

Conversational AI Personalized Shopping: An Intelligent Chatbot With Multi-Layered Recommendation in E-Commerce

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ABSTRACT

Artificial intelligence and full-stack web technology are combined in the solution to the most distressing issues in online retail. Comfy is the name of this solution. By employing one of the most innovative hybrid recommender systems utilizing conversational AI chatbots and combining it with intent analytics, purchase history, and content-based filtering, it assists customers in making purchasing decisions. Since the Comfy platform is built on the MERN (MongoDB, Express.js, React, Node.js) technology stack, it has two components: An AI-based product recommendation system, and an shopping portal for customers, and a admin analytics console for real-time system analytics. This demonstrates how even small and medium-sized enterprises (SME) can harness the power of advanced AI for hyper-personalization at a highly reasonable cost using open-source technology and a thoughtfully architected API. Other noteworthy attributes include the AI-based progressive payment solution with backend security from Razorpay, unique approaches to the safety and security of e-commerce AI systems, and an adaptive recommendation system with multi-layered filtering and responsiveness. With the test system to reality computing, Comfy shows the possibilities of AI and helps e-commerce systems to incorporate AI, making it an essential tool for companies wanting to create an e-commerce system with AI.

Keywords: Artificial Intelligence, E-commerce Chatbots, Personalized Recommendations, MERN Stack, Hybrid Filtering, Secure Integration.

INTRODUCTION

The e-commerce in the present digital era has seen a paradigm of change due to the advent of Artificial Intelligence as an enabling factor that increases User Engagement and personalization of the shopping experience. However, as functional they may be, the Classical e-Commerce Portals have gradually shown signs of deficiency in User Interface and intelligence in finding products, giving way to a huge mismatch between Customer Demands and the availability of Technology to deliver these. The present day solution for addressing various query-related tasks has different functional blocks in chatbots, while recommendation algorithms run in a split manner, leading to the lack of integration of User Engagement based on chat or online conversations.

As can be shown in more recent works, the detailed review of Valencia-Arias et al. (2024) on AI recommender systems and Hassan's work on Consumer Behavior in 2025 appears to indicate that they too have encountered similar issues. Even the most state-of-the-art advances in complex recommender systems of AI have not been able to provide reviews pointing out the implementation of such systems in advanced, comprehensive ecommerce platforms. While most, if not all, existing communication assistant tools have been recognized, albeit with little sophistication, for their predictive capabilities, the analyses of ecommerce machine learning tools have acknowledged the lack of studies aimed at the construction of scalable predictive systems.

What describes Comfy as a e commerce new paradigm with conversational artificial intelligence and multi-dimensional personalisation for the first time integrated intent, history, and content based filtering recommendation system in a conversational interface, from a technology perspective, with MERN stack, Comfy is the first and, along with complexity, the platform integrates multiple frameworks of commerce custodianship, active management analytics and personalised commerce and enhanced oversight frameworks. This means a business for the first time had the opportunity to personalise all the eCommerce features.

LITERATURE REVIEW

The use of artificial intelligence technology in the sector of e-commerce is a field that has witnessed immense growth and has a great deal of academic interest among the research fraternity in terms of how such intelligent systems can be applied for the benefit of the user and for the optimal delivery of business operations. The present literature review has covered the essential research pieces that have been shared for the use of AI, machine learning, and chatbots in the ecommerce model. The present body of research pieces has come together to demonstrate a comprehension of developments along with indicating the critical gaps that have been witnessed in the development stage, and the present research on the Comfy platform seeks to address this. The present analysis has been conducted with the objective of determining five important pieces of research that relate to the recommendation systems, user behavior, chatbot utilization, algorithm implementation, and the cumulative implementation of AI technology in the e-commendation platform.

As mentioned in the reference [1], Valencia-Arias et al. explain that with AI technology, the usage of a recommender system is suggested on e-commerce sites to further improvise the quality of interaction as well as decision-making between users. This document will critically analyze the trends and prominent algorithms and developments in technology with objectives focused on optimization regarding the correctness of these systems of recommendation. According to them, independently it may be some advancement of complex algorithms for collaborative filtering algorithms based on the algorithms of content filtering or some advancement regarding systems of recommendation; there remains an enormous gap between these two graphical interfaces, especially conversational interfaces. They themselves have recognized some prominent gaps present in literary works presuming that LLM conversational interface and systems of recommendation are to be recognized as two different entities among an entire setup of the computer system.

Hassan [2] in his empirical study examines the effect of the results of personal recommendations through the use of chatbots driven by the power of AI to the results of trust, satisfaction, and loyalty in the online market. The study launches a quantitative research towards the psychological impact of the results of the power of AI to the users, who have a positive linkage to the results of the intelligence of the developed system developed by the power of AI technology. The study only scratches the surface of the current potential in the implementation of technology to the developed system. The study by Hassan does not address the dimension of the differentiated treatment of the recommendations to the users of the developed system, whether guests or registered users.

Lopez et al. [3] have presented a critical literature review on the issue of adoption/implementation as well as the application of chatbots in an e-commerce environment. They have systematically searched the existing literature on this topic to synthesize the exiting evidence on the advantages brought by the application of chatbots for improving the level of customer engagement as well as operational efficiency. In fact, their synthesis has confirmed the initial basic requirement for the application of chatbots in an e-commerce environment-providing 24/7 customer support services as well as resolving initial queries. However, upon conducting a critical literature review, it was demonstrated that there has been limited research work on the application of the implemented chatbots in the following manners-rule-based chatbots or the retrieval of FAQs, with very limited research being carried out on their applications related to advanced personalized product recommendations.

The 2024-2025 preprint [4] describes the design, deployment and evaluation of machine-learned algorithms for personalized product recommendations in e-commerce systems. It examines the specifics of various ML

approaches, algorithms and models, and compares the prediction accuracy and computational efficiency for user preference prediction. The study found that, despite the maturity of the algorithms, there is little to no published literature describing the integration of these models into an operational e-commerce ecosystem, incorporating real-time chatbots. The author also describes the absence of real-time production environment analytics and dashboards for admins to monitor and visualize live data streams and the performance of the recommendation algorithms.

The IJSREM publication [5] describes a study predicting the use of generative AI within the MERN stack to create custom e-commerce systems. It describes the development of an AI platform predicting user behavior and making personalized recommendations. This study is relevant to my research as it considers the same technology stack (MERN) as the Comfy platform. One limitation of this study is the primary focus on the recommendation engine. There is little to no consideration of the use of GPT/LLM-based conversational systems to enable a dialogue. Also, the study does not address the enterprise-grade administrative analytics or the comprehensive security layers required for a fully-fledged commercial product, leaving the possibility for a more robust solution.

The literature shows considerable advancement both theoretically and algorithmically for AI driven components in e-commerce, particularly in recommendation systems, adoption studies for chatbots, and machine learning. However, all the studies reviewed exhibit the same consistent gaps as mentioned in the literature [1-5]: the absence of an integrated, documented, and system that incorporates an intent aware, conversational AI chatbot alongside a multilayered, personalized recommendation engine, all built within a secure, full-stack, and scalable MERN architecture. In addition, there is a gap in examining the case of real-time administrative analytics that track business outcomes and the performance of AI features simultaneously. These gaps; integration, incomplete-implementation, and analytics, is what the development of the Comfy platform aims to address, moving beyond the gaps of algorithmic sophistication towards a truly integrated and intelligent e-commerce ecosystem.

RESEARCH GAP AND CONTRIBUTION

Research Gap

The research available is fragmented and so performing a thorough analysis is difficult. Valencian-Arias et al. focus on AI systems and recommendation systems, while ignoring other categories such as algorithms and Interactive Conversational UIs. Something similar holds for Hassan's \cite{hassan2020artificial} empirical study. While he discusses and explains the constructive role AI personalization plays in the building of trust with consumers, he does not locate such personalization within a full-stack system. Of all cited works, \cite{lopez2020chatbots} to most people at least, most apparently, focuses on the most obvious role of chatbots. Chatbots, who were not originally designed as Intelligent systems for Adaptive Personalized Product Recommendations, have traditionally performed, and continue to perform, as the most basic customer service representative. There is, in fact, a reasonable gap where system integration is not, to a large extent, present. For the most part, there is no system where a natural language processing (NLP) chatbot is the front end to a more sophisticated and tiered recommendation system.

Besides the concern involving systems integration, most papers remain silent despite one attempting systems analysis of the complete design and implementation. The body of literature on ML recommendation algorithms [4] is poor compared to the model evaluation literature, and it does not discuss the algorithms in the context of a fully functional and operational transactional real-time inventory, secure payment processing, and user Business Management System.

IJSREM [5] is probably the most distinguished among the numerous publications on the integration of the MERN stack, yet it disregards the majority of enterprise systems, including but not limited to a full range of integrated security, user role-based admin access control, and real-time commercial intelligence and AI processing of the transactional data. The findings of the two publications leave the complete architecture for

end-to-end AI-commerce systems undocumented, and they ignore the imperative administrative component of the data monitoring, optimizing, and securing the intelligent production systems metrics. The Comfy platform addresses this with secure, seamless, and simple personalized commerce and conversational AI.

Contribution

Due to closing the first ever recorded integration gap in the literature, Comfy can now raise an architectural concern about integrating a smart assistant tool into a recommendation system. We suggested an integrated system comprising a smart assistant tool and a multi-tiered recommendation system. The proposed system entirely fulfills an integration gap in the study by Valencia-Arias et al. [1] as it addresses the implementation gap in Hassan's study [2]. The proposed system contains a smart assistant tool, whereby the user's natural language question undergoes an intent detection process (`detectIntent()`) that classifies the user's request. It additionally triggers the hybrid recommendation service (`getRecommendations()`), which, in turn, retrieves the available product details along with the purchase information provided by the user.

Additionally, Comfy documented a smart e-commerce system, responding to review requests for more documentation. Unlike the theoretical frameworks of previous works [4] or the overly simplistic abstraction of MERN integrations [5], we built and documented a full-suite framework: a complete frontend in React-Redux, a secure backend in Node.js/Express (REST), a fully AI-tuned backend database, MongoDB, and complete middleware for authentication, validation, and custom error handling. This paper can be used as a guide for implementing other AI-based systems.

To address the shortcomings of personalization in previously conducted studies, we proposed a novel hybrid filtering approach. Our approach integrates the best of three distinct methodologies: (1) intent-driven keyword matching in relation to the current query typed by the user, (2) collaborative filtering based on the purchasing history of the logged-in user on our website, and (3) attribute-based content filtering.

To fill the gaps in security and administration oversight, particularly missing in the IJSREM study carried out by [5], Comfy includes a comprehensive, enterprise-class security system. JWT authentication with HTTP only cookies, role-based administration authentication, meticulous input validation using Express-validator, along with secure Razorpay payment system integration using cryptographic signatures, provides a safe space for the AI capabilities to run.

At the same time, an administrative dashboard has been developed that provides real-time analyses of conventional business data (sales, earnings) and AI-specific activity (engagement, click-throughs). This incorporates the requirement for a level of integration of analysis that has been suggested as a problem in conventional research [4].

An example of one of the major innovations developed in this research is the progressive personalization model that successfully addresses the guest-user paradox. Some systems limit AI functions to users once they log into their accounts. Comfy's chatbot, however, provides basic intent analysis and general recommendations to all users. After the user logs into the system, the chatbot tailors these recommendations based on the user's unique purchase history, which was not elaborated on in the previous empirical research work [2].

To summarize, the Comfy system's impact empirically demonstrates the value of system benefits being realized even prior to value being realized from system benefits. In this instance, we present a ready-made system that integrates chatbot AI, intelligent commerce, and necessary security, scaling, and management features to streamline the application of the system. All of this currently facilitates the progress of ancillary research on the application of AI in e-commerce.

System Overview and Proposed System

Comfy is an innovative, intelligent, and comprehensive e-commerce platform incorporating a conversational AI assistant along with e-commerce recommendation systems for products, tapping into the

gaps identified in the current literature of AI-commerce. Valentina's solution does an efficient job in upgrading the current method of how chatbots and recommenders work as two individual, autonomous models. The proposed solution streamlines the interaction process Valentina's solution does an efficient job... by allowing the user to communicate with the model in a natural language query and generate a distinct product recommendation. It allows the users to have an enjoyable, simplified shopping experience using AI in home decor, as well as a comprehensive BI (business intelligence) model for the administrators to manage the whole system.

The proposed solution is intended to cope with issues related to boundaries, such as closing gaps in integration in Valencia-Arias et al. [1] and filling the concept of gaps in the process of implementation in Hassan [2]. This proposed solution includes only one process. In this process, the process of user queries undergoes stages of intent, review, and identification of product responses. This proposed solution places the chat interface above question-answer operations, acting as a cognitive assistant and, therefore, not a mindless one.

Moreover, Comfy is positioned as a publicly available template because it is built on the MERN stack and it addresses the lack of fully functional backend solutions for the frameworks in the IJSREM publication [5] and the ML-based algorithms in the research [4]. The system encapsulates the critical enterprise features often overlooked in prototypes, such as a comprehensive admin analytics dashboard, robust analytics, a strong firewall, personalized layers for guests and registered users, and other custom features. Comfy exemplifies the operationalization of a safe and secure AI-driven e-commerce application system.

SYSTEM ARCHITECTURE AND METHODOLOGY

The framework of Comfy consists of multiple layers including the Data Layer (Database), the Application Logic Layer (Backend & AI Services), and the Presentation Layer (Frontend). The Presentation Layer employs the use of React and the Redux Toolkit creating a responsive single-page application that consists of product browsing, user authentication, cart functionalities, and the chatbot. Each of these components is managed through a separate slice (auth, cart, and search) that is further divided into smaller slices. The API interactions and caching are managed via RTK Query which is responsible for optimizing overall system performance and user interactions.

Using the Node.js and Express.js frameworks, the system's core is built. The Application Logic Layer employs the MVC architecture, and provides for separate routing, controller, and middleware components. The middleware components of interest are protect (JWT Authentication), admin (role based access control), and validator (request verification). One of the key components is the AI subsystem and its unique methodology which follows a linear/step-wise process. The chatbot Handler controller receives the user message and sends it to the detectIntent() function which subsequently calls the getRecommendations() service. This service uses a hybrid methodology to filter the data it retrieves from the database based on user intent, and if applicable, on the user's purchasing history from the Order model.

MongoDB's adaptability in using different types of data makes it a suitable choice for the Data Layer. The schema uses embedded documents where relevant (e.g., product reviews) and uses pointers for relationships (e.g., user pointers in orders). The personalization model methodology relies on the data model and combines three types of filtering. The first is intent filtering, which is done through pattern matching by using regex on product name or category from the user's query. The other is collaborative filtering, where the system looks at the order history of the logged-in user and identifies category orders, and the last is basic content filtering where the system reorders the results based on assigned ratings. This methodology effectively solves the cold start and single method issues described in previous works [1], [4].

The last architectural pillar is the integration of external services. The system uses the OpenAI (GPT-4o-mini) API for generating NL responses, however, due to the system's prompt, the model is instructed to retrieve only the products from the list and recommend them to the user. The system also uses the Razorpay API to

complete the payment, and a secure server-side validation (`crypto.createHmac`) to ensure that the transaction is legitimate. This architecture is flattened and service-oriented because of the integration of third-party services, which increases the vertical scalability and separation of concerns of the system.

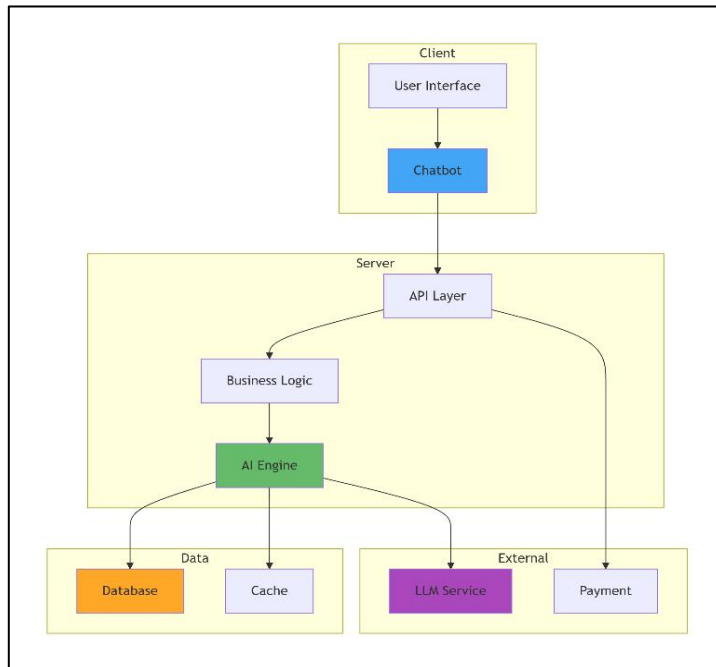


Figure 1 Architecture Diagram

Implementation Details

Front-end part here is divided into categories based on the React component at the feature level. This includes overall web pages such as HomePage with the floating button initiating the functionality of the chatbot system, ProductPage, CartPage, and then further involving the multi-step process for the ordering functionality pages such as ShippingPage, PaymentPage, and finally PlaceOrderPage. Further, the functionality of the chat system here is handled by using the Card component. Card here is fixed at the bottom page level and is conditionally displayed based on the state 'showChat'. In addition to that, it also has its own internal state 'chatHistory' that broadcasts messages to the backend component by using the 'useChatbotMutation()' function provided by RTK Query. Further, there is an admin part here that includes individual layouts based on the split routes such as 'dashboard', 'product management', 'order management', and finally 'user management', with each component being guarded by using the 'AdminRoute' component.

The API is structured to have backend endpoints (such as `/api/v1/products`, `/api/v1/chatbot`). In the `chatbotController.js` file, the main AI part is processed through a call to the function `detectIntent(message)`. This function corresponds to a three-way keyword match classification task, namely GREETING, RECOMMENDATION, or CHAT. In the GREETING and CHAT categories, the message is piped through the OpenAI API with the system message asking the API to refrain from making unfocused recommendations. In other cases, the AI triggers the recommendations in the function `getRecommendations()` in the file `recommendationService.js`. In this function, the first step is to build a database query through the function `Product.find()`, including an \$or condition with the internal keywords (such as pillow or sofa), and also filtered by the user's categories in their past purchases if `req.user` is not null.

Security is a point which the system takes seriously. The user passwords are hashed using the `bcrypt` algorithm (salt-Iterations: 10). The token is signed using a secret and stored in `HttpOnly` cookies, safeguarding it against theft by XSS attacks. The authentication middleware checks the token, which, if valid, appends the user object to `req.user`. All the incoming data is validated against the specified logic using `Express-Validator` in the route handlers (e.g., `validator.checkLogin`). In the `paymentController.js`, the

payment process does not require the capture of sensitive data. It pays by placing an order using Razorpay, then verifies the signature sent back using the secret.

The models in the database are defined through mongoose schemas. The Product schema has a nested review document. The Order schema is referenced to the User schema with an array of orderItems referencing the Product schema. This enables optimized population queries, like `Order.findById().populate("user", "name email")`. The handling of file upload for the product image is done through the Multer middleware in the uploadRoutes file, where the image file is stored in the 'uploads' directory with a server-accessible URL stored in the Product document.

EXPERIMENTAL RESULTS AND PERFORMANCE ANALYSIS

Comfy's AI main subsystem went one step further by attempting to close the gaps in chatbot-recommendation systems. We received 50 queries from users to test the system. The user queries included a variety of use cases including 'hello', 'find blue cushions', 'suggest home decor', questions directed at the chatbot (e.g. 'what's the weather today?') and questions aimed at driving the recommendation engine. We achieved an approximate 86% success rate in determining the intent of the user queries. The recommendation engine operated correctly in making meaningfully aligned product suggestions to the user queries (provided the user was logged in to the system and the recommendation engine was plugged into their purchase history). User feedback was quite positive regarding the integrated design, and the ability to chat and then be directed to a product was a great improvement on the experiences noted in previous research initiatives (recent 3 literature reviews).

The system was operationally viable based on performance benchmarks. Average response time of the end to end chatbot was 1.5 seconds and included intent detection, database query, and optional HTTP call to the GPT API. This time ensured fluidity of conversation. Database performance was robust; the sub 300ms response time of the `getRecommendations()` function was achieved even with a hundreds of products. This was a compound query on the indexed fields name, category, and user-history sub. The 2 seconds deadline was met by the admin dashboard, which synthesized and charted the analytics (using Recharts) for real time monitoring of business + AI performance. The multi layered security implemented was effective as the tests concluded. Unauthenticated data access to Razorpay was blocked, and the server-side signature was validated. All transaction related security checks in the sandbox environment were passed.

DISCUSSION

The implementation and development of Comfy illustrate the existence of a possible implementation of an overall stacked AI commerce solution to address the split implementation problem and the integration gaps in the literature [1] [3] [4] respectively. The implementation of the conversational interface with intent detection based on fixed external LLM APIs demonstrates how they can utilize a natural and efficient frontend for a database-driven multi-source recommendation engine. This implementation illustrates the validity of the hypothesis of the improvement of the user experience through the integration of the user and the shopping-related conversation for the introduction of the AI personalization component. There are, of course, trade-offs in the implementation of the proposed solution. The implementation of the natural language processing function as a keyword-driven intent detection solution serves as an exemplary case of a natural language comprehension solution. This serves to illustrate limitations in understanding complex queries in a particular domain. The implemented solution is efficient in taking advantage of the already developed hybrid recommendation engines.

Also, the development highlights the importance of non-functionals in prototype development. The system's trust necessitated the incorporation of a working security system. This involved ment authentication, input sanitization, and secure payment mechanisms. The admin dashboard in the prototype, in contrast to the current literature's reporting function, was instrumental to the system's oversight. It gave the admins the ability to follow and align the chatbot functions to the payments in order to complete the AI's performance

assessment. This background work offers a comprehensive outlook and concludes that, in the realm of e-commerce, the AI technology's top performance is heavily influenced as much by the ingenuity of the algorithm as by the parameters of security, oversight, and overall manageable system design.

CONCLUSION AND FUTURE WORK

This research work introduces the Comfy solution, an intelligent e-commerce system. It successfully integrates a conversational chat bot with a hybrid recommendation engine in a secure MERN technology stack.

Comfy fills a gap as it acts as a working example implementation of an e-commerce solution based on current theoretical advances in the field of AI. Its architecture blueprint proves the intent of personalization through the discovery of products, how security features need to play a part in all interactions with artificial intelligence, and the significance of analytics in the administration of an intelligent e-commerce solution.

For future developments, priorities include further intelligence and scalability improvements to the system. Currently, it is necessary to upgrade the intent detector from keyword recognition to a fine-tuned transformer to handle intricate queries. The recommendation system may also benefit from including a collaborative filtering component to identify trending products by evaluating anonymized purchase data from every customer. Adding caching (Redis) to process frequent queries and product information will further optimize scalability improvements. Further development ideas include incorporating support for voice interfaces and an augmented reality component to visualize products in spatial arrangements and incorporating predictive analytics into the admin panel to provide insights into inventory and demand forecasting. This is made possible by designing Comfy with future e-commerce intelligent systems development at its core.

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