in online shopping. The proposed design also focuses on reducing user effort during product discovery by unifying search over multiple marketplaces and presenting a clear ranked output supported by source-aware reasoning. This makes the system suitable for intelligent commerce environments where product information changes frequently and user expectations are highly personalized.

Introduction

The rapid growth of e-commerce platforms has transformed the way people shop by offering access to a large number of products across multiple online marketplaces. Although this expansion improves convenience and choice, it also creates challenges such as information overload, fragmented product data, inconsistent ranking strategies, biased recommendations, and the lack of personalized guidance. Users often need to search across multiple platforms, compare prices and reviews manually, and make decisions using incomplete or overwhelm-ing information.

To address these issues, this work proposes an AI-powered cross-platform e-commerce search and ranking platform using Agentic AI. The system provides a unified and intelligent shopping interface in which multiple autonomous agents collaborate to perform product discovery, data aggregation, analysis, ranking, and personalized recommendation. Unlike conventional recommendation engines that rely mainly on static algorithms, the proposed approach reasons over real-time data and user preferences to produce more accurate and transparent results.

The platform allows users to search through a single inter-face while collecting and standardizing product information from multiple e-commerce sources. By combining natural language processing, learning-based ranking methods, and agent-driven decision making, the system aims to identify products that best match user intent and constraints. To im-prove trust, the platform also exposes reviews and source links for informed decision making.

In current digital commerce ecosystems, users do not simply search by keywords such as product name or brand. They often express complex intent such as low budget, better battery life, trusted seller, latest model, quick delivery, or best overall value. Traditional systems frequently fail to understand this deeper intent because they are optimized for direct term match-ing or platform-specific ranking objectives. In contrast, an agent-based architecture can decompose the user request into smaller tasks, gather related evidence from multiple sources, and produce a more human-like decision support process. This makes Agentic AI a practical direction for modern search and recommendation.

Another important motivation for this work is the need for result transparency. Online users increasingly expect systems not only to recommend products but also to justify why

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certain products appear above others. By structuring the ranking pipeline through multiple AI agents, the proposed system can preserve intermediate reasoning signals such as relevance, price suitability, review sentiment, and availability confidence. These signals help produce ranked results that are easier to inspect and refine. Therefore, the proposed platform aims to improve not only search quality but also user trust, usability, and cross-platform shopping efficiency.

Objective

The objective of this project is to develop an AI-powered cross-platform e-commerce search and ranking system using Agentic AI. The system provides a single intelligent interface for product discovery across multiple e-commerce platforms. It analyzes user queries, preferences, and product attributes to return relevant ranked results. Agentic AI enables the system to autonomously fetch missing information, refine searches, and adapt ranking strategies. The platform is intended to reduce user effort, improve search relevance, and deliver personalized and context-aware recommendations.

A further objective is to build a scalable architecture that can support both mobile and web environments without changing the core ranking workflow. The system also aims to make product comparison more meaningful by normalizing heterogeneous data from multiple marketplaces into a common structure. This enables fairer comparison across products that may be described differently by different platforms. An additional goal is to create a design that can be extended later with richer analytics, feedback-driven adaptation, and domain-specific recommendation logic.

Problem Statement

Online shoppers often struggle to identify the most relevant products because data is distributed across multiple e-commerce platforms. Traditional search systems commonly rely on keyword matching, which can lead to poor relevance and weak ranking quality. Users are therefore forced to compare products manually across different websites, making the process time-consuming and inefficient. An intelligent unified search and ranking system that can dynamically adapt using Agentic AI is needed.

The problem becomes more difficult when product names are inconsistent, review quality varies across sources, and some attributes are missing or represented in incompatible formats. A user may search for one product category, yet rele-vant results may depend on hidden intent such as affordability, long-term durability, or brand preference. Existing systems often treat these factors independently instead of combining them in a coordinated and adaptive way. Hence, there is a clear need for a system that can understand intent, normalize data, and produce cross-platform rankings that remain useful under uncertainty and incomplete information.

Literature Review

Prior work on e-commerce search and recommendation has focused mainly on keyword-based search, collaborative filtering, and content-based recommendation. These approaches improve personalization within individual platforms, but they are less effective in handling cross-platform heterogeneity and dynamic user intent. Recent AI-driven recommendation research introduces machine learning and deep learning models, yet many such systems remain centralized and do not fully incorporate autonomous decision-making. Agent-based approaches improve adaptability and scalability, but their application to cross-platform e-commerce search and ranking remains limited. The present work combines agent autonomy with semantic intelligence to address these gaps.

Traditional recommendation methods have made important contributions to personalization, especially in environments where user history is abundant and product catalogs are tightly controlled. However, such methods may become less reliable when a system needs to combine information from multiple independent platforms that use different metadata standards, pricing logic, and review structures. In those scenarios, recommendation quality depends not only on user-item similarity but also on the ability to reconcile conflicting information and make decisions under incomplete evidence.

Recent developments in large language models have expanded the possibility of semantic product understanding. These models can interpret natural language queries, extract user preferences from conversational prompts, and support more expressive ranking logic than simple keyword overlap. Even so, language models by themselves are not sufficient for real-time commerce search unless they are combined with structured retrieval, platform connectors, and a clear orchestration mechanism. This is where Agentic AI becomes relevant. Autonomous agents can divide the overall search task into smaller responsibilities such as query understanding, source retrieval, review interpretation, and final ranking synthesis.

Another major theme in the literature is the shift from platform-centric optimization to user-centric decision support. Rather than prioritizing sponsored listings or isolated platform objectives, intelligent cross-platform systems should aim to maximize utility for the end user. This includes balancing relevance, affordability, availability, seller credibility, and interpretability. The proposed system follows this perspective by using a hybrid ranking strategy that can integrate semantic reasoning with practical constraints. As a result, the system aligns with current research trends while addressing a concrete gap in unified cross-platform e-commerce search.

Methodology

The proposed methodology follows a workflow similar to how a human shopper searches, compares, and selects products across online marketplaces, but executes the process in an automated and intelligent way through Agentic AI. The system first gathers user search queries, preferences, constraints, and context. It then evaluates search rules and platform-level constraints such as pricing variation, product availability, attribute inconsistency, and relevance conditions. After validation, autonomous agents retrieve, normalize, and evaluate product information from multiple e-commerce platforms.

Rule-Based Methodology

This methodology embeds predefined logical rules such as attribute consistency, relevance thresholds, platform fairness, and result transparency. Autonomous agents verify these rules before producing ranked output.

Constraint-Based Methodology

Operational limits are modeled as explicit constraints, including platform-specific restrictions, price boundaries, availability conditions, and user context. Ranking is produced only after these constraints are satisfied.

Optimization Methodology

The optimization stage balances relevance, cost-effectiveness, quality signals, and personalization. It attempts to reduce

redundancy, shorten search time, and improve the comparative value of recommendations.

Adaptive Learning-Based Methodology

The adaptive component learns from historical interactions, user search behavior, and feedback. Over time, agents refine semantic interpretation, ranking weights, and response strategies to improve personalization.

Hybrid Intelligence Methodology

The system integrates rule-based, constraint-based, optimization, and learning-based methods within a single Agentic AI framework. This hybrid design improves robustness, flexibility, and scalability.

Automated Workflow Methodology

The complete workflow, from query input to data retrieval, ranking, and output presentation, is automated. Once the user initiates a search, agents manage all intermediate steps with minimal manual intervention.

System Architecture

The system architecture is modular and layered to support scalability, reliability, and maintainability. Each module performs a dedicated role and interacts with the others through defined interfaces.

Mobile Frontend

A Flutter-based mobile application serves as the main user-facing interface. It supports login, product search, and display of AI-generated ranked results through secure API communication.

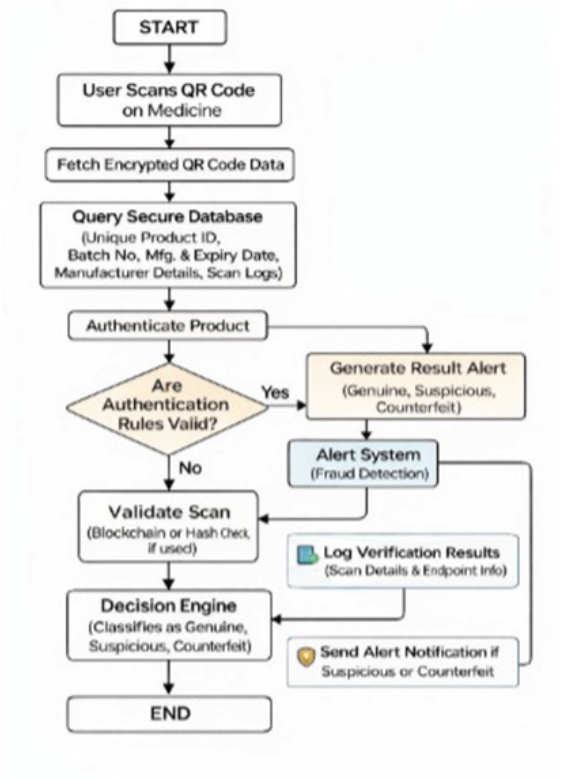

Fig. 1. *System architecture and workflow of the cross-platform e-commerce search and ranking platform.*

Web Frontend

A web interface is used for administration, testing, and monitoring. It helps manage static data, validate API responses, and inspect system behavior during development.

Backend Server

The FastAPI backend acts as the central controller. It receives requests from client applications, executes business logic, integrates AI services, and returns structured responses.

Authentication and Authorization

Supabase Authentication manages user registration, login, and session validation. It secures access to protected resources.

AI Processing Layer

The AI layer uses large language models and related AI services to process prompts, expand search intent, evaluate products, and support intelligent ranking and recommendation

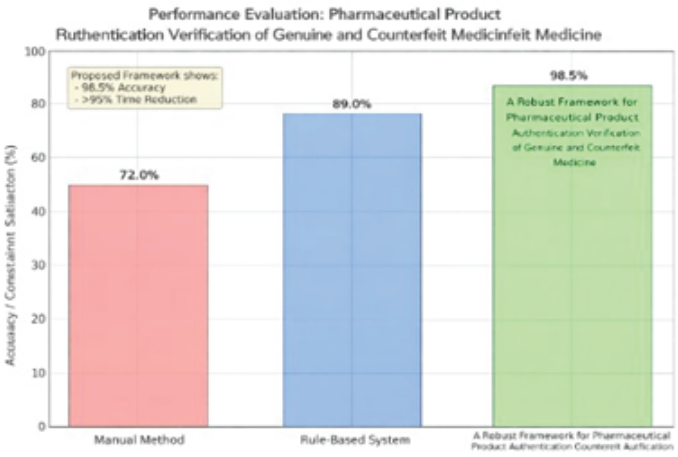

Fig. 2. *Experimental results of the proposed system.*

Results

The implementation demonstrates intelligent and unified product discovery across multiple e-commerce platforms. The system aggregates product data and processes search queries in real time. Agentic AI enables dynamic search expansion by fetching missing or incomplete product information when necessary. The ranking engine prioritizes products using relevance, user preferences, and contextual factors. Personalized output improves search quality and reduces irrelevant listings. The adaptive learning mechanism further refines ranking based on user feedback. Overall, the platform reduces the time users spend comparing products across websites and presents ranked results in a clear format that supports better decision making. The observed behavior of the system indicates that com-bining multiple ranking signals is more effective than using a single relevance score. For example, products that are seman-tically aligned with the query but poorly rated or unavailable can be pushed lower in the final ranking, while products with stronger overall utility can rise higher. This improves the practical usefulness of results because users generally evaluate products through multiple criteria rather than keyword similarity alone. The architecture also supports a smoother interaction flow because the user receives a consolidated response instead of repeatedly switching between platforms.

An additional outcome is the reduction of manual cognitive effort. In a conventional workflow, users often scan several pages, compare duplicated items, and interpret inconsistent specifications on their own. In the proposed system, the normalization and ranking stages absorb much of this burden. This leads to a more focused result set and a clearer shopping path. From a systems perspective, the modular design also demonstrates that search expansion, ranking, and presentation can be improved independently without redesigning the full application.

Discussion

The project shows that Agentic AI can strengthen conventional e-commerce search systems by adding autonomy and adaptability. Unlike basic keyword-based search, the proposed system considers user intent and context to generate more meaningful results. Data integration across multiple platforms creates challenges such as inconsistency and incomplete availability, which are addressed through adaptive search expansion. The dynamic ranking mechanism adjusts continuously using user behavior and feedback. The modular design also supports future integration of new data sources and AI models. Privacy, security, and response-time optimization remain important considerations for deployment in real-world environments.

One important discussion point is scalability. As the number of supported platforms increases, the system must handle more variation in schemas, response latency, and product duplication. The agent-based design is useful here because each stage can be distributed or optimized independently. Similarly, fault isolation becomes easier when one source fails or returns incomplete data. Instead of breaking the full search pipeline, the system can continue operating with partial information and still provide ranked results.

Another discussion point concerns explainability. E-commerce systems influence purchasing decisions, so users may benefit when the platform explains why a product is ranked highly. A transparent explanation can include factors such as match to user intent, favorable pricing, better reviews, or stronger availability. Such explanation is especially valuable when different platforms provide conflicting signals. There-fore, explainability should be treated as a core quality factor rather than an optional feature. The proposed system is well suited for this because agent outputs can be recorded and summarized into human-readable rationale.

Future Work

Several extensions can further improve the platform. First, the system can incorporate stronger sentiment analysis over customer reviews to separate reliable feedback from noisy or repetitive opinions. Second, multimodal understanding can be added so that product images, specifications, and textual descriptions are analyzed together for better ranking quality. Third, the platform can support conversational follow-up search, where users refine results through natural language prompts such as requesting cheaper alternatives, better brands, or improved delivery options.

The system can also be extended with stronger feedback learning. Instead of learning only from clicks or final selections, it can learn from skipped products, browsing duration, and repeated query reformulations. Such signals would improve personalization and ranking calibration. Another useful direction is fairness-aware ranking so that products are not over-prioritized merely because one source contains richer metadata. Future versions may also include domain-specific ranking modules for categories such as electronics, fashion, books, or groceries, where user priorities differ significantly.

A production-ready implementation can additionally benefit from caching, monitoring dashboards, and evaluation pipelines that measure relevance, latency, and user satisfaction more systematically. These improvements would support large-scale deployment and continuous refinement.

Conclusion

This work presents an AI-powered cross-platform e-commerce search and ranking system using Agentic AI to overcome limitations of traditional product search methods. By integrating autonomous intelligent agents, the system delivers personalized and context-aware results across multiple plat-forms. The adaptive ranking mechanism improves relevance while reducing user effort and search time. Cross-platform support increases accessibility and scalability for practical deployment. The system provides a foundation for future intelligent commerce applications.

Overall, the project demonstrates that intelligent orchestration is essential for next-generation commerce search. A useful shopping assistant must do more than retrieve products; it must interpret intent, resolve ambiguity, compare options fairly, and present results in a form that supports confident decisions. By combining search, normalization, ranking, and personalization under an Agentic AI framework, the proposed system offers a practical and extensible path toward that goal.

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