# Artificial Intelligence (AI), Internet of Things (IoT), and Blockchain-Powered Chatbots for Improved Customer Satisfaction, Experience, and Loyalty

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**Abstract:** Artificial Intelligence (AI), Internet of Things (IoT), and blockchain-powered chatbots are revolutionizing customer service, significantly enhancing customer satisfaction, experience, and loyalty. This research paper investigates the development and implementation of AI chatbots, emphasizing their capability to facilitate personalized and efficient customer interactions. Utilizing Natural Language Processing (NLP) and Machine Learning (ML), these chatbots can comprehend and address customer inquiries in real-time, providing smooth support akin to human conversations. The paper highlights current trends, such as the use of sentiment analysis to understand customer emotions and customize responses accordingly, creating a more interactive and empathetic experience. Additionally, the deployment of predictive analytics allows chatbots to foresee customer needs and offer proactive solutions, thereby minimizing response times and boosting overall satisfaction. Moreover, the study examines how AI chatbots enhance customer loyalty by delivering consistent, round-the-clock support, making customers feel appreciated and heard. Through various industry studies, the research demonstrates the positive effects of AI chatbots on customer retention and brand reputation. The study suggests that ongoing innovation and the integration of sophisticated AI features will continue to improve the efficiency of chatbots in the customer service sector.

**Keywords:** artificial intelligence, chatbots, customer-service, natural language processing, customer satisfaction, customer loyalty, internet of things, blockchain

#### 1. Introduction

In today's digital landscape, businesses are continuously seeking innovative solutions to enhance customer satisfaction, experience, and loyalty. One significant innovation in this realm is the use of Artificial Intelligence (AI)-powered chatbots [1–3]. These advanced systems have transformed customer service by enabling instant, personalized, and efficient interactions [2, 4, 5]. The evolution of chatbots, from basic automated responders to sophisticated virtual assistants, is driven by advancements in machine learning, Natural Language Processing (NLP), and big data analytics [6–8]. These technologies have collectively empowered chatbots to deliver unprecedented levels of customer engagement and support. Several factors contribute to the growing reliance on AI-powered chatbots in customer service. The increasing demand for

24/7 customer support has rendered traditional customer service models insufficient. AI chatbots offer a scalable solution, capable of providing round-the-clock assistance without human intervention, thus meeting customer expectations for immediate responses [5, 9–11]. Furthermore, AI technologies enable chatbots to deliver highly personalized experiences. By analysing customer data, chatbots can tailor interactions based on individual preferences, purchase history, and behaviour patterns, enhancing customer satisfaction and fostering loyalty.

In addition, AI chatbots present a cost-effective solution for customer service operations [3, 12–14]. Businesses continually seek ways to reduce operational costs while maintaining high service standards. AI-powered chatbots automate routine tasks, reducing the workload on human agents and allowing them to focus on more complex issues requiring human intervention [3, 15–17]. This leads to significant cost savings and improves the overall efficiency of customer service operations. The impact of AI-powered chatbots on customer satisfaction, experience, and loyalty is substantial [18–20]. Research indicates that businesses integrating AI chatbots report higher customer satisfaction rates, increased customer engagement, and improved loyalty [15, 21, 22]. These outcomes are attributed to chatbots' ability to provide quick, accurate, and relevant responses, ensuring a seamless customer experience. Additionally, the continuous learning capabilities of AI chatbots enable them to improve over time, adapting to customer needs and preferences, further enhancing their effectiveness.

Despite the numerous benefits, adopting AI-powered chatbots also presents challenges [23–25]. Ensuring the security and privacy of customer data is a major concern, as chatbots often handle sensitive information. Moreover, developing and maintaining sophisticated AI chatbots require significant investment and technical expertise [5, 26, 27]. However, with ongoing advancements in AI technologies and increasing adoption rates, these challenges are being addressed, paving the way for more widespread and effective use of AI chatbots in customer service [4, 28–30]. This research aims to explore the impact of AI-powered chatbots on customer satisfaction, experience, and loyalty. By conducting a comprehensive literature review and utilizing keyword analysis, co-occurrence, and cluster analysis, this study seeks to provide a deeper understanding of the trends and patterns in this evolving field. The findings of this research will contribute to the existing body of knowledge by highlighting the key factors influencing the effectiveness of AI chatbots and identifying areas for future research and development.

#### 1.1. Contributions of the Research Work

- 1) This research provides an extensive review of recent literature on AI-powered chatbots, examining their impact on customer satisfaction, experience, and loyalty. It integrates findings from various studies to present a comprehensive view of the current state of knowledge.
- 2) The study employs advanced keyword and co-occurrence analysis to identify the most relevant and trending topics in the field of AI chatbots. This analysis helps in understanding the key themes and research areas that are gaining prominence.
- 3) Through cluster analysis, the research identifies thematic groupings and patterns within the literature, offering insights into emerging trends and areas of focus. This contributes to a more nuanced understanding of the field and highlights potential gaps and opportunities for future research.

# 2. Methodology

This study employs a systematic approach to investigate the influence of artificial intelligence-powered chatbots on customer satisfaction, experience, and loyalty, focusing on four primary phases: literature review, keyword extraction, co-occurrence analysis, and cluster analysis. The literature review involved a thorough examination of scholarly articles, conference proceedings, and industry reports relevant to AI chatbots and

their role in customer service. Key academic databases, including Scopus, Web of Science, and Google Scholar, were searched for publications from 2015 onward to ensure up-to-date coverage of technological advancements and contemporary insights. Articles were selected based on their relevance to AI chatbots, customer satisfaction, experience, and loyalty, and their contribution to the theoretical and practical understanding of these topics. In the keyword extraction phase, important terms and concepts were identified from the reviewed literature. Text mining techniques were used to extract key phrases and words from the abstracts, titles, and keywords of the selected papers. This process involved Natural Language Processing (NLP) tools to accurately capture relevant terms and ensure a comprehensive representation of the literature. The co-occurrence analysis phase analysed the relationships between the extracted keywords to understand how different concepts are related within the literature. A co-occurrence matrix was constructed to calculate the frequency of keywords appearing together in the same documents. This matrix provided insights into prominent themes and the strength of associations between various concepts related to AI-powered chatbots and customer outcomes. In the final phase, cluster analysis, the co-occurrence data was used to identify distinct thematic clusters within the literature. Clustering algorithms, such as hierarchical clustering and k-means clustering, were applied to group keywords into coherent clusters based on their co-occurrence patterns.

# 3. Results and Discussion



# 3.1. Co-occurrence and Cluster Analysis of the Keywords

Fig. 1. Co-occurrence analysis of the keywords in literature.

The network diagram (Fig. 1) illustrates the co-occurrence and cluster analysis of keywords to highlights the interconnections and thematic groupings of various keywords central to the domain of AI-powered chatbots and their impact on customer-related outcomes.

#### 3.1.1. Central cluster: Artificial intelligence and chatbots

At the core of the network lies the central cluster encompassing "artificial intelligence" and "chatbots." These keywords stand out due to their prominence, indicating their pivotal role in the overall discourse. AI serves as the foundational technology that enables the development and deployment of chatbots. The dense connections around these nodes suggest that AI is deeply intertwined with numerous aspects of chatbot functionality and application, making it a central theme in this research area. Chatbots, as an application of AI, are crucial for enhancing customer satisfaction, experience, and loyalty. The proximity of terms like "customer service," "customer support," and "customer satisfaction" to "chatbots" underscores the primary use case of these AI agents in improving customer interactions. This central cluster reveals that AI-powered chatbots are integral to modern customer service strategies, facilitating efficient, responsive, and personalized customer engagement.

#### 3.1.2. Red cluster: Natural language processing and machine learning

To the left of the central cluster, a prominent red cluster dominated by keywords such as "Natural Language Processing (NLP)," "machine learning," "learning algorithms," and "deep learning" can be observed. This cluster emphasizes the technological foundation that enables chatbots to understand and generate human-like responses. NLP is essential for interpreting customer queries and providing accurate and contextually relevant answers. Machine learning, including learning algorithms and deep learning, enhances the chatbot's ability to learn from interactions, thus improving its performance over time. The presence of "neural networks" within this cluster further highlights the role of advanced machine learning techniques in developing sophisticated chatbots capable of handling complex queries and providing human-like interactions. This cluster signifies the deep technological integration required for creating effective AI-powered chatbots.

#### 3.1.3. Green cluster: Customer experience and anthropomorphism

On the right side of the network, a green cluster focuses on "customer experience," "customer satisfaction," and "anthropomorphism." This cluster explores the psychological and experiential aspects of chatbot interactions. Keywords like "customer care," "online customers," and "social presence" indicate the importance of creating engaging and satisfying user experiences. Anthropomorphism, or attributing human-like qualities to chatbots, is highlighted as a key factor in enhancing user engagement and trust. The connections between "conversational agents," "ethical technology," and "AI chatbot" suggest a focus on designing chatbots that are not only functional but also perceived as trustworthy and relatable by users. This cluster underscores the importance of human-centric design principles in the development of AI-powered chatbots.

# 3.1.4. Blue cluster: Business applications and E-commerce

The blue cluster, located at the bottom of the diagram, includes keywords such as "electronic commerce," "e-commerce," "digital transformation," and "virtual reality." This cluster emphasizes the application of AI-powered chatbots in business contexts, particularly in enhancing e-commerce operations. The integration of chatbots in e-commerce platforms facilitates personalized shopping experiences, efficient customer support, and improved sales processes. The presence of "digital transformation" indicates that the adoption of chatbots is part of broader digital initiatives within businesses. This cluster reflects the strategic importance of AI-powered chatbots in driving business innovation, improving operational efficiency, and ultimately boosting customer loyalty and satisfaction.

#### 3.1.5. Yellow cluster: Trust and technology adoption

Towards the top-right, a yellow cluster centers around "trust," "technology adoption," and "AI chatbot." This cluster delves into the factors influencing the acceptance and trustworthiness of AI-powered chatbots. Keywords like "service quality," "satisfaction," and "perception" highlight the critical role of user trust in the successful adoption of chatbots. The link between "technology acceptance model" and "trust" indicates that users' willingness to adopt chatbot technology is closely tied to their trust in the technology's reliability and effectiveness. This cluster points to the need for transparent, ethical, and user-friendly chatbot designs that foster trust and encourage widespread adoption.

Beyond the major clusters, the network diagram includes several peripheral keywords and connections that provide additional insights into the research landscape. Terms like "sentiment analysis," "predictive analytics," and "automation" reveal the analytical capabilities of chatbots in understanding and predicting customer behavior, further enhancing their effectiveness in customer service roles. Keywords such as "performance," "social media," and "virtual assistants" indicate the diverse applications and performance metrics associated with chatbots. The inclusion of "Python," a programming language widely used in AI development, underscores the technical aspect of chatbot creation and customization. The co-occurrence and cluster analysis of the keywords in this network diagram offer a comprehensive view of the research domain surrounding AI-powered chatbots and their impact on customer satisfaction, experience, and loyalty. The central position of "artificial intelligence" and "chatbots" highlights the foundational role of AI in driving chatbot functionalities and applications. The red cluster underscores the technological enablers, such as NLP and machine learning, essential for creating sophisticated chatbots capable of handling complex interactions. The green cluster emphasizes the importance of human-centric design and anthropomorphism in enhancing user experience and trust. The blue cluster illustrates the strategic business applications of chatbots, particularly in e-commerce and digital transformation initiatives. The yellow cluster points to the critical factors influencing user trust and technology adoption, emphasizing the need for ethical, transparent, and user-friendly chatbot designs.

# **3.2.** Artificial Intelligence (AI), Internet of Things (IoT), and Blockchain-Powered Chatbots: Technology and Functionality

The convergence of Artificial Intelligence (AI), the Internet of Things (IoT), and blockchain technology is driving significant advancements across various industries by enhancing efficiency, security, and user experiences [3, 31–33]. One of the most exciting applications of these technologies is in the development and deployment of advanced chatbots [15, 34–36]. These chatbots, powered by AI, IoT, and blockchain, offer seamless, secure, and intelligent interactions. AI-powered chatbots are designed to mimic human conversation and provide intelligent, instant responses to user queries [37, 38]. Utilizing Natural Language Processing (NLP), Machine Learning (ML), and deep learning algorithms, these chatbots effectively understand and respond to user inputs. Table 1 shows the AI, IoT, and blockchain-powered chatbots: technology and functionality. The primary function of AI chatbots is to analyze user queries, process the language, and generate appropriate responses [39, 40]. As AI technology progresses, chatbots are becoming more adept at understanding context, sentiment, and intent, resulting in more accurate and human-like interactions. Recent trends in AI-powered chatbots include the integration of advanced generative AI models, which can generate human-like text based on extensive training data. These models enable chatbots to provide more natural and coherent responses, improving user satisfaction. Additionally, AI chatbots are increasingly used in customer service, healthcare, finance, and e-commerce to handle inquiries, offer recommendations, and conduct transactions.

The Internet of Things (IoT) connects various physical devices to the internet, allowing them to

communicate and exchange data [8, 10]. When combined with AI, IoT-enabled chatbots can interact with smart devices, providing users with a seamless experience across both physical and digital environments. These chatbots can control IoT devices, monitor real-time data, and provide actionable insights based on the collected information [20–22]. In a smart home environment, for example, an IoT-enabled chatbot can control lighting, thermostats, security cameras, and other connected devices. Users can interact with the chatbot through voice or text commands to manage their home settings remotely. In industrial applications, IoT-enabled chatbots can monitor equipment, detect anomalies, and alert maintenance teams to prevent downtime. The integration of AI and IoT in chatbots enhances automation, efficiency, and convenience.

	Table 1. Al, 101, and blockchain-powered chatbots. Technology and functionality						
Sr No	Technology	Functionality	Key Features	Applications			
1	Artificial Intelligence (AI)	NLP for understanding and generating human language	Speech recognition, Analyzing sentiment, Understanding context	Customer service, Virtual assistants, Automated support, Marketing and sales			
2	Artificial Intelligence (AI)	ML for learning from interactions and improving responses	Predictive analytics, detecting anomalies, Recognizing patterns	Fraud detection, Personalizing recommendations, Dynamic pricing			
3	Artificial Intelligence (AI)	Deep Learning for advanced decision-making and pattern recognition	Recognizing images and voices, Solving complex problems, Using multi-layer neural networks	Medical diagnostics, Self- driving cars, financial analysis			
4	Internet of Things (IoT)	Enhancing interaction and automation by integrating chatbots with IoT devices	Collecting data in real-time, Monitoring and controlling remotely, Communication between devices	Smart homes, Industrial automation, Health monitoring			
5	Internet of Things (IoT)	Enabling context-aware interactions through sensor data	Sensing the environment, tracking user activity, Automating based on context	Personalizing user experiences, Predictive maintenance, Managing energy			
6	Blockchain	Securing and ensuring transparent chatbot interactions	Storing data in a decentralized manner, recording transactions immutably, Enhancing data privacy	Secure messaging, verifying identities, Conducting secure financial transactions			
7	Blockchain	Facilitating trusted interactions and transactions	Using smart contracts, implementing consensus mechanisms, Creating tamper- proof records	Managing supply chains, Managing digital assets, Decentralized finance (DeFi)			

Table 1. AI, IoT, and blockchain-powered chatbots: Technology and functionality

Blockchain technology provides a decentralized and secure framework for recording transactions and storing data. When applied to chatbots, blockchain enhances security, privacy, and transparency [8-10]. Blockchain-powered chatbots ensure that user data is encrypted and stored securely, preventing unauthorized access and tampering. Additionally, blockchain facilitates secure and transparent transactions, making it ideal for financial services and e-commerce applications [2, 10]. One of the key functionalities of blockchain-powered chatbots is identity verification. By utilizing blockchain, chatbots can verify the identity of users without relying on centralized authorities, reducing the risk of identity theft and fraud. Furthermore, blockchain enables secure and transparent supply chain management, allowing chatbots to track and verify the authenticity of products and services.

Integrating AI, IoT, and blockchain in chatbots creates a powerful synergy that enhances their functionality and reliability. AI provides the intelligence needed for natural interactions, IoT connects the chatbots to the physical world, and blockchain ensures security and transparency. This combination enables chatbots to perform complex tasks, such as managing smart devices, processing secure transactions, and providing personalized recommendations based on real-time data. For instance, in the healthcare industry, a chatbot integrated with AI, IoT, and blockchain can monitor patients' health through connected medical devices, analyze the data using AI algorithms, and securely store the information on a blockchain. The chatbot can provide real-time health updates to patients and healthcare providers, recommend treatments, and facilitate secure sharing of medical records.

The applications of AI, IoT, and blockchain-powered chatbots are vast and varied [2, 6, 8]. In the financial sector, these chatbots handle customer inquiries, perform transactions, and provide investment advice while ensuring data security through blockchain [10–12]. In retail, chatbots assist customers with product recommendations, track orders, and facilitate secure payments. In manufacturing, chatbots monitor equipment, predict maintenance needs, and optimize production processes through real-time data analysis. Another emerging use case is in smart cities, where chatbots manage public services, monitor environmental conditions, and enhance citizen engagement. For example, a chatbot in a smart city can provide information about public transportation, monitor air quality through IoT sensors, and facilitate secure voting processes using blockchain. Despite the numerous advantages, challenges exist in integrating AI, IoT, and blockchain in chatbots. These include technical complexities, data privacy concerns, and the need for interoperability among different systems. Ensuring seamless integration and real-time processing of data from diverse sources can be technically demanding. Additionally, maintaining user privacy and complying with regulations like GDPR is crucial when dealing with personal data. The convergence of these technologies will lead to the development of highly intelligent, secure, and versatile chatbots that can transform industries and improve user experiences.

# 3.3. Enhancing Customer Satisfaction, Experience, and Loyalty with Artificial Intelligence Chatbots

In the contemporary digital landscape, customer satisfaction, experience, and loyalty are essential for business success [5–7, 40]. Companies are leveraging innovative solutions to enhance these elements, and one of the most significant advancements is the use of Artificial Intelligence (AI) chatbots [6-8,30]. AI chatbots are revolutionizing customer interactions by providing seamless, efficient, and personalized experiences that meet and often exceed customer expectations [10–12]. Table 2 shows the enhanced customer satisfaction, experience, and loyalty with artificial intelligence chatbots.

Sr No	Aspect	Description	Benefits	Implementation Example	Technology Used
1	Personalized Interaction	AI chatbots utilize customer data to deliver customized responses and suggestions.	Enhancescustomersatisfactionbyprovidingmorerelevantandpersonalizedinteractions.	An online store offering product suggestions based on user browsing history.	Natural Language Processing (NLP), Machine Learning (ML)
2	24/7 Availability	Chatbots operate continuously, ensuring customers receive assistance at any time.	Improves customer experience with instant support, leading to higher satisfaction and loyalty.	A bank's app providing around-the-clock customer service.	AI, Automation
3	Quick Response Times	AI chatbots deliver immediate responses to customer inquiries, drastically reducing waiting periods.	Enhances customer satisfaction by quickly addressing concerns, leading to a more positive experience.	A telecommunications company resolving frequent issues instantly.	Real-time Processing, AI

Table 2. Enhancing Customer Satisfaction, Experience, and Loyalty with Artificial Intelligence Chatbots

4	Consistency in Responses	Chatbotsensureconsistentandaccurate information isprovided, reducing thelikelihood of errors.	Builds trust and reliability, which enhances customer loyalty by maintaining consistent service quality.	A travel agency providing uniform booking information.	Knowledge Base Integration, AI
5	Handling Multiple Queries	AI chatbots can manage numerous customer interactions simultaneously without delays.	Increases efficiency by ensuring that more customers receive prompt attention, improving overall satisfaction.	An online retailer handling a high volume of inquiries efficiently.	AI, Parallel Processing
6	Proactive Engagement	Chatbots can initiate conversations based on customer behavior, such as offering help or suggesting products.	Enhancescustomerexperiencebyprovidingtimelyandsupport,leadingtohighersatisfactionsatisfactionloyalty.	A software-as-a-service platform offering tips based on user activity.	Behavior Analysis, Al
7	Feedback Collection	AI chatbots can collect customer feedback after interactions to improve services and address issues.	Helpsbusinessesunderstandcustomerneedsbetterandimproveservices,leadingtoincreasedsatisfactionand loyalty.	Post-service surveys conducted through chatbot interactions.	Sentiment Analysis, NLP
8	Multilingual Support	Chatbotscancommunicateinmultiplelanguages,catering to a diversecustomer base.	Enhancestheexperiencefornativespeakers,leadingtogreatersatisfaction and loyalty.	A global retail brand supporting interactions in multiple languages.	Translation APIs, AI
9	Cost Efficiency	Using chatbots can reduce the need for a large customer support team, leading to cost savings.	Allows businesses to reallocate resources to other areas, potentially improving overall service quality and customer satisfaction.	Small businesses using chatbots as their primary support tool.	AI, Automation
10	Seamless Integration	AI chatbots can be integrated across various platforms (e.g., websites, social media, messaging apps), providing a unified support experience.	Ensures customers receive consistent support across all channels, enhancing satisfaction and loyalty.	Providing integrated support on web, app, and social media platforms.	API Integration, AI
11	Emotional Intelligence	Advanced AI chatbots can detect and respond to the emotional tone of customer messages, offering empathetic and supportive responses.	Improvescustomerexperienceby makinginteractionsfeel morehumanandunderstanding,significantlyboostingsatisfactionand loyalty.	Health services offering empathetic support through chatbots.	Emotion Recognition, AI
12	Data-Driven Insights	Chatbots can analyze customer interactions to provide businesses with insights into customer preferences and behavior.	Enables businesses to tailor their services and products better, enhancing customer satisfaction and loyalty through more targeted and effective support.	Retail analytics for improving personalized marketing strategies.	Data Analytics, AI

#### 3.3.1. Personalized interactions

AI chatbots significantly enhance customer satisfaction through personalized interactions. By utilizing advanced AI algorithms, chatbots can analyze extensive data, including customer preferences, purchase history, and browsing patterns, to offer highly tailored experiences. For example, chatbots can recommend products based on past purchases or customize responses to address specific customer needs. This level of personalization creates a more engaging and satisfying experience, as customers feel recognized and valued by the business. Furthermore, personalization extends to customer service. AI chatbots can identify repeat customers and recall previous interactions, ensuring consistent and coherent support. This continuity is crucial for building loyalty, as it shows the company's dedication to understanding and meeting individual customer needs over time.

#### 3.3.2. Round-the-clock availability and immediate responses

In today's fast-paced world, customers expect quick responses to their inquiries. AI chatbots provide the advantage of being available 24/7, ensuring that customers can get support at any time, day or night. This constant accessibility is particularly beneficial for businesses with a global customer base, eliminating the constraints of time zones and traditional business hours. Moreover, AI chatbots offer instant responses, significantly reducing wait times for customers. This immediacy is critical in maintaining customer satisfaction, as it prevents frustration and demonstrates that the company values its customers' time. Rapid responses also contribute to a smoother customer experience, allowing issues to be resolved swiftly and efficiently, thereby enhancing overall satisfaction and loyalty.

#### 3.3.3. Managing high volumes of inquiries

Businesses often face a high volume of customer inquiries, especially during peak periods or promotional events. AI chatbots are capable of handling multiple interactions simultaneously, ensuring that all customers receive timely assistance. This scalability is a significant advantage over traditional customer service methods, where human agents might struggle to keep up with demand, leading to long wait times and potential dissatisfaction. By effectively managing high volumes of inquiries, AI chatbots help maintain a positive customer experience even during busy times. This capability not only improves satisfaction but also fosters loyalty, as customers appreciate the consistent and reliable support provided by the company.

#### 3.3.4. Enhancing interactions with natural language processing

Natural Language Processing (NLP) is a branch of AI that enables chatbots to understand and respond to human language in a natural, conversational manner. Recent advancements in NLP have significantly improved chatbots' ability to comprehend and generate human-like responses, making interactions more fluid and intuitive. With NLP, chatbots can understand the context and intent behind customer inquiries, allowing them to provide more accurate and relevant responses. This capability enhances the user experience by making interactions with chatbots feel more like conversations with human agents. Customers are more likely to be satisfied when they feel understood and can communicate naturally with the chatbot.

#### 3.3.5. Proactive engagement with customers

AI chatbots are not limited to reactive interactions; they can also engage customers proactively. For example, chatbots can send personalized messages based on browsing behaviours, such as helping if a customer spends a significant amount of time on a particular page or providing reminders about abandoned shopping carts. This proactive engagement can guide customers through their journey, address potential issues before they arise, and encourage them to complete their purchases. Proactive engagement also includes post-purchase interactions. Chatbots can follow up with customers after a sale to gather feedback, provide updates on order status, or suggest complementary products. These proactive measures demonstrate a company's commitment to customer satisfaction and can significantly enhance loyalty by

creating a more comprehensive and attentive experience.

#### **3.3.6.** Seamless integration with other systems

AI chatbots can integrate seamlessly with other systems and platforms, such as Customer Relationship Management (CRM) software, e-commerce platforms, and social media channels. This integration allows chatbots to access and utilize a wealth of customer data, providing more informed and effective support. For instance, integration with CRM systems enables chatbots to retrieve customer information and history, allowing them to provide personalized responses and recommendations. Integration with e-commerce platforms allows chatbots to assist with order tracking, returns, and product inquiries directly within the chat interface. By providing a seamless and cohesive experience across multiple channels, AI chatbots enhance satisfaction and loyalty.

#### 3.3.7. Continuous improvement through learning

One of the most compelling aspects of AI chatbots is their ability to learn and improve over time. Machine learning algorithms enable chatbots to analyze past interactions, identify patterns, and continuously refine their responses. This continuous learning process ensures that chatbots become more effective and efficient with each interaction, providing an ever-improving customer experience. Additionally, businesses can leverage analytics and insights from chatbot interactions to identify common customer issues, preferences, and trends. This information can inform product development, marketing strategies, and customer service improvements, further enhancing the overall customer experience and satisfaction.

As AI chatbots handle a significant amount of customer data, security and privacy are critical considerations. Modern chatbots incorporate robust security measures, such as encryption and authentication protocols, to protect sensitive information. Moreover, businesses must ensure compliance with data protection regulations, such as the General Data Protection Regulation (GDPR), to maintain customer trust. By prioritizing security and privacy, businesses can alleviate customer concerns and build confidence in their AI chatbot interactions. This trust is essential for fostering loyalty, as customers are more likely to remain loyal to companies that prioritize their data security and privacy. The field of AI chatbots is continuously evolving, with new trends and innovations shaping the future of customer interactions. One such trend is the integration of AI chatbots with voice assistants, enabling customers to interact with chatbots using voice commands. This development offers a more convenient and hands-free experience, further enhancing satisfaction and accessibility. Another emerging trend is the use of AI chatbots in Augmented Reality (AR) and Virtual Reality (VR) environments. These immersive technologies can create more engaging and interactive experiences, allowing customers to visualize products, receive virtual assistance, and explore services in a more dynamic way. Furthermore, advancements in AI ethics and transparency are becoming increasingly important. As AI chatbots become more sophisticated, ensuring ethical use and transparency in their operations is crucial. Businesses must provide clear information about how chatbots operate, the data they collect, and how it is used. By addressing these ethical considerations, companies can build trust and foster long-term loyalty.

#### 3.4. Measuring the Effectiveness of Artificial Intelligence-Powered Chatbots

User Experience (UX) and satisfaction are critical when evaluating the effectiveness of chatbots [4, 9]. A chatbot's ability to deliver smooth, intuitive, and enjoyable interactions greatly influences customer loyalty and perception [10–12]. Metrics like Customer Satisfaction Score (CSAT) and Net Promoter Score (NPS) are commonly used to measure user satisfaction. These scores are obtained from post-interaction surveys where users rate their experience, with higher scores indicating better performance. In addition to quantitative metrics, qualitative feedback from users offers valuable insights into the chatbot's functionality. This

feedback can reveal strengths and areas needing improvement, such as language comprehension, accuracy, and overall usability. Recent advances in Natural Language Processing (NLP) and sentiment analysis allow businesses to analyze large volumes of user feedback, uncovering trends and sentiments that can guide enhancements [14–16].

# 3.4.1. Resolution rate and efficiency

Another vital metric is the resolution rate, which measures the percentage of queries successfully resolved by the chatbot without human assistance. A high-resolution rate indicates the chatbot's effectiveness in handling a wide range of questions, reducing the need for human agents and lowering operational costs. Conversely, a low-resolution rate may point to limitations in the chatbot's capabilities. Efficiency metrics, such as average response time and handling time, are also important. AI chatbots are designed to provide quick responses, a feature highly valued by users. Average handling time measures the time taken to resolve an issue, with shorter times indicating more efficient problem-solving.

# 3.4.2. Accuracy and comprehension

A chatbot's response accuracy is crucial for its effectiveness. This involves assessing how often the bot provides correct and relevant answers. Metrics like precision, recall, and F1 score, commonly used in machine learning, are applicable here. Precision measures the proportion of correct responses out of all responses, while recall measures the proportion of relevant responses correctly identified. The F1 score, a balance of precision and recall, provides a comprehensive measure of accuracy. Chatbots must also understand the context and nuances of user queries, requiring advanced NLP capabilities. The ability to interpret user intent accurately, including idiomatic expressions and varied sentence structures, is essential. Evaluations through conversational tests, where human judges determine whether a response was human or bot-generated, can provide insights into the chatbot's conversational abilities.

# 3.4.3. Engagement and retention

User engagement and retention rates are significant indicators of a chatbot's success. Engagement can be measured by the number of interactions per session and the duration of these interactions. High engagement rates suggest that users find the chatbot helpful and are willing to rely on it for various needs. Retention rates measure how frequently users return to interact with the chatbot. High retention rates indicate sustained user interest and trust in the chatbot's capabilities, which are crucial for businesses aiming to build long-term customer relationships.





# 3.4.4. Conversion and sales impact

For e-commerce and sales-oriented chatbots, conversion rates are a key measure of effectiveness. This metric tracks the percentage of interactions that result in desired actions, such as making a purchase or

signing up for a service. A high conversion rate indicates that the chatbot effectively guides users through the sales process and contributes to business growth. Sales impact can also be assessed by analyzing the average order value and total sales generated through chatbot interactions. Integrating AI chatbots with customer relationship management (CRM) systems enables businesses to track these metrics, providing a clear picture of the chatbot's impact on revenue.

#### 3.4.5. Operational efficiency and cost savings

AI-powered chatbots can significantly reduce operational costs by automating repetitive tasks. Measuring cost savings involves comparing the costs of chatbot deployment and maintenance against employing human agents for similar tasks. Metrics like cost per interaction and total operational savings offer quantifiable measures of the chatbot's economic impact. Additionally, chatbots enhance operational efficiency by handling high volumes of inquiries simultaneously without compromising response quality. This scalability is particularly beneficial during peak times, ensuring continuous customer support.

#### 3.4.6. Learning and improvement

A key advantage of AI chatbots is their ability to learn and improve through machine learning. Measuring the effectiveness of this continuous learning involves tracking improvements in key performance metrics like resolution rate, accuracy, and user satisfaction over time. Regular updates and retraining based on user interactions and feedback are essential for maintaining and enhancing performance.

Despite the benefits and measurable metrics, evaluating chatbot effectiveness presents challenges. Issues such as data privacy, user trust, and potential bias in AI algorithms need to be addressed. Ensuring that chatbots provide fair and unbiased support is crucial for maintaining user trust and satisfaction. Future trends in AI chatbots include integrating advanced technologies like emotion detection and contextual understanding. These enhancements aim to create more human-like interactions, improving user experience and satisfaction. Additionally, the development of multilingual capabilities is becoming increasingly important in a globalized world, enabling businesses to effectively serve a diverse customer base.

The Sankey diagram (Fig. 2) offers a representation of how user interactions flow through different stages and influence business outcomes. Starting with 1000 user interactions, 750 are addressed by chatbot responses, while 250 are escalated to human agents. Of the chatbot responses, 600 lead to successful resolutions and 150 to unsuccessful ones. For the interactions escalated to human agents, 200 are resolved successfully, and 50 remain unresolved. Successful resolutions from both chatbots and human agents result in 700 instances of positive feedback and 100 instances of neutral feedback, while unsuccessful resolutions generate 200 instances of negative feedback. Positive feedback leads to 500 cases of customer retention and 200 instances of customer satisfaction. Neutral feedback splits evenly into 50 cases of customer retention and 50 of customer satisfaction. Negative feedback leads to 200 instances of customer churn. Customer retention from positive and neutral feedback, totaling 550 cases, results in a revenue increase, whereas customer churn leads to a revenue decrease. The revenue increase and brand loyalty, the latter comprising 250 instances from customer satisfaction, contribute to overall profitability. Conversely, the revenue decrease from customer churn negatively impacts profitability. The overall profitability, bolstered by increased revenue and brand loyalty, drives business growth.

#### 3.4.7. Advancements in artificial intelligence and chatbot technologies

Machine Learning (ML) and Natural Language Processing (NLP) have been pivotal in this development [10–12, 30]. Initially, chatbots were constrained to rule-based interactions, often resulting in limited user experiences [24–26, 41]. However, the incorporation of ML and NLP has enabled chatbots to understand and generate human-like responses, significantly enhancing their usability [38–40]. Deep learning algorithms, particularly those based on neural networks, have further augmented chatbot capabilities [3, 4]. These

algorithms enable chatbots to learn from extensive data sets, improving their contextual understanding and relevance of responses. Moreover, the emergence of transformer models, such as OpenAI's GPT-40 and its successors, has revolutionized natural language understanding and generation, making chatbots more sophisticated and adept at handling complex interactions.

#### 3.4.8. Improved user experience and personalization

A major advancement in chatbot technologies is their ability to deliver personalized user experiences. Modern chatbots utilize AI to analyse user data and preferences, providing tailored recommendations and solutions. This level of personalization is especially valuable in customer service, where chatbots can offer customized support, reducing wait times and enhancing customer satisfaction. AI-powered chatbots can also engage in more natural and fluid conversations. By understanding the subtleties of human language, including idiomatic expressions, slang, and emotional cues, chatbots can respond more empathetically and appropriately. This capability is particularly beneficial in mental health support, where chatbots offer nonjudgmental, round-the-clock assistance to those in need.

#### 3.4.9. Seamless integration with omnichannel communication

Integrating chatbot technologies with omnichannel communication platforms has been transformative for businesses. Chatbots can now interact seamlessly across multiple channels, such as websites, social media, messaging apps, and voice assistants. This omnichannel approach ensures that customers receive consistent and coherent support, regardless of the platform they use. For instance, a customer might start an inquiry on a company's website and continue the conversation on a messaging app without losing context. This seamless transition is made possible by AI's ability to maintain context and continuity across different channels. Such integration not only enhances the customer experience but also streamlines business operations by centralizing communication efforts.

#### 3.4.10. Advancements in voice-activated chatbots

Voice-activated chatbots represent another significant leap forward in the field. The widespread adoption of smart speakers and voice assistants like Amazon Alexa, Google Assistant, and Apple's Siri has popularized voice-based interactions. Voice-activated chatbots leverage advanced speech recognition and NLP technologies to understand and respond to spoken queries. These chatbots provide a more intuitive and hands-free user experience, making them ideal for various applications, including smart home management, customer service, and accessibility support. For example, voice-activated chatbots can assist visually impaired individuals in accessing information and services, promoting inclusivity and accessibility.

#### 3.4.11. AI-Driven customer insights and analytics

AI-driven chatbots are not only improving direct customer interactions but also providing valuable insights and analytics. By analysing conversations and user behaviour, chatbots can generate data-driven insights that help businesses understand customer needs, preferences, and pain points. This information is crucial for refining products, services, and marketing strategies. Moreover, AI-driven analytics can identify patterns and trends in customer interactions, enabling proactive problem-solving. For example, if a chatbot detects a recurring issue among customers, it can alert the relevant department to address the problem promptly. This proactive approach enhances customer satisfaction and loyalty by demonstrating a commitment to continuous improvement.

#### 3.4.12. Ethical and responsible AI in chatbots

As AI and chatbot technologies advance, ethical considerations have become increasingly important. Ensuring that chatbots operate responsibly and ethically is crucial for maintaining user trust and avoiding potential harm. Key ethical considerations include data privacy, transparency, and bias mitigation. Data

privacy is a critical concern, as chatbots often handle sensitive user information. Implementing robust data protection measures and transparent data usage policies is essential to safeguarding user privacy. Transparency in chatbot interactions, such as clearly identifying that user are conversing with a chatbot, helps manage user expectations and build trust. Bias mitigation is another important aspect of ethical AI. AI models can inadvertently perpetuate biases present in training data, leading to unfair or discriminatory outcomes. Ongoing efforts to develop fair and unbiased AI models are essential to ensure that chatbots serve all users equitably. The future of AI and chatbot technologies holds exciting possibilities. Continued advancements in AI research, including breakthroughs in natural language understanding, machine learning, and cognitive computing, will further enhance chatbot capabilities. Emerging technologies like Augmented Reality (AR) and Virtual Reality (VR) are also poised to revolutionize chatbot interactions, providing immersive and interactive experiences. One promising area of innovation is the development of emotionally intelligent chatbots. By incorporating sentiment analysis and emotion recognition, chatbots can better understand and respond to users' emotional states. This capability is particularly valuable in customer service and mental health applications, where empathetic interactions are crucial. Additionally, the integration of AI chatbots with Internet of Things (IoT) devices will enable more seamless and intelligent interactions within smart environments. For example, chatbots could manage smart home devices, provide real-time updates on environmental conditions, and offer personalized recommendations based on user preferences and behaviours patterns.

#### 4. Conclusions

AI chatbots, utilizing advanced Artificial Intelligence (AI), Internet of Things (IoT), blockchain, Natural Language Processing (NLP) and Machine Learning (ML) technologies, provide an unprecedented level of efficiency and personalization in customer service. They are capable of handling numerous inquiries concurrently, offering immediate responses and solutions, which drastically reduces waiting times and enhances the overall customer experience. By learning from past interactions and continually refining their responses, AI chatbots ensure that customers receive accurate and contextually relevant information, tailored to their specific needs. A notable benefit of AI chatbots is their ability to offer 24/7 support, addressing customer inquiries at any hour and ensuring continuous engagement and satisfaction. This constant availability meets the expectations of today's tech-savvy consumers and significantly contributes to higher customer loyalty. Businesses that deploy AI chatbots can maintain a consistent and reliable communication channel, essential for building trust and long-term customer relationships. Moreover, AI chatbots are crucial in collecting and analysing customer data. They track interactions, preferences, and feedback, providing businesses with valuable insights into customer behaviour and trends. This data-driven approach allows companies to refine their products, services, and customer engagement strategies, leading to improved customer satisfaction and loyalty. Additionally, the predictive capabilities of AI chatbots enable them to anticipate customer needs and proactively offer solutions or recommendations, making interactions more intuitive and satisfying. Ensuring data privacy and security, addressing technical limitations, and managing customer expectations are critical considerations. It is essential to balance automation with human touch, as interactions that are overly automated may lack the empathy and understanding that human agents provide. Therefore, integrating AI chatbots as a complement to human customer service representatives, rather than a replacement, can maximize the benefits of both. As technology continues to evolve, the potential for AI chatbots to further revolutionize customer service is vast, establishing them as an essential asset for businesses aiming to excel in customer engagement.

# Conflicts of interest

The authors declare no conflict of interest.

# Author Contributions

Liladhar Rane and Saurabh P. Choudhary: Conceptualization, Data Collection, Analysis. Jayesh Rane: Writing, Editing, concluding; all authors had approved the final version.

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