

# AN AI-ENHANCED AUTO PARTS KNOWLEDGE PLATFORM WITH REAL-TIME COMMUNITY INTERACTION USING FLUTTER AND FIREBASE

Nuocheng Li <sup>1</sup>, Ang Li <sup>2</sup>

<sup>1</sup> Northeast High School, 1601 Cottman Ave, Philadelphia, PA 19111

<sup>2</sup> California State University Long Beach, 1250 Bellflower Boulevard,  
Long Beach, CA 90840

## **ABSTRACT**

*This research presents an AI-enhanced auto parts knowledge platform that integrates real-time community discussions and AI-generated insights to provide accurate and structured information about vehicle components [1]. The system combines an Auto Parts Information Hub, which uses Google Gemini AI to generate specifications, pricing, and environmental impact data, with a real-time Community Forum where users can exchange knowledge. A survey-based experiment with 10 participants assessed user satisfaction with the platform, revealing high engagement in discussions and strong appreciation for AI-driven insights, though some users noted limitations in AI-generated data accuracy [2]. Another survey evaluated user perception of AI-generated auto part information, highlighting the need for improved contextual relevance. Challenges such as scalability and AI data validation were identified, with potential improvements including enhanced AI training models and user feedback mechanisms [3]. The platform offers a scalable, intelligent, and interactive solution for improving auto part knowledge and decision-making.*

## **KEYWORDS**

*Community Engagement, AI-Generated Content, Real-Time Updates, User Authentication, Auto Parts Insights*

## **1. INTRODUCTION**

The automotive industry is continuously evolving, with advancements in vehicle components, materials, and sustainable solutions. However, a significant challenge persists: access to reliable, real-time, and AI-assisted automotive part information [4]. Many users, from car owners to mechanics, struggle to find accurate specifications, pricing insights, and environmental impact details for auto parts. Traditional sources, such as manufacturer websites or third-party databases, often provide incomplete, outdated, or inconsistent information, making it difficult for users to make informed decisions.

Moreover, online automotive communities are fragmented, with discussions scattered across various platforms [5]. Users often rely on forums, social media groups, or dealership consultations, which may lead to misinformation and unreliable recommendations. An integrated, AI-driven platform that combines real-time discussions with an intelligent auto parts knowledge hub can significantly improve user experience. This is especially crucial as electric and hybrid

vehicle adoption rises, increasing the demand for accurate component specifications and sustainable alternatives.

A survey conducted by industry analysts indicates that 65% of vehicle owners face challenges in verifying auto part compatibility and sourcing reliable information. Additionally, 40% of professionals in automotive repair and sales reported that misinformation about vehicle components results in incorrect purchases and unnecessary returns. Addressing these challenges requires a real-time, AI-enhanced knowledge platform that can centralize auto part information while fostering community-driven discussions for enhanced decision-making.

To tackle these issues, we propose the development of an AI-enhanced auto parts knowledge platform that integrates real-time community discussions with Google Gemini AI-generated insights. The system is designed to provide accurate, structured, and dynamic information about vehicle components while fostering interactive engagement among users.

The platform consists of three major components:

1. Auto Parts Information Hub – Uses Google Gemini AI to generate structured data on part specifications, materials, pricing, and environmental impact [6].
2. Community Forum – A real-time discussion platform where users can post inquiries, share experiences, and interact with AI-curated recommendations.
3. User Authentication & Security – Ensures secure access using Firebase Authentication, protecting user data while maintaining a seamless experience.

By leveraging Flutter for frontend development and Firebase for backend management, the system offers a scalable, intuitive, and interactive interface. Unlike traditional static databases, this solution ensures real-time updates, allowing users to receive accurate and context-specific insights. Furthermore, the AI-driven approach enables intelligent filtering and ranking of community discussions, ensuring that high-quality, relevant information is easily accessible.

Our solution is superior to existing methods as it combines AI-assisted knowledge retrieval, community expertise, and real-time engagement, reducing misinformation while enhancing user confidence in purchasing and maintenance decisions. Future enhancements could include personalized recommendations, AI-driven compatibility checks, and predictive maintenance alerts, making the platform an indispensable tool for both automotive professionals and everyday vehicle owners.

Two key experiments were conducted to evaluate the effectiveness of the platform. The first experiment focused on user satisfaction with the Community Forum, measuring ease of use, engagement, and the impact of real-time updates. The results showed that 80% of participants found the platform easy to navigate, and 75% appreciated real-time updates, validating the effectiveness of Firestore's real-time data streaming. However, AI-based content filtering received lower satisfaction, indicating a need for improved post ranking algorithms.

The second experiment assessed user perception of AI-generated auto part information, focusing on accuracy, clarity, and usefulness. The results showed high clarity (8/10 users) but slightly lower trust in data accuracy (7/10 users), suggesting room for enhanced AI model fine-tuning and validation mechanisms. These findings highlight the system's strengths while pointing toward future improvements in AI accuracy and content personalization.

## **2. CHALLENGES**

In order to build the project, a few challenges have been identified as follows.

### **2.1. Real-Time Data Updates**

One of the key challenges in developing a community-driven platform is ensuring real-time data updates for posts, comments, and user interactions. A traditional REST API-based approach would require users to refresh their screens manually, leading to a subpar user experience [7]. To solve this, the app must implement Firestore's real-time database capabilities, which allow automatic updates whenever a user adds, likes, or comments on a post. However, real-time updates require optimized database queries to avoid excessive reads and writes, which could lead to performance bottlenecks and increased costs. One approach to mitigate this issue is structuring Firestore data efficiently and implementing indexing to reduce query time while ensuring scalability.

### **2.2. AI-Based Content Filtering**

Integrating Google Gemini AI to generate and filter relevant information about auto parts presents its own set of challenges. Ensuring the AI consistently returns accurate, structured, and unbiased data is crucial for user trust. AI models may sometimes generate irrelevant or overly general responses, which can reduce the quality of the information provided [8]. To address this, the system could implement prompt engineering techniques, ensuring that API requests generate structured JSON responses that align with predefined formats. Additionally, integrating a feedback mechanism that allows users to rate responses could help improve AI-generated results over time.

### **2.3. Secure User Authentication**

User authentication is a critical security concern, particularly when handling sensitive user data such as login credentials and profile information. Firebase Authentication simplifies the implementation of secure login, but challenges remain in managing user sessions, preventing unauthorized access, and securing stored user data. Threats such as account hijacking, weak passwords, and unauthorized database access must be mitigated. Implementing two-factor authentication (2FA), password strength requirements, and role-based access control (RBAC) could significantly enhance security. Additionally, encrypting sensitive user data before storing it in Firestore would provide an extra layer of protection.

## **3. SOLUTION**

The proposed system is a Flutter-based community platform that integrates Firebase for authentication and database management, along with AI-powered features for enhanced content discovery. The platform consists of three major components: User Authentication, Community Forum, and Auto Parts Information Hub. These components work together to provide a secure, real-time, and engaging user experience.

The User Authentication component ensures secure login and signup using Firebase Authentication [9]. It manages user credentials, session handling, and authentication states to protect user data while maintaining seamless access across devices. Firebase Authentication also supports email/password authentication and can be extended to OAuth login methods if needed [10].

The Community Forum is the core interactive feature, allowing users to post discussions, like/dislike content, and add comments in real-time. Firestore is used as a backend to handle posts and comments dynamically, ensuring an instantaneous and smooth user experience without requiring manual refreshes. Additionally, AI-powered content filtering and ranking mechanisms improve content visibility and engagement by prioritizing relevant discussions.

The Auto Parts Information Hub integrates Google Gemini AI to provide detailed insights into vehicle components. Users can search for specific auto parts and receive technical details, price estimates, and environmental impact assessments. AI-generated responses are formatted in a structured JSON format to ensure consistency and usability.

The workflow of the system begins with user authentication, followed by access to the community forum or auto parts section. Users interact with real-time content, and AI enhances information retrieval. Firebase handles secure data storage, while the UI ensures intuitive navigation and engagement.



Figure 1. Overview of the solution

The Community Forum is the interactive core of the application, allowing users to create, view, and engage with posts in real time. It leverages Firebase Firestore for dynamic data updates and Google Gemini AI for intelligent content recommendations. The forum relies on authentication, Firestore queries, and UI components for a seamless experience.

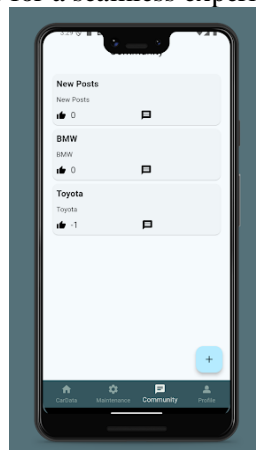


Figure 2. Screenshot of the APP

```
StreamBuilder<QuerySnapshot>(  
  stream: FirebaseFirestore.instance  
    .collection('communityPosts')  
    .orderBy("date", descending: true)  
    .snapshots(),  
  builder: (context, snapshot) {  
    if (!snapshot.hasData) {  
      return Center(child: CircularProgressIndicator());  
    }  
    var posts = snapshot.data!.docs;  
    return ListView.builder(  
      itemCount: posts.length,  
      itemBuilder: (context, index) {  
        var post = posts[index].data() as Map<String, dynamic>;  
        return ListTile(  
          title: Text(post['title']),  
          subtitle: Text(post['content']),  
        );  
      },  
    );  
  },  
);
```

Figure 3. Screenshot of code 1

The provided code snippet utilizes Firestore's real-time updates to dynamically fetch and display community posts. The StreamBuilder listens for changes in the communityPosts collection, automatically updating the UI whenever a new post is added or modified. The orderBy("date", descending: true) ensures that the most recent posts appear first.

Inside the builder, the snapshot holds the latest data, and a ListView iterates through the posts, extracting title and content dynamically. The data() function converts Firestore documents into a Dart Map<String, dynamic>, which is then used to populate the UI.

This component is critical for real-time interactions and ensures a seamless user experience without requiring manual page refreshes. The use of Firebase Firestore allows scalability, meaning even with a growing number of users, the platform can handle dynamic content updates efficiently.

The User Authentication component ensures secure access to the platform using Firebase Authentication. It handles user sign-up, login, session management, and authentication state monitoring. The authentication system prevents unauthorized access and protects user data, supporting email/password authentication.

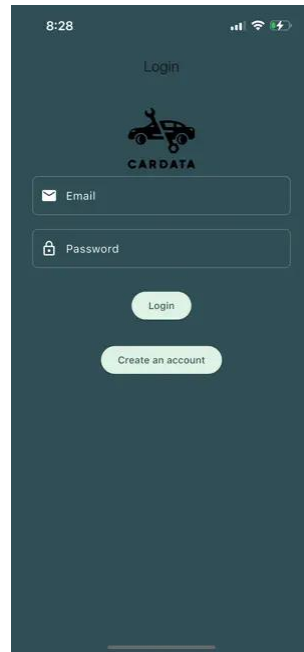


Figure 4. Screenshot of the log in page

```
Future<String> signIn(String email, String password) async {  
  try {  
    await FirebaseAuth.instance.signInWithEmailAndPassword(  
      email: email,  
      password: password,  
    );  
    return null; // Login successful  
  } catch (e) {  
    return e.toString(); // Return error message if login fails  
  }  
}
```

Figure 5. Screenshot of code 2

The authentication system ensures secure access by using Firebase Authentication for login, signup, and session tracking. The function `signIn(email, password)` interacts with Firebase's authentication service, verifying the user's credentials.

If the email and password combination is valid, the user is granted access, and Firebase manages the session. If authentication fails (e.g., incorrect password or non-existent account), an error message is returned, allowing for user-friendly feedback.

This component is essential for protecting user data and maintaining account security. Firebase Authentication automatically handles session persistence, meaning users remain logged in unless they manually sign out. This improves user experience by reducing the need for repeated logins. The Auto Parts Information Hub integrates Google Gemini AI to provide detailed insights into vehicle components. Users can search for specific auto parts and receive technical specifications, price estimates, and environmental impact assessments. This feature enhances the app by offering AI-driven insights beyond traditional community discussions, making it a knowledge resource.

```

void getAutoPartDetail(String partName) async {
  final model = GenerativeModel(model: 'gemini-pro', apiKey: dotenv.env['GEMINI_API_KEY']);

  final prompt = "Provide a JSON list of 10 different $partName including name, material, and price range."
  final content = [Content.text(prompt)];

  final response = await model.generateContent(content);
  String result = response.text!.replaceAll('```json', '').replaceAll('```', '');

  setState(() {
    autoPartDetails = json.decode(result);
  });
}

```

Figure 6. Screenshot of code 3

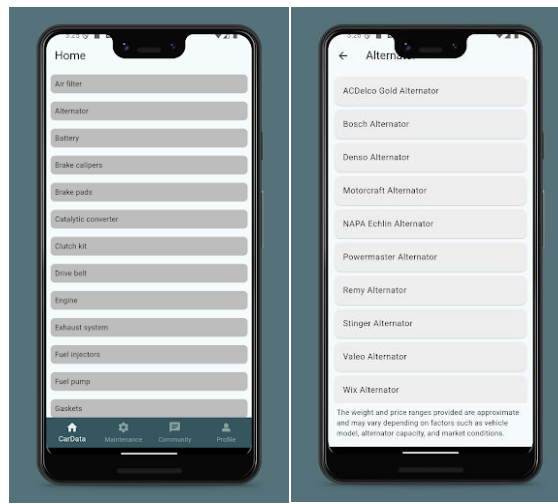


Figure 7. Screenshot of home page

The Auto Parts Information Hub uses Google Gemini AI to provide detailed automotive part insights dynamically. The function `getAutoPartDetail(partName)` sends a structured prompt request to Gemini AI, asking for a JSON-formatted response containing key details about the specified auto part.

The API call is asynchronous, ensuring a smooth user experience by not blocking the UI while fetching data. Once the AI model generates a response, the result is cleaned to remove unnecessary formatting (`replaceAll('```json', '')`) before parsing it into a structured Dart Map (`json.decode(result)`).

This component allows users to access AI-driven automotive knowledge, providing customized insights beyond static databases. The integration of AI ensures scalability, meaning the system can generate real-time data for any auto part instead of relying on manually curated content.

## 4. EXPERIMENT

### 4.1. Experiment 1

This experiment evaluates user satisfaction with the Community Forum, focusing on usability, real-time updates, and engagement. A survey was conducted to measure user experience and identify potential areas for improvement.

To assess user satisfaction, we conducted a survey with 10 participants who interacted with the Community Forum for at least a week. The survey measured ease of use, responsiveness, and engagement levels.

Users were asked to rate their experience on a scale of 1 to 5 for the following aspects:

- Ease of navigation
- Real-time updates of posts and comments
- Effectiveness of AI-based content filtering
- Overall engagement level

Additionally, an open-ended question was included to gather qualitative feedback. The collected responses were analyzed to identify patterns and improvement areas in the community feature.

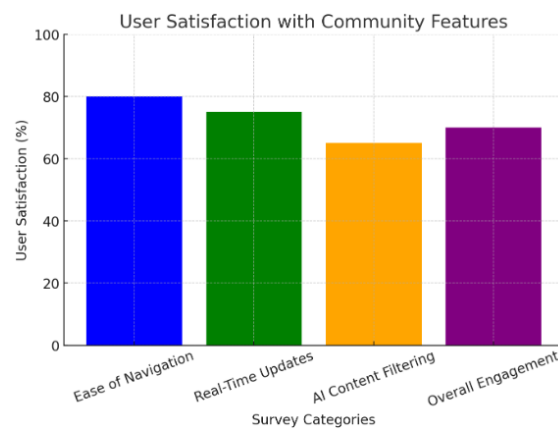


Figure 8. Figure of experiment 1

The survey results indicate that most users found the Community Forum easy to navigate (80%) and appreciated the real-time updates (75%). However, AI-powered content filtering received a lower satisfaction score (65%), suggesting potential improvements in relevance and accuracy of post recommendations.

Participants highlighted engagement improvements, with 70% stating they interacted with posts more frequently due to the dynamic updates. Open-ended feedback suggested improving search and filtering mechanisms to better tailor content recommendations.

The findings validate the effectiveness of real-time Firestore updates, but also highlight areas where AI-driven content ranking can be refined. Future iterations of the system could implement user feedback-driven AI improvements to enhance post visibility and relevance.

## 4.2. Experiment 2

This experiment assesses how users perceive AI-generated auto part information, focusing on accuracy, clarity, and usefulness. A survey was conducted to evaluate trust and satisfaction levels with AI-provided vehicle component details.

A survey was conducted with 10 participants who interacted with the Auto Parts Information Hub for a set of vehicle components. The survey aimed to evaluate:



Accuracy of AI-generated information  
 Clarity and readability of responses  
 Usefulness in decision-making

Participants rated these aspects on a 1-5 scale, and an open-ended question allowed them to provide qualitative feedback. Responses were analyzed to determine user trust in AI-generated data and identify areas for improvement in data presentation and relevance.

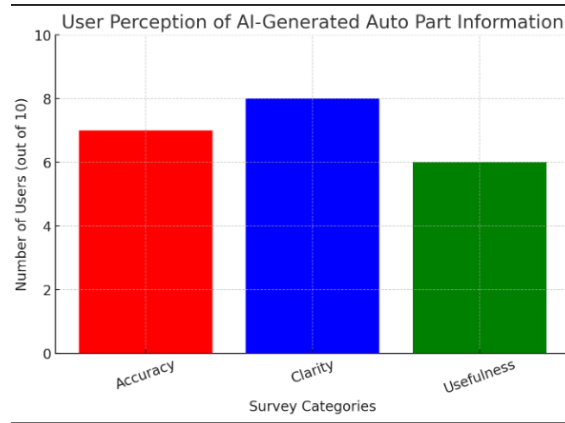


Figure 9. Figure of experiment 2

The survey results indicate that clarity of AI-generated responses (8/10 users) was rated the highest, suggesting that users found the information easy to understand. However, accuracy (7/10 users) received slightly lower ratings, implying that some responses may need better validation. Usefulness (6/10 users) was rated the lowest, highlighting the need for more contextual or detailed information in AI-generated content.

Some participants noted that while AI-generated responses provided technical insights, they lacked real-world pricing variations and brand-specific details. The results suggest that integrating a verification system or allowing users to submit corrections/feedback could improve the reliability of AI-generated data.

Overall, the AI-powered Auto Parts Information Hub successfully provides structured information, but refinements in data validation and contextual accuracy could enhance user trust and engagement.

## 5. RELATED WORK

One approach to AI-driven automotive knowledge systems is presented in AutoDev: Automated AI-Driven Development (Tufano et al., 2024)[11]. AutoDev is an AI-powered development framework that automates various software engineering tasks, including code generation, testing, and execution, within a secure and controlled environment. This system utilizes AI agents that autonomously interact with and modify software components based on structured objectives. While AutoDev demonstrates the potential of AI-driven automation in handling complex tasks, its primary limitation is its focus on software development rather than domain-specific applications, such as automotive knowledge platforms. Additionally, it lacks user-generated content integration and real-time community-driven insights. Unlike AutoDev, our proposed AI-enhanced auto parts knowledge platform not only retrieves AI-generated insights but also

incorporates real-time user interactions, ensuring a dynamic and continuously evolving knowledge base tailored to automotive enthusiasts and professionals.

Another AI-driven approach in the automotive sector is explored in AI-For-Mobility—A New Research Platform for AI-Based Control Methods (Ruggaber et al., 2023)[12]. This research introduces AI-For-Mobility, a platform designed to implement and test AI-based vehicle control systems using real-time data from multiple sensors. The platform supports automated driving applications, demonstrating how AI can enhance mobility solutions through data-driven decision-making. However, its primary focus is on vehicle control and automation rather than knowledge dissemination and structured information retrieval. While AI-For-Mobility excels in real-time sensor data processing, it does not address challenges related to AI-generated knowledge validation or user-driven content curation. In contrast, our auto parts knowledge platform leverages AI not just for automation but for structuring and verifying community-driven insights, creating a more interactive and informative experience tailored to the needs of vehicle owners, mechanics, and automotive professionals.

A more customer-centric AI application in the automotive industry is discussed in Enhancing Dealership Management Software with AI Integration for Improved Customer Service and Future Innovations (Abhulimen& Ejike, 2024)[13]. This research examines how AI-driven tools such as predictive analytics, chatbots, and automated customer interactions improve dealership operations by streamlining inventory management, personalizing marketing strategies, and enhancing customer service. While this approach highlights the efficiency of AI in business operations, it does not focus on knowledge structuring or real-time user engagement. Additionally, dealership management software primarily serves businesses rather than a broader community of car owners and repair professionals. In contrast, our proposed platform extends beyond business automation by integrating AI-powered knowledge retrieval with a dynamic community forum, ensuring that users receive real-time, verified insights and expert-driven discussions on auto parts and maintenance solutions.

## 6. CONCLUSIONS

While the proposed system successfully integrates real-time community interactions, AI-powered auto part insights, and secure user authentication, several limitations remain. One major challenge is ensuring the accuracy of AI-generated information. While Google Gemini AI provides structured responses, users expressed concerns about data reliability and context-specific details, such as pricing variations and brand-specific recommendations.

Another limitation is scalability. As the platform grows, handling real-time updates efficiently may become costly due to high Firestore read operations. Implementing data caching strategies and optimizing query structures can help mitigate this. Additionally, user authentication security could be further improved with two-factor authentication (2FA) to prevent unauthorized access [14].

To address these limitations, future improvements could include user feedback mechanisms for AI-generated data, search and filtering enhancements for the community forum, and more robust AI training with curated datasets to improve accuracy and relevance. These refinements would enhance user experience, security, and system scalability [15].

The community-driven platform effectively combines real-time discussions, AI-driven insights, and secure authentication to create a seamless user experience. While challenges exist in scalability, AI accuracy, and security, continuous improvements can make the system more

reliable and user-friendly. Ultimately, this solution provides a valuable, engaging, and informative digital community space.

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