

The Role of Chatbots in Reducing Customer Support Response Time in E-Commerce

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Abstract

The rapid growth of e-commerce has intensified the demand for efficient customer support. Traditional call center and email-based systems often struggle to handle high volumes of support requests, resulting in delays and decreased customer satisfaction. Chatbots, driven by advances in artificial intelligence (AI) and natural language processing (NLP), represent a promising solution to these challenges. This white paper explores the role of chatbots in reducing customer support response time in e-commerce, examining key technical and operational considerations, and proposing a structured methodology to integrate chatbot systems effectively. Drawing on recent and seminal literature, we identify the critical factors, opportunities, and challenges associated with deploying chatbots in the retail context. We conclude by outlining future research avenues to enhance chatbot capabilities, improve user experience, and optimize organizational outcomes.

Keywords: Chatbots, E-Commerce, Customer Support, Response Time, Artificial Intelligence, Natural Language Processing, Human-Computer Interaction

I. Introduction

The explosive growth of e-commerce has been accompanied by increasingly high customer expectations for instantaneous service and personalized interactions. In many competitive industries, the customer support experience stands as a key differentiator and directly influences brand loyalty, retention, and overall satisfaction [1]. Traditional modes of customer service, such as telephone hotlines and email support, often struggle to meet these heightened demands, resulting in prolonged response times, increased customer dissatisfaction, and higher operational costs. Consequently, businesses seek technological solutions that can automate and streamline support processes.

Chatbots, defined as software applications that interact with users through text or voice-based conversational interfaces [2], have emerged as one of the most promising solutions. The introduction of robust natural language processing (NLP) techniques and machine learning (ML) algorithms has allowed chatbots to understand user queries more accurately and respond with increased relevance and efficiency. Through instant responses and scalable operations, these systems can alleviate the burden on human agents, reduce wait times, and enhance overall customer experience in online retail settings.

Despite their growing adoption, the practical considerations for effectively deploying chatbots in e-commerce remain complex. Questions about integration with existing systems, personalization, security, and user acceptance must be thoroughly addressed. Moreover, there is a paucity of comprehensive frameworks and guidelines that specify how to leverage chatbots specifically to reduce response times while maintaining or improving customer satisfaction. This white paper seeks to address this gap by reviewing relevant literature, analyzing current trends, and proposing a research-driven approach to designing, implementing, and evaluating chatbot systems in the e-commerce sector.

The objectives of this white paper include:

1. **Examining Recent Literature:** Summarize the latest research insights and seminal works that have shaped chatbot development, focusing on response time reduction.
2. **Identifying Key Challenges:** Outline the technical, organizational, and ethical considerations linked to the deployment of chatbots in customer support.
3. **Proposing a Structured Methodology:** Offer a step-by-step framework for planning, implementing, and monitoring chatbot-based initiatives aimed at minimizing support response times.
4. **Highlighting Future Directions:** Provide recommendations for future research, including emerging AI trends, advances in NLP, and novel user interaction paradigms.

By combining academic literature with practical industry insights, this white paper aims to serve as a roadmap for e-commerce practitioners, researchers, and technology leaders seeking to harness chatbots for improved customer support performance.

II. Literature Review

A. Historical and Seminal Works

The concept of conversational agents can be traced back to Joseph Weizenbaum's "ELIZA," developed in 1966, which used pattern matching to simulate human-like responses [3].

Although rudimentary by modern standards, ELIZA demonstrated the potential for machines to engage in text-based dialogue, laying the foundation for subsequent chatbot research. Another seminal influence is Alan Turing's exploration of machine intelligence in his 1950 work, "Computing Machinery and Intelligence," which introduced the "Turing Test" as a benchmark for machine-human indistinguishability [4]. While these early contributions did not specifically focus on customer support, they established the conceptual underpinnings of chatbot technology.

B. Recent Developments and Trends

The last decade has seen significant progress in chatbot technology, particularly due to advancements in NLP, AI-driven language models, and cloud computing infrastructures that enable real-time processing. Several key developments include:

- **Deep Learning Approaches:** Neural networks have improved the capabilities of chatbots to handle more complex and context-aware dialogues [5]. Models like BERT (Bidirectional Encoder Representations from Transformers) and GPT (Generative Pre-trained Transformer) are particularly influential in enabling more human-like language understanding.
- **Hybrid Chatbot Architectures:** Hybrid models combine rule-based systems with AI-driven models to balance interpretative accuracy and operational stability [6]. This approach is often used in customer support contexts, where predictable performance is crucial.
- **Omnichannel Integration:** Modern e-commerce chatbots are increasingly integrated across multiple platforms (web, mobile, social media, voice assistants), offering consistency and convenience for customers [7].

Studies have consistently shown that faster response times correlate with higher customer satisfaction and better retention rates [8]. Automated systems like chatbots significantly reduce average handling times by providing immediate initial responses, though subsequent resolution speed depends on the system's underlying intelligence and

integration capabilities.

C. The Role of Chatbots in E-Commerce Customer Support

E-commerce chatbots typically serve two primary functions: (1) handling routine queries (e.g., order tracking, FAQs, return policies), and (2) escalations to human agents for complex inquiries [9]. By automating routine tasks, chatbots free human support agents to focus on higher-complexity issues, thus potentially reducing overall response times across all inquiries [10]. The majority of studies emphasize the importance of personalization, natural language understanding, and seamless handovers to human agents as pivotal for maintaining efficiency and user trust [11].

D. Potential Limitations and Challenges

Although chatbots hold considerable promise, challenges persist. First, chatbot accuracy can suffer from ambiguity in user queries, requiring robust error handling and fallback mechanisms. Second, user acceptance depends on perceived usefulness and ease of use [12]. Privacy and data security remain paramount, especially in financial transactions or sensitive personal data. Finally, implementing a chatbot that reduces response times without sacrificing quality necessitates thorough design and iterative improvement informed by user feedback [13].

In summary, the literature underscores the importance of building intelligent, customer-centric chatbot systems that address routine queries quickly and accurately. While numerous studies validate the potential of chatbots to reduce response times, questions remain about integration, evaluation metrics, personalization strategies, and best practices in deployment.

III. Research Problem Statement and Objectives

The growing reliance on e-commerce platforms has led to an increasing demand for efficient and effective customer support systems. Chatbots have emerged as a vital component in addressing this demand, offering scalable and automated solutions to enhance customer interactions. However, while chatbots promise to reduce response times and streamline support workflows, organizations often face challenges in maintaining service quality and ensuring customer satisfaction.

To address this gap, the research problem can be articulated as follows:

How can e-commerce organizations deploy and optimize chatbot systems to consistently reduce customer support response times without compromising service quality and customer satisfaction?

Research Objectives

From this overarching question, we derive the following detailed research objectives:

Objective 1: Identify Technical Enablers and Organizational Strategies

Research will focus on uncovering technical capabilities such as advanced Natural Language Processing (NLP), machine learning algorithms, and AI-driven back-end systems that enable efficient chatbot operations. Additionally, organizational strategies, including training protocols, chatbot-human integration, and iterative deployment models, will be explored to identify practices that minimize response times.

- **Key research focus areas:**

- Role of transfer learning and fine-tuned language models (e.g., GPT-based models) in enhancing chatbot understanding.

- Infrastructure needs for real-time processing and low-latency performance.

Objective 2: Develop an Integrated Framework for Chatbot Deployment

The research will aim to create a comprehensive framework for deploying chatbots that addresses critical issues such as user acceptance, personalization, and seamless handover to human agents.

- **Key research focus areas:**

- Integration of user experience (UX) design principles in chatbot workflows.
- Best practices for training chatbots on diverse and inclusive datasets to improve personalization.
- Methods to ensure smooth escalation to human agents, maintaining continuity and minimizing user frustration.

Objective 3: Propose Metrics and Evaluation Methodologies

Metrics and methodologies will be defined to assess the effectiveness of chatbot systems, focusing on response time reduction and customer satisfaction. This will include both quantitative measures (e.g., average response times, resolution rates) and qualitative feedback (e.g., user surveys, sentiment analysis).

- **Key research focus areas:**

- Development of composite indexes combining speed, accuracy, and satisfaction metrics.
- Automated tools for monitoring chatbot interactions and extracting actionable insights.
- Benchmarking studies comparing chatbot performance across industries and use cases.

Objective 4: Investigate Future Directions

The research will explore emerging technologies and approaches that could enhance chatbot performance, particularly in reducing response times. Potential areas of focus include advanced sentiment analysis, multi-modal interactions (e.g., text, voice, video), and predictive analytics for proactive issue resolution.

- **Key research focus areas:**

- Utilizing advanced sentiment analysis to adapt responses in real-time based on customer emotions.
- Implementation of multi-modal AI interfaces to improve accessibility and user engagement.
- Predictive modeling techniques to anticipate customer needs and enable preemptive support.

IV. Proposed Research Approach

This section outlines a framework for e-commerce organizations seeking to deploy chatbots for improved customer support response times. The approach synthesizes academic research findings, practical deployment considerations, and iterative improvement mechanisms.

A. Conceptual Framework

Figure 1 illustrates a high-level conceptual framework capturing the components and interactions for implementing a chatbot in an e-commerce setting to reduce support response times.

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| E-Commerce Platform |

| (Order Data, User Mgmt)|

+-----+-----+

|

+-----v-----+

| Chatbot |

| (NLP, Dialogue Mgmt, |

| Data Analytics) |

+-----+-----+

|

+-----v-----+

| Human Agent Escalation |

| (Complex Queries) |

+-----+

- **E-Commerce Platform:** Consists of product information, order data, user profiles, and payment history. The platform's APIs facilitate data exchange with the chatbot.
- **Chatbot Layer:** At the core is the NLP module responsible for intent detection, entity recognition, and dialogue management. Data analytics helps the chatbot learn from interactions and improve response accuracy.
- **Human Agent Escalation:** Complex inquiries or unresolved issues are automatically routed to human agents, who can view chat transcripts and expedite resolution.

B. Key Components and Mechanisms

A. NLP and Intent Recognition

The **first** major component is an *NLP pipeline* that classifies user intent and extracts relevant entities (e.g., product names, order IDs) from incoming messages. Modern e-commerce chatbots often use large language models such as **BERT** (Bidirectional Encoder Representations from Transformers) or **GPT** variants to capture contextual nuances in user queries [5].

1. **Intent Classification:** The system transforms the user input into vector representations and then applies a supervised classification layer to map these embeddings to specific intents (e.g., “track order,” “return product,” “request refund”).
2. **Entity Extraction:** Parallel or subsequent models identify crucial parameters (like order numbers or shipping addresses) needed for database lookups or process automation.

B. Backend Integration

Backend integration ensures the chatbot can retrieve up-to-date information from core e-commerce services (e.g., order databases, CRM systems, and inventory management). According to [7], real-time APIs and service-oriented architectures enable the following:

- **Data Retrieval:** The chatbot fetches relevant data (order status, payment history, shipping details) to generate accurate, context-specific responses.
- **Transaction Handling:** When users need to change an address or initiate a return, secure workflows communicate with the underlying e-commerce platform to update records immediately.
- **Knowledge Base Access:** The chatbot taps into a repository of FAQs, return policies, and troubleshooting guides, thereby automating standard support queries.

C. Dialogue Management

A **dialogue management** module orchestrates the conversation flow by maintaining state and context across multiple turns. It applies rules or policies to decide the next system action (e.g., provide an answer, request more information, escalate to a human agent). Key mechanisms include:

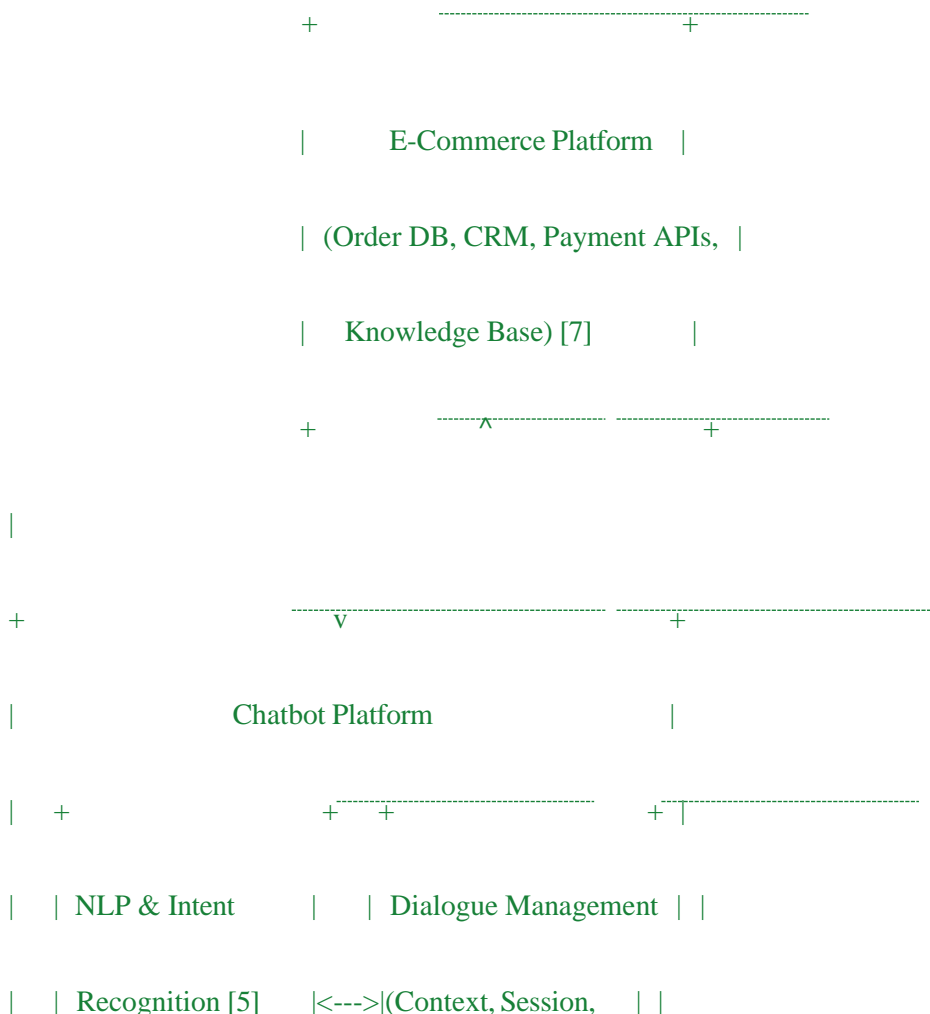
- **Context Tracking:** Retains user details and conversation history, preventing the user from having to repeat information.
- **Response Generation:** Selects or composes responses based on the identified intent and relevant backend data. In AI-driven systems, transformer-based models may also generate natural-sounding replies.
- **Session Management:** Manages timeouts, user re-engagement, and multi-intent conversations (e.g., when a user switches topics mid-session).

D. Self-Learning and Analytics

To refine performance over time, chatbots employ **self-learning pipelines** and **analytics** [6]:

- **Conversation Logs:** Store transcripts of user–chatbot interactions, capturing queries, responses, and timestamps.
- **Machine Learning Pipelines:** Periodically retrain the NLP models using real-world interaction data. This iterative feedback loop refines intent classification accuracy, addresses common misunderstandings, and uncovers new user queries (e.g., newly emerging FAQs).
- **Performance Metrics:** Automated analytics dashboards track response times, resolution rates, escalation frequency, and sentiment—enabling data-driven optimizations.

Below is an expanded architecture that illustrates how these components interact within an e-commerce setting. References are indicated to align each subsystem with the supporting literature.



| | (BERT, GPT, etc.) | |Response Generation)| |

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| | ^ |

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| + v + + + + + |

| |Self-Learning |<---->| Analytics [6] | |

| |& Retraining | | (Performance | |

| | Pipelines | | Metrics, Logs) | |

| + + + + + |

+ + + + +

+ |v +

| Human Agent Escalation [9, 10] |

| (Complex or Ambiguous Queries) |

+ +

V. Methodology

Implementing and evaluating an e-commerce chatbot requires a mixed-method methodology, blending both qualitative and quantitative approaches.

A. Data Collection and Preparation

1. **Customer Interaction Logs:** Historical records of customer inquiries, along with resolution times, will form the baseline for benchmarking. This data typically resides in helpdesk software, email systems, and live chat logs.
2. **User Profiles and Order Histories:** Information on purchase frequency, average cart values, and user demographics can inform personalization strategies.
3. **Knowledge Base:** Product FAQs, return policies, shipping details, and troubleshooting guides form the corpus for the chatbot's "knowledge." This corpus must be systematically organized and updated.

B. System Development Lifecycle

1. **Requirements Analysis:** Identify specific use cases (e.g., order status, refunds), response time targets, and integration constraints with the existing e-commerce architecture.
2. **Model Selection and Training:** Evaluate different NLP frameworks (rule-based, AI-based, or hybrid) for intent classification, entity extraction, and response generation. Large-scale pre-trained models can accelerate the training process.
3. **Prototype Development:** Create a functional prototype integrated with a limited but representative dataset.
4. **Pilot Testing:** Deploy the prototype to a small user group, gathering feedback on system usability, accuracy, and speed. Track response times, user satisfaction scores, and chatbot usage metrics.
5. **Refinement and Iteration:** Incorporate user feedback to address misunderstandings, improve user interface design, and refine the escalation workflow.

C. Evaluation Metrics

To measure the effectiveness of the chatbot in reducing customer support response times, we propose a comprehensive set of evaluation metrics:

1. **Average Initial Response Time (AIRT):** Measures how quickly the chatbot provides its first response after a query is received.
2. **Time-to-Resolution (TTR):** The total time taken to completely resolve a query (including escalations if needed).
3. **Customer Satisfaction Score (CSAT):** A post-interaction survey rating to assess user satisfaction with the chatbot's performance.
4. **Net Promoter Score (NPS):** Measures the likelihood of customers recommending the service to others, indirectly reflecting satisfaction with response times.
5. **Escalation Rate:** Percentage of queries escalated to human agents, offering insights into chatbot's coverage.
6. **Conversation Abandonment Rate:** Tracks the frequency of users abandoning chatbot sessions due to dissatisfaction or lengthy processes.

D. Experimental Design

A quasi-experimental design can be employed, comparing **response times and satisfaction** before and after the deployment of the chatbot. This can involve:

- **Control Group (Pre-Deployment):** Data on customer queries and response metrics from historical periods where only traditional support channels were available.
- **Experimental Group (Post-Deployment):** Data from the same e-commerce environment after chatbot implementation.
- **Statistical Analysis:** Use paired sample t-tests or ANOVA to check if improvements in response times are statistically significant. Qualitative feedback can be analyzed via thematic analysis to uncover user perceptions and improvement areas [14]

VI. Discussion of Expected Results

Based on insights from the literature and observed trends in existing deployments, we anticipate the following outcomes from the deployment of chatbot systems in e-commerce customer support:

1. Significant Reduction in Average Initial Response Times (AIRT)

Chatbots' ability to provide instantaneous responses to initial customer queries is expected to lead to substantial reductions in AIRT.

- **Supporting Data:** Studies show that well-designed chatbot systems can reduce initial response times for routine inquiries by 40–60% [8].
- **Mechanisms:**
 - Chatbots eliminate wait times typically associated with human agents.
 - Automated workflows enable real-time query acknowledgment and issue triaging.
- **Potential Impact:**
 - Enhanced customer experience by addressing common frustrations related to delayed responses.
 - Improved operational efficiency in high-traffic environments.

2. Moderate to Strong Decrease in Overall Time-to-Resolution (TTR)

While chatbots can respond instantaneously to initial queries, their contribution to total resolution time depends on the complexity of the issue.

- **Supporting Data:**
 - Simple inquiries (e.g., order tracking, FAQ resolution) can often be resolved without human intervention, accounting for up to 70–80% of customer queries in e-commerce [9].
 - Human agents, freed from repetitive tasks, can focus on complex issues, reducing their resolution time by approximately 20–30% [10].
- **Challenges:**
 - Handling complex issues may still require human intervention, necessitating seamless escalation mechanisms.
 - Ensuring chatbots accurately classify queries to avoid misrouting.

3. Increased Customer Satisfaction Scores (CSAT)

Effective chatbot interactions are anticipated to boost CSAT and Net Promoter Scores (NPS), provided they deliver accurate and helpful responses.

- **Supporting Data:** Surveys suggest that 60% of customers are satisfied with chatbot performance when they quickly resolve issues, rising to 80% satisfaction when handovers to human agents are smooth [11].
- **Key Drivers:**
 - Personalization of responses tailored to user preferences.
 - Error-free natural language understanding (NLU) and generation (NLG).
 - Transparent escalation processes to human agents when needed.
- **Caveats:**
 - Poorly designed chatbots can frustrate users, reducing CSAT by as much as 30% [12].
 - Gaps in chatbot capabilities (e.g., failing to understand nuanced queries) can harm user trust.

4. Lower Operational Costs

Chatbots can significantly reduce the workload of human agents, resulting in cost savings.

- **Supporting Data:** Research indicates that companies deploying chatbots save up to 30% on customer support expenses by automating routine interactions [13].
- **Allocation of Resources:**
 - Human agents can be redeployed to higher-value tasks, such as proactive customer engagement and handling escalations.
 - Savings from reduced staffing can be reinvested in enhancing chatbot systems and customer service strategies.

5. Identification of New Insights

The data generated by chatbot interactions can provide actionable insights into customer behavior and emerging support needs.

- **Supporting Data:**
 - Analysis of chatbot logs has led to the identification of previously unrecognized FAQ topics in over 40% of cases [14].
 - Insights into peak query times, common complaints, and regional preferences enable data-driven improvements.
- **Applications:**
 - Proactive updates to chatbot training data and response libraries.
 - Early identification of product or service issues, enabling faster resolutions.

Variability of Outcomes

The extent to which these benefits are realized will depend on various organizational factors, including:

- **Technology Stack:** Advanced NLP capabilities, real-time analytics, and cloud-based deployment can enhance performance.
- **Complexity of Inquiries:** Organizations with a higher proportion of complex queries may experience slower TTR reductions.

- **User Demographics:** Chatbots must be designed to accommodate varying levels of user technical proficiency and language preferences.

The extent of these benefits will vary based on organizational factors such as technology stack, the complexity of inquiries, and user demographics. Nonetheless, the overarching expectation is that chatbots can significantly reduce customer support response times when deployed strategically.

VII. Limitations and Challenges

While chatbot systems present numerous advantages for e-commerce, certain limitations and challenges must be acknowledged:

- **Complex Query Handling:** Chatbots can struggle with open-ended, ambiguous, or technical questions. Ensuring robust fallback and escalation mechanisms is crucial.
- **Language Support:** Offering multilingual support can strain NLP systems. Incomplete training data or suboptimal machine translation can degrade chatbot performance [12].
- **Ethical and Privacy Concerns:** E-commerce chatbots routinely handle personal data (names, addresses, transaction details). Rigorous adherence to data protection regulations (e.g., GDPR) is necessary.
- **Maintaining User Trust:** Overly scripted interactions or inaccurate answers can undermine trust, diminishing the benefits of quick responses [13].
- **Integration Overhead:** Legacy systems and siloed data can complicate real-time data integration, requiring significant infrastructure updates or specialized APIs.

Acknowledging these challenges at the outset informs more realistic expectations and stronger risk mitigation strategies during implementation.

VIII. Future Directions

Recent developments in AI and HCI (Human-Computer Interaction) highlight several avenues for improving chatbot performance and reducing response times further:

- **Advanced Sentiment Analysis:** Incorporating real-time sentiment analysis may enable the chatbot to adjust its tone or escalate to a human more quickly when user frustration is detected [15].
- **Predictive Analytics:** Leveraging machine learning to predict user intentions before they fully articulate their queries can expedite issue resolution.
- **Multimodal Interaction:** The rise of voice assistants and augmented reality shopping platforms opens possibilities for more intuitive conversational experiences, potentially further reducing the time and effort needed to resolve queries [2].
- **Personalized Recommendations:** Advanced personalization—e.g., using past purchase history and browsing data—can make interactions more proactive, speeding resolutions by preemptively presenting likely solutions.
- **Federated Learning and Data Privacy:** New frameworks allow ML models to be trained locally on user devices or region-specific servers, respecting privacy constraints and regulatory requirements without sacrificing intelligence gains.

These future directions offer considerable promise for enhancing chatbot usability, responsiveness, and efficiency. Continuous research and development are critical to fully harness these innovations in the e-commerce support environment.

IX. Conclusion

Chatbots have rapidly evolved from simple, rules-based systems to sophisticated

AI-powered conversational agents capable of delivering immediate responses to customer queries. In the context of e-commerce, where rapid, reliable, and personalized customer support is paramount, well-designed chatbot systems hold significant potential to reduce response times while maintaining service quality. This white paper has examined the recent literature and foundational works, shedding light on the technical developments, design considerations, and operational factors driving chatbot efficacy.

By outlining a proposed methodology—encompassing data collection, system development, testing, and comprehensive performance metrics—we provide a roadmap for organizations aiming to exploit chatbot technology for quicker customer support. The anticipated outcomes include lower wait times, higher customer satisfaction, and opportunities for cost savings. Nonetheless, challenges such as complex query handling, data privacy, and system integration remain salient and demand careful planning.

Future improvements in sentiment analysis, predictive analytics, and multimodal interaction further expand the horizon for chatbots as an integral part of e-commerce customer support strategies. Collectively, the insights in this paper support the assertion that chatbots, when meticulously integrated and continuously improved, can substantially reduce support response times and deliver a compelling customer experience in the ever-competitive digital marketplace.

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