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User-Centered Conversational AI for Small Business Customer Service: A Cost-Effective and Accessible Framework

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Abstract: The rapid digitalization of small and medium-sized enterprises (SMEs) has highlighted the need for cost-effective and accessible customer service solutions. Traditional commercial conversational AI platforms, such as Dialog flow and AWS Lex, often present high costs and steep learning curves, which pose significant barriers for SMEs. This paper proposes a user-centered conversational AI framework based on an open-source technology stack, including the Microsoft Bot Framework (MBF), OpenStreetMap, Azure Cognitive Services, and MongoDB. The framework is designed to support essential customer service functions—automated order processing, FAQ management, and voice-enabled interactions—while maintaining accessibility compliance (ADA). We demonstrate that this approach reduces operational costs, simplifies deployment, and enhances usability for SMEs. Experimental evaluation comparing our system with commercial alternatives shows competitive accuracy and latency, alongside improved accessibility satisfaction. Finally, we discuss the practical implications, limitations, and future directions for expanding knowledge automation and sentiment analysis integration.

Keywords: conversational AI; small and medium enterprises (SMEs); accessibility; Microsoft Bot Framework; customer service automation

1. Introduction

Small and medium-sized enterprises (SMEs) play a crucial role in the global economy, yet they often face significant challenges in providing efficient and cost-effective customer service. Traditional customer support mechanisms, such as call centers or dedicated support staff, impose high operational costs that can be prohibitive for SMEs. As digital transformation accelerates, conversational AI has emerged as a promising solution to automate routine interactions, reduce response times, and enhance overall customer satisfaction.

Despite these advantages, existing commercial natural language processing (NLP) solutions, such as Google Dialog flow and AWS Lex, remain largely inaccessible to SMEs due to their high subscription fees, complex integration processes, and steep learning curves. Furthermore, many of these platforms do not adequately address accessibility requirements, limiting their usability for individuals with disabilities.

This paper introduces a user-centered conversational AI framework specifically designed for SMEs, leveraging a cost-effective, open-source technology stack that combines the Microsoft Bot Framework (MBF), OpenStreetMap, Azure Cognitive Services, and MongoDB. The proposed system emphasizes low deployment costs, ease of use, and compliance with accessibility standards, including ADA guidelines. By integrating automated order processing, FAQ management, and voice-enabled interactions, the framework aims to provide SMEs with a practical and scalable solution for customer service automation.

The main contributions of this work are threefold. First, we propose an accessible and affordable conversational AI framework tailored to the specific needs of SMEs. Second, we present a modular system design that allows easy customization and integration across web and mobile platforms. Third, we evaluate the system's performance through

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cost, accuracy, latency, and usability metrics, demonstrating its feasibility as a practical alternative to commercial solutions. Overall, this work seeks to bridge the gap between advanced conversational AI technologies and the operational constraints of small businesses, enabling more inclusive and efficient customer service.

2. Related Work

Conversational AI has become a critical component in the digital transformation of small and medium-sized enterprises (SMEs). Prior research has highlighted that SMEs often struggle with limited resources, making traditional customer service solutions financially and operationally challenging. Several studies have explored the adoption of chatbot technologies in SMEs, demonstrating potential benefits such as cost reduction, faster response times, and improved customer engagement. However, most existing implementations rely on commercial platforms, which may be expensive and difficult to customize for specific SME needs.

Natural Language Processing (NLP) has emerged as a cornerstone of Human-Computer Interaction (HCI), enabling machines to understand, interpret, and generate human language. In the context of SMEs, NLP facilitates automated customer interactions by allowing chatbots to comprehend user queries, provide relevant responses, and guide users through complex tasks without human intervention. Modern NLP models support intent recognition, entity extraction, and dialogue management, which are essential for developing responsive and context-aware conversational agents.

Accessibility in HCI focuses on designing interfaces that can be used effectively by individuals with varying abilities, including those with visual, auditory, motor, or cognitive impairments. Integrating accessibility into conversational AI involves multimodal interaction techniques such as text-to-speech (TTS), speech-to-text (STT), and adaptive user interfaces. Research shows that accessible NLP systems can significantly improve usability and inclusivity, allowing users with disabilities to engage in seamless communication with automated systems. Voice-enabled interfaces, simplified dialogue structures, context-aware prompts, and personalized feedback are all examples of accessibility-enhancing strategies. Moreover, adherence to accessibility standards, such as the Americans with Disabilities Act (ADA) guidelines, ensures that conversational agents are designed with inclusive principles from the outset.

Several open-source solutions have been proposed to address the cost and accessibility challenges. The Microsoft Bot Framework (MBF) provides a flexible and extensible platform for building conversational agents, while cloud-based NLP services such as Azure Cognitive Services offer scalable language understanding and text-to-speech functionalities. Open data sources like OpenStreetMap can enrich chatbot applications with location-based services. Prior work demonstrates the feasibility of combining these technologies, yet comprehensive frameworks tailored for SME customer service—emphasizing affordability, accessibility, and ease of integration—remain limited.

This paper builds on these insights by proposing a user-centered, cost-effective conversational AI framework for SMEs, integrating modular system components, accessible interaction mechanisms, and open-source technologies. In doing so, it addresses gaps identified in both the SME digital transformation and HCI accessibility literature, offering a practical and scalable solution for small business customer service automation.

3. System Design

3.1. Technology Stack

The proposed conversational AI framework leverages a combination of open-source and cloud-based technologies to provide a cost-effective and scalable solution for SMEs. The core components include:

Microsoft Bot Framework (MBF): Serves as the backbone for dialogue management and integration with multiple communication channels, including web and mobile applications.

Azure Cognitive Services: Provides advanced natural language understanding (NLU), text-to-speech (TTS), speech-to-text (STT), and sentiment analysis capabilities.

MongoDB: Functions as a flexible, document-oriented database to store user interactions, order information, and FAQ knowledge.

OpenStreetMap: Offers location-based data to support customer queries related to store locations, deliveries, and service areas.

This combination ensures the system is highly modular, scalable, and capable of handling diverse customer service tasks without incurring the high costs of fully commercial NLP platforms.

3.2. Modular System Design

The framework is divided into three primary modules, each addressing key aspects of SME customer service:

Customer Dialogue Module: Handles real-time interactions with users, including intent recognition, entity extraction, and multi-turn conversation management.

Automated Order Processing Module: Integrates with backend inventory and order management systems to facilitate order placement, status tracking, and basic payment confirmation.

FAQ Knowledge Base Module: Provides instant responses to common queries by leveraging a structured knowledge repository stored in MongoDB, which can be continuously updated with minimal effort.

Each module is designed to operate independently yet seamlessly integrates with others to ensure a smooth end-to-end customer experience. The modularity also allows SMEs to adopt only the functionalities relevant to their business context, minimizing complexity.

3.3. Accessibility Features

Accessibility is a key consideration in the framework's design, ensuring compliance with ADA standards and promoting inclusive use. Key accessibility features include:

Voice Input and Output: Users can interact with the system via speech, enabling hands-free operation and supporting visually impaired individuals.

Simplified User Interface: Minimalistic web and mobile interfaces reduce cognitive load, making it easier for users with varying technical literacy to engage with the system.

Contextual Prompts and Feedback: Dynamic hints, progress indicators, and personalized suggestions guide users through interactions, improving both usability and accessibility satisfaction.

By integrating these accessibility features, the framework not only broadens the potential user base but also enhances overall user experience and system effectiveness.

4. Implementation

4.1. Web and Mobile Integration

The proposed framework is designed to function seamlessly across both web and mobile platforms, enabling SMEs to engage with customers through multiple channels efficiently. The web client is implemented using a responsive front-end framework, allowing real-time interaction with the conversational AI via an intuitive chat interface. Features such as message threading, typing indicators, and adaptive UI components enhance the user experience by mimicking human-like conversation flows.

The mobile client leverages native device capabilities, including push notifications, speech recognition, voice output, and device sensors, to provide a richer and more inter-

active experience. For example, speech-to-text and text-to-speech functionalities allow users to interact hands-free, supporting accessibility for visually impaired or motor-impaired customers. Notifications and alerts ensure that customers remain informed of updates, such as order status or responses to queries, even when the app runs in the background.

Both platforms are connected to the Microsoft Bot Framework (MBF) via a unified RESTful API layer, ensuring consistent message handling, session management, and response logic across devices. This architecture allows SMEs to deploy the system rapidly without extensive platform-specific customization, reducing development time and operational costs [1]. Additionally, the framework supports modular integration, enabling businesses to selectively enable features such as automated FAQ handling, order processing, or location-based services based on their operational needs.

4.2. Data Flow

The system's data flow is structured to optimize responsiveness, reliability, and data integrity, ensuring smooth and consistent customer interactions. The key components include:

User Input Processing: User messages, whether text or voice, are captured by the client interface and sent to MBF for intent recognition, entity extraction, and contextual understanding. Advanced NLP techniques enable the system to interpret complex queries, handle synonyms, and manage ambiguous user input.

Dialog Management: MBF orchestrates the conversation, maintaining context across multi-turn interactions, determining appropriate responses, and invoking relevant backend modules such as order management or knowledge base retrieval. The framework also incorporates fallback mechanisms to gracefully handle unrecognized queries, prompting the user for clarification without breaking the conversational flow.

Knowledge Base Interaction: Frequently asked questions and domain-specific knowledge are stored in MongoDB, which allows flexible and scalable data management. The system can dynamically retrieve relevant entries, update contextual logs, and continuously learn from new interactions, supporting ongoing improvements in accuracy and relevance.

Response Delivery: Responses are generated and delivered in real-time, including synthesized speech when necessary. The system can adapt the tone, verbosity, or language of the response based on user preferences, accessibility requirements, or prior interactions, providing a more personalized experience.

4.3. Deployment Architecture

The framework adopts a cloud-based deployment model, which ensures scalability, high availability, and centralized maintenance. Core components—including MBF, Azure Cognitive Services, and MongoDB—are hosted on secure cloud platforms, benefiting from redundancy, load balancing, and containerization to maintain performance during peak demand [2].

For SMEs with limited technical expertise, deployment is further simplified using pre-configured templates, automated provisioning scripts, and step-by-step setup guides. These tools reduce the need for specialized IT staff and accelerate time-to-market, enabling businesses to implement advanced conversational AI solutions without substantial investment in infrastructure.

Moreover, the architecture supports future extensibility. New modules, such as sentiment analysis, predictive customer analytics, or multi-language support, can be integrated without significant modifications to the core system. This design ensures that SMEs can gradually scale their AI capabilities as their business grows and as customer needs evolve.

In summary, the implementation combines robust technical design, user-centered features, and practical deployment strategies to provide a scalable, cost-effective, and accessible conversational AI solution tailored for SMEs.

5. Evaluation

5.1. Comparative Experiments

To evaluate the proposed conversational AI framework, we conducted experiments comparing it with Google Dialog flow and AWS Lex. Three key metrics were considered: **monthly operational cost**, **intent recognition accuracy**, and **response latency**. The experiments were performed using a dataset of 500 representative customer queries across various SME scenarios, including order inquiries, FAQs, and location-based requests (Table 1).

Table 1. Chatbot Platform Comparison.

Platform	Monthly Cost (USD)	Intent Recognition Accuracy (%)	Average Response Latency (ms)	Notes
Proposed Framework (MBF + Azure)	50	92	450	Low-cost, fully customizable, supports voice and accessibility features
Google Dialog flow	130	94	430	High accuracy, but higher cost and complex integration
AWS Lex	120	91	480	Moderate accuracy, latency slightly higher, limited accessibility support

The results indicate that the proposed framework achieves competitive intent recognition accuracy and response latency while significantly reducing operational costs—approximately 60% lower than commercial alternatives. Importantly, the framework's open-source design allows SMEs to customize dialogue flows and knowledge bases without incurring additional subscription fees. Furthermore, the integration of voice interaction and accessibility compliance distinguishes it from commercial platforms, which often require additional configuration to support ADA standards.

5.2. User Testing

A controlled user study was conducted to assess system usability, accessibility, and overall user satisfaction. Twenty participants were recruited, including ten individuals with visual or motor impairments, to ensure accessibility evaluation. Participants were asked to complete typical SME customer service tasks, such as placing an order, checking delivery status, and querying FAQs.

System Usability: The System Usability Scale (SUS) was employed, and the framework achieved an average SUS score of 85, indicating excellent usability. Users highlighted the intuitive dialogue flow, clear prompts, and responsive feedback as key strengths [3,4].

Accessibility Satisfaction: Participants reported that voice input/output and the simplified interface significantly enhanced usability. Users with visual impairments were able to complete tasks independently, while those with motor impairments appreciated the minimal reliance on precise clicks or swipes. Overall, the accessibility satisfaction score averaged 4.6 out of 5.

Error Handling: The framework effectively managed unrecognized queries using fallback prompts and clarification questions, maintaining smooth interaction without user frustration. This feature was highlighted as critical for SMEs with limited support staff.

Overall, the evaluation demonstrates that the proposed framework balances technical performance, cost-effectiveness, and accessibility, offering SMEs a practical solution that is both affordable and inclusive [5].

6. Discussion

The evaluation results demonstrate that the proposed user-centered conversational AI framework provides a cost-effective, accessible, and technically competent solution for SME customer service. Its modular architecture and open-source technology stack allow SMEs to adopt only the components they need, minimizing complexity while maximizing operational efficiency.

6.1. Potential in SME Applications

The framework's low-cost deployment and ease of integration make it particularly suitable for SMEs, which often operate with limited technical resources and tight budgets. By automating routine customer service tasks such as order processing, FAQ resolution, and location-based queries, SMEs can reduce staffing costs and improve response times, enhancing overall customer satisfaction. Additionally, the accessibility features ensure that a wider range of customers—including those with disabilities—can interact effectively with the business, expanding market reach and demonstrating corporate social responsibility.

6.2. Limitations

Despite its advantages, the framework has several limitations. First, while accuracy is competitive, the system may struggle with highly specialized or ambiguous queries that require domain-specific knowledge beyond the pre-configured knowledge base. Second, the reliance on cloud-based NLP services like Azure Cognitive Services introduces potential latency fluctuations during periods of high network traffic. Third, although accessibility compliance has been prioritized, continuous evaluation and updates are necessary to ensure compliance with evolving ADA standards and best practices in inclusive design. Finally, SMEs with extremely limited IT expertise may still face challenges during initial deployment, highlighting the need for comprehensive setup guides and support tools.

6.3. Alignment with National AI Strategies

The proposed framework aligns with broader national AI development strategies that emphasize digital inclusion, innovation in small business sectors, and ethical AI deployment. By leveraging open-source technologies and promoting accessible design, the system contributes to policy goals such as increasing SME participation in AI-driven digital transformation, reducing barriers to technological adoption, and ensuring AI services are inclusive for all citizens. Moreover, the modular design facilitates future integration with emerging AI capabilities, such as sentiment analysis, automated knowledge base expansion, and predictive analytics, further supporting national objectives for AI-driven economic growth.

In conclusion, the framework presents a practical and scalable solution for SMEs seeking to implement conversational AI, balancing affordability, accessibility, and performance while contributing to national AI and digital transformation initiatives. Addressing the identified limitations in future iterations will further strengthen its impact and usability.

7. Conclusion & Future Work

This paper presents a user-centered conversational AI framework specifically designed for small and medium-sized enterprises (SMEs), emphasizing cost-effectiveness, accessibility, and ease of deployment. By integrating the Microsoft Bot Framework (MBF), Azure Cognitive Services, MongoDB, and OpenStreetMap, the framework enables SMEs

to automate key customer service tasks such as order processing, FAQ resolution, and location-based queries. Evaluation results demonstrate that the proposed system achieves competitive accuracy and response latency while significantly reducing operational costs compared to commercial platforms. User studies further indicate high satisfaction with usability and accessibility, highlighting the framework's potential to serve a diverse customer base, including individuals with disabilities.

The contributions of this work are threefold: it develops a modular, open-source conversational AI framework tailored to SME requirements, implements accessibility-compliant features including voice input/output and simplified interfaces to ensure inclusive user interactions, and provides empirical evidence demonstrating cost reduction, high performance, and positive user experience, validating its practical applicability. Several directions can further enhance the framework in subsequent iterations. Integrating machine learning techniques for automated knowledge base expansion would allow FAQs and domain-specific knowledge to be updated with minimal manual effort. Incorporating sentiment analysis and emotion recognition could enable sentiment-aware responses, improve customer engagement and provide more personalized interactions. Expanding the system to support multiple languages would address the needs of global SME customer bases, while implementing adaptive interfaces that adjust based on user preferences and abilities would ensure continued accessibility compliance. Additionally, integrating the framework with emerging AI tools, such as predictive modeling, analytics, and recommendation systems, could further enhance decision-making and customer service effectiveness.

In summary, the proposed framework provides a scalable, inclusive, and affordable solution for SME customer service automation. By addressing operational constraints, supporting accessibility, and leveraging open-source technologies, it offers SMEs a practical pathway to adopt advanced AI capabilities, contributing to broader digital transformation initiatives.

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