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RESEARCH ARTICLE

The Effects of Artificial Intelligence on Marketing Process Optimization: A Mixed-Methods Study using Thematic Analysis and Analytic Hierarchy Process

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Abstract

The rapid advancement of artificial intelligence (AI) has transformed business environments and created new opportunities for optimizing marketing processes. This study aims to investigate and prioritize the effects of AI on marketing process optimization, with a particular focus on improving operational efficiency, decision-making accuracy, customer experience, and organizational competitiveness. A mixed-methods approach was employed, combining thematic analysis of semi-structured interviews with 13 experts in marketing and information technology and the Analytic Hierarchy Process (AHP) to evaluate and rank the identified themes. The findings reveal that AI significantly enhances marketing processes by reducing operational and advertising costs, minimizing human errors, improving decision-making quality, accelerating marketing activities, and enabling personalized customer interactions. Among the identified factors, the reduction of human error emerged as the most influential effect, whereas resource management improvement received the lowest priority. The results further indicate that AI can strengthen firms' competitive advantage and improve marketing effectiveness; however, its successful implementation requires careful management of privacy concerns and the development of strategies aligned with local cultural and market conditions. Overall, the study highlights AI as a strategic enabler of marketing process optimization and sustainable business performance.

Keywords: Artificial Intelligence, Intelligent marketing, Marketing management, Digital marketing, Analytic Hierarchy Process (AHP), Industry 4.0.

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1. Introduction

The rapid advancement of technology over recent decades has led to revolutionary innovations that are transforming societies, economies, and industries worldwide. Among these developments, AI has emerged as one of the most significant technological breakthroughs, enabling organizations to analyze complex data, identify patterns, generate predictions, provide recommendations, and support automated decision-making processes. The integration of AI technologies across various sectors has contributed to the emergence of the Fourth Industrial Revolution (Industry 4.0), characterized by unprecedented levels of automation, intelligence, and digital transformation [1]. In today's business environment, marked by accelerating globalization and digitalization, organizations operate within increasingly dynamic and competitive markets. International markets face numerous challenges, including rapidly changing customer demands, intense competition, and cultural diversity. Consequently, marketing and sales processes have undergone substantial transformations, requiring firms to adopt innovative approaches and advanced technologies to maintain their competitiveness and market position [2]. In this context, AI has emerged as a transformative technology that plays a crucial role in optimizing marketing and sales processes [3]. By leveraging big data analytics, customer behavior prediction, and personalized marketing strategies, AI enables organizations to effectively address the growing complexities of global markets [4]. One of the most significant challenges facing international businesses is managing diverse markets with varying customer preferences,

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regulatory requirements, and environmental conditions [5].

Strategies that prove effective in one market may not necessarily yield similar outcomes in another. Therefore, AI assists organizations in analyzing market and customer data, facilitating more informed decision-making and enabling the development of marketing strategies tailored to both local and global market conditions [6]. As a result, businesses can enhance their competitive advantage by optimizing advertising activities, increasing conversion rates, and improving customer experiences within their target markets [7]. Furthermore, AI plays a vital role in the automation of marketing processes.

Marketing automation not only enhances workforce productivity but also reduces operational costs and improves overall organizational performance [8]. The AI-powered tools analyze historical data and forecast future trends, enabling marketers and sales professionals to engage more effectively with potential customers and optimize marketing activities in a data-driven manner [9]. In addition, AI possesses the capability to analyze vast amounts of structured and unstructured data, including customer reviews, social media interactions, and behavioral patterns. This capability allows organizations to gain deeper insights into customer sentiments, expectations, and preferences, thereby facilitating the personalization of communication styles and marketing messages. AI-powered catboats and virtual assistants can deliver fast, accurate, and personalized responses, significantly enhancing customer experience [10]. These capabilities are particularly valuable in complex international markets characterized by diverse products, services, cultures, regulations, and consumer preferences. By utilizing AI to analyze large volumes of customer data and tailor marketing communications to individual needs, organizations can foster deeper customer engagement, strengthen customer loyalty, and ultimately improve sales performance. Consumer engagement theories provide a valuable framework for understanding the impact of AI-driven personalization on customer relationships and marketing effectiveness [11]. Further, cloud-assisted AI systems are reported in [45], [47] for enhancement of business eco-systems.

In international markets where cultural diversity and varying consumer preferences are prominent characteristics, the customization of marketing strategies has become a critical success factor. The application of machine learning algorithms to analyze customer behavior and predict future needs enables organizations to deliver products and services more accurately to different customer segments [12]. Such personalization not only enhances customer satisfaction but also contributes to improved conversion rates, higher returns on investment (ROI), and increased organizational profitability [13]. Today, organizations must continuously improve their marketing and sales processes to survive and thrive in highly competitive environments. Increasing sales, attracting new customers, retaining existing customers, and improving the effectiveness of marketing activities are among the primary objectives pursued by businesses. Consequently, the optimization of marketing and sales processes has become a strategic necessity for modern organizations [9]. In this regard, AI, with its innovative capabilities and advanced analytical power, has become one of the most influential drivers of transformation in marketing,

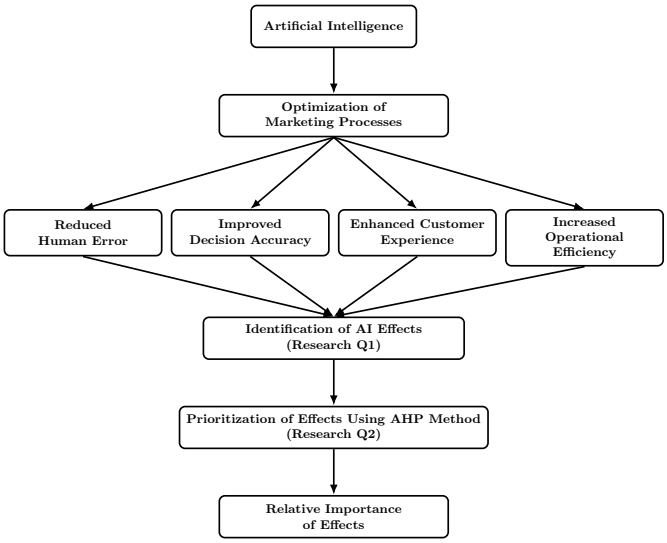

Figure 1: Conceptual framework for identifying and prioritizing the effects of artificial intelligence on marketing processes using the AHP method.

fundamentally changing the way marketing activities are designed, implemented, and evaluated [14]. Despite the growing adoption of AI technologies in marketing, this field remains relatively new within the academic literature, and comprehensive studies examining its multifaceted impacts remain limited compared to other established research domains. Therefore, identifying the various dimensions of AI's influence on marketing processes and evaluating the relative importance of these impacts is of considerable scholarly and practical significance. Accordingly, this study adopts a mixed-methods approach to investigate the effects of Artificial Intelligence on marketing process optimization and seeks to provide a comprehensive understanding of the opportunities, benefits, and implications associated with the application of AI in contemporary marketing practices.

Figure 1 presents the conceptual framework of the study. As illustrated, AI serves as the primary enabling factor influencing the optimization of marketing processes through capabilities such as data analytics, process automation, and customer intelligence. Based on this framework, the study addresses two main research questions. First, it seeks to identify the key effects of AI on marketing process optimization. Second, it aims to determine the relative importance and priority of these effects using the AHP. The framework provides a structured basis for examining how AI contributes to enhancing marketing performance and supports the evaluation of its most significant impacts.

2. Smart marketing

Smart marketing has emerged as a modern and transformative approach in business and marketing management that leverages data and advanced technologies, particularly AI and ML, to optimize and personalize marketing activities and strategies [15], [44]. This approach has evolved in response to the increasing complexity of business environments, the rapid growth of data generation, and the changing expectations of customers. By utilizing intelligent technologies, organizations are able to make more

informed marketing decisions based on comprehensive data analysis and actionable insights. The primary objective of smart marketing is to achieve a deeper understanding of customers, analyze their behavioral patterns, and utilize this knowledge to design and implement more effective marketing strategies. Through advanced analytical tools and AI-driven algorithms, organizations can process vast amounts of data and gain valuable insights into customer preferences, needs, and purchasing behaviors. This capability enables businesses to predict customer actions more accurately and personalize marketing communications according to individual customer characteristics and expectations [16]. Consequently, firms can deliver the right message to the right customer at the right time through the most appropriate communication channels. One of the key distinctions between smart marketing and traditional marketing lies in the way customers are segmented and targeted. Conventional marketing approaches often categorize customers based on demographic variables such as age, gender, income level, or geographic location. In contrast, AI-driven marketing systems can create significantly more refined customer segments by analyzing a broader range of data points, including purchase history, online behavior, social media interactions, personal interests, and even predicted future actions [17]. This enhanced level of segmentation allows organizations to allocate marketing resources more efficiently and improve the effectiveness of their promotional activities.

In smart marketing, data serve as the fundamental resource for decision-making processes. Organizations can utilize data-driven analytics to identify market trends, discover emerging opportunities, and predict customer needs with greater accuracy. These data are collected from various sources [20], including website interactions [46] , online purchasing activities [47], social media platforms [48], customer relationship management (CRM) systems, and other digital touch points [6]. The integration and analysis of such information provide valuable insights that support strategic decision-making and reduce uncertainty in marketing activities. Furthermore, smart marketing enables organizations to continuously monitor market dynamics and respond rapidly to environmental changes [9].

3. Marketing processes

Marketing processes encompass all activities and actions undertaken by organizations to attract customers, create value, and achieve their sales and business objectives across different operational levels. These processes typically involve a sequence of interconnected stages, including market analysis, identification of customer needs and preferences, development of appropriate products and services, establishment of effective customer communication channels, and ultimately the completion of sales transactions and post-purchase relationship management [18]. As a core organizational function, marketing serves as a bridge between businesses and customers, ensuring that products and services are aligned with market demands and consumer expectations. The effectiveness of marketing processes largely depends on an organization's ability to understand its target market and accurately identify customer needs. Market analysis and customer insight generation are therefore among the most critical components of modern marketing. Organizations must continuously gather, process, and interpret information regarding customer behavior, purchasing patterns, preferences, and expectations in order to design more effective marketing strategies. Such information enables firms to improve advertising campaigns, enhance product development initiatives, and increase customer satisfaction by delivering value that closely matches consumer requirements [6].

Effective communication, customer engagement, relationship management, and personalized interactions are increasingly recognized as essential elements of successful marketing strategies. Consequently, organizations must ensure that their marketing processes are designed not only to attract new customers but also to retain existing ones by continuously delivering superior value and positive customer experiences. Within the sales function, particular emphasis is placed on increasing conversion rates and optimizing interactions between sales representatives and customers. Organizations seek to improve the efficiency of their sales activities by identifying high-potential prospects, understanding customer motivations, and tailoring sales approaches to specific customer segments. Effective coordination between marketing and sales activities is essential for maximizing organizational performance and achieving sustainable growth [6]. As customer journeys become increasingly complex, businesses must adopt more sophisticated approaches to managing customer interactions throughout the purchasing process. To address these challenges, many organizations have adopted advanced technologies and marketing automation systems that streamline routine activities, improve operational efficiency, and generate more effective marketing outcomes [19]. These technologies enable firms to execute marketing campaigns more efficiently, monitor performance in real time, and make data-driven adjustments to their strategies. The growing integration of Artificial Intelligence into marketing processes has further accelerated this transformation.

AI-powered technologies provide organizations with the ability to analyze large volumes of customer data, identify hidden patterns, and generate actionable insights that support strategic decision-making. By leveraging AI's analytical capabilities, companies can design marketing activities that directly reflect individual customer preferences, purchase histories, and online behaviors. This level of personalization allows organizations to establish deeper and more meaningful relationships with consumers, enhance customer engagement, strengthen brand loyalty, and ultimately create a significant competitive advantage in increasingly dynamic markets [43], [45]. Overall, marketing processes have evolved from traditional, transaction-oriented activities into highly integrated, data-driven, and customer-centric systems. The adoption of advanced technologies, particularly Artificial Intelligence, has significantly enhanced organizations' ability to understand customers, optimize marketing performance, improve sales effectiveness, and achieve sustainable competitive success in contemporary business environments.

4. Applications of AI in marketing

Artificial intelligence has rapidly emerged as one of the most influential technologies for optimizing and enhancing marketing processes across industries. Through the application of machine learning algorithms, predictive analytics, and advanced data-processing capabilities, AI enables organizations to better understand customer behavior, anticipate market trends, and improve the effectiveness of marketing strategies. By leveraging these capabilities, businesses can develop more targeted and personalized marketing initiatives, resulting in improved customer engagement and significantly higher ROI [8]. Organizations that utilize AI-driven data analytics, customer segmentation techniques, and real-time personalization tools are able to create highly targeted marketing campaigns that resonate with individual customer needs and preferences. Such capabilities allow firms to move beyond traditional mass-marketing approaches and adopt customer-centric strategies that foster deeper engagement and stronger emotional connections with consumers. As a result, organizations can strengthen brand loyalty, improve customer retention, and achieve superior business performance. With the continuous advancement of AI technologies, the potential for marketing personalization continues to expand, creating unprecedented opportunities for businesses to deliver customized experiences at scale [21]. One of the most important applications of AI in marketing is big data analytics.

Modern organizations generate and collect enormous volumes of customer-related data from various digital channels, including websites, social media platforms, mobile applications, online transactions, and customer relationship management systems. AI technologies possess the computational capability to process these large and complex datasets efficiently, identify hidden patterns, and uncover valuable insights regarding customer preferences, purchasing behavior, and decision-making processes [9]. Such insights enable organizations to make more informed marketing decisions and develop evidence-based strategies that align closely with customer expectations. The ability of AI to transform raw data into actionable intelligence provides significant advantages for marketers. By analyzing customer information in real time, organizations can identify emerging trends, anticipate future customer needs, and proactively adapt their marketing efforts. Consequently, businesses are able to design more effective marketing campaigns and tailor promotional messages according to the unique characteristics of individual customers and market segments [22]. This level of precision contributes to improved campaign performance, higher conversion rates, and more efficient allocation of marketing resources. Another critical application of AI in marketing is the automation of marketing processes. Marketing automation technologies powered by AI include intelligent email marketing systems, recommendation engines, campaign management platforms, and customer engagement tools. These systems can automatically perform repetitive marketing tasks, optimize campaign execution, and deliver personalized content to customers without extensive human intervention. As a result, organizations can improve operational efficiency while simultaneously enhancing the customer experience [23]. Among AI-powered marketing tools, chatbots and virtual assistants have become particularly important components of customer service and customer relationship management strategies. AI-based chatbots can respond to customer inquiries, address complaints, provide product recommendations, and offer support services around the clock. By delivering immediate and personalized responses, these technologies improve customer satisfaction and contribute to a more seamless customer journey [24]. Furthermore, intelligent chatbots can continuously learn from interactions, enabling them to provide increasingly accurate and context-specific responses over time. This capability allows organizations to deliver fast, efficient, and personalized customer service while reducing operational costs. Beyond its operational applications, AI has become a strategic enabler of value creation in contemporary marketing. Effective marketing practices facilitate opportunities for the exchange of goods and services [25] while simultaneously contributing to the development of sustainable competitive advantages [26].

Modern marketing has become increasingly dependent on intelligent and automated data-driven systems that support more accurate decision-making and enhance organizational responsiveness. This highly focused and analytical marketing approach has demonstrated a direct impact on marketing outcomes and organizational performance [27]. Technological advancements have continuously driven the evolution of marketing practices, demonstrating that marketing and AI can work synergistically to create meaningful value for both organizations and customers [28]. When technology operates at a personalized level, it establishes stronger connections between businesses and consumers. By leveraging AI to understand individual customer preferences and behaviors, marketers can create highly relevant and engaging experiences that significantly enhance customer value creation [29]. Such personalized interactions not only improve customer satisfaction but also strengthen long-term relationships and increase customer lifetime value. Furthermore, advanced AI-driven marketing solutions are capable of adapting rapidly to changing business requirements and market conditions. These innovative technologies facilitate the delivery of customized communication strategies and integrated solution packages that address the needs of various stakeholders while supporting organizational objectives [30] . As business environments become increasingly dynamic and customer expectations continue to evolve, the adaptability provided by AI-based marketing systems becomes a critical organizational capability. From a strategic perspective, the importance of Artificial Intelligence in marketing continues to grow. Many organizations have improved their performance through the adoption of AI-powered platforms and technologies. These systems enhance customer interactions across multiple marketing channels, improve market forecasting capabilities, and increase the effectiveness of marketing automation initiatives. As a result, AI is widely recognized as one of the most transformative technologies for modern business, with its global market value projected to increase from approximately $10.1 Billion in 2018 to nearly $126 Billion by 2025 [31]. This remarkable growth highlights the increasing significance of AI as a driver of innovation, competitiveness, and sustainable success in contemporary

marketing environments.

Previous studies have shown in Table 1, in which AI is a new topic in discussions and integration of marketing, marketing with AI and its scientific challenges and concerns. Therefore, it is important to examine AI on the proposed processes and can help fill this gap and provide new perspectives in this field.

5. Research design and methodology

The research process was conducted in two complementary phases. In the first phase, qualitative data were collected through semi-structured interviews with experts and managers specializing in marketing and information technology. To ensure the relevance and richness of the collected information, theoretical sampling was employed. Theoretical sampling is a purposive sampling technique in which participants are selected based on their expertise, experience, and direct relevance to the research topic. This approach enabled the researcher to obtain in-depth insights regarding the various dimensions of AI applications in marketing and their impact on organizational performance. The interview process continued until theoretical saturation was achieved. Theoretical saturation occurs when additional interviews no longer generate new information, concepts, or themes relevant to the research objectives. In this study, saturation was reached after thirteen interviews, as the collected responses became repetitive and no new themes emerged. Conducting thirteen interviews ensured both the comprehensiveness and credibility of the qualitative findings while providing a robust foundation for subsequent analysis. The collected qualitative data were analyzed using thematic analysis. This method was selected because of its effectiveness in identifying, organizing, and interpreting meaningful patterns within textual data.

Thematic analysis enables researchers to explore qualitative data in depth and uncover relationships among different concepts and perspectives expressed by participants. Given that the present study aims to develop a comprehensive understanding of the effects of AI on marketing process optimization, thematic analysis was considered particularly appropriate. The analysis process began with a thorough review and familiarization with the interview transcripts. Subsequently, open coding was performed to identify significant concepts and recurring patterns within the data. Similar codes were then grouped together to form broader categories, leading to the identification of both main and sub-themes. These themes represent the key concepts expressed by participants and encompass various dimensions of AI's impact on marketing and sales processes. Through this systematic coding and categorization procedure, a conceptual framework of AI-driven marketing optimization was developed.

In the second phase of the study, the AHP was employed as a quantitative decision-making technique to evaluate and prioritize the identified themes. The AHP was selected because of its ability to assess multiple criteria simultaneously and determine their relative importance through pairwise comparisons. This method integrates subjective expert judgments with objective analytical procedures, making it particularly suitable for prioritizing factors that influence marketing process optimization through AI technologies. Since one of the primary objectives of this research was to determine the relative importance of the themes identified during the qualitative phase, AHP provided an effective quantitative framework for ranking these factors. Initially, the main criteria associated with AI-driven marketing optimization were extracted from the thematic analysis results.

Subsequently, pairwise comparison questionnaires were developed and distributed to eight experts and managers with extensive knowledge and experience in marketing and information technology. These participants included academics, industry professionals, and practitioners with relevant expertise in AI applications and marketing management. The collected data were processed using specialized AHP software to calculate the relative weights of the identified criteria and determine their priority rankings. Through pairwise comparison analysis, the significance of each factor was quantified, enabling a systematic evaluation of the most influential effects of AI on marketing process optimization.

The integration of thematic analysis and AHP represents one of the major strengths of this study. The qualitative phase facilitated the identification and exploration of key concepts and dimensions associated with AI applications in marketing, while the quantitative phase enabled the measurement and prioritization of these dimensions based on expert judgments. This mixed-methods approach provided both depth and rigor, allowing for a comprehensive examination of the research problem and generating findings that are both theoretically meaningful and practically applicable. Data Collection Procedure A total of thirteen semi-structured interviews were conducted with specialists and experts in the fields of marketing and AI.

The initial interview questions were developed based on an extensive review of the relevant literature and were designed to explore the various dimensions of AI's impact on marketing process optimization. The interview structure was intentionally designed to encourage exploratory discussions by beginning with broad, open-ended questions. This approach enabled participants to freely express their experiences, perspectives, and insights regarding the role of AI in marketing activities. As the interviews progressed, additional probing questions were developed based on participants' responses to clarify emerging concepts and validate newly identified themes. This iterative and flexible approach allowed the data collection and analysis processes to evolve simultaneously, enhancing the richness and depth of the findings. The dynamic interaction between the researcher and participants facilitated the discovery of nuanced perspectives and contributed to a more comprehensive understanding of the research phenomenon. Detailed information regarding the interview participants, including their professional expertise, work experience, and fields of specialization, is presented in Table 2. It means that after conducting 11 interviews, the researchers reached data saturation- no new themes were emerging. However, to increase the rigor and trustworthiness of the study, they conducted 2 additional interviews. Table 3 provides the details of main themes and sub-themes with frequency of appearance across interviews.

Table 1: Research conducted in the field of applying artificial intelligence in marketing.

Sl. No.	Subject	Results	Reference
1	AI for the real world	The authors present a multidimensional framework for understanding the impact of AI, including levels of intelligence, tasks, and the use of robots. They also discuss privacy, bias, and ethics challenges and emphasize that AI should augment rather than replace human managers.	[9]
2	AI in marketing: Systematic review and future research	This study systematically reviews the literature to illustrate the importance of AI in marketing and outlines future research directions.	[32]
3	AI in business: State of the art and future research agenda	Current state of AI research in business has twelve major themes grouped into four categories: collective impact, organizational impact, AI systems, and AI methods.	[33]
4	A strategic framework for AI in marketing	A step-by-step strategic marketing framework is proposed that combines machine learning, analytical AI, and emotional AI to support segmentation, targeting, positioning, and marketing implementation activities.	[34]
5	AI in marketing: A systematic literature review	The study identifies five strategic marketing domains and twenty subtopics. A total of 201 AI applications reported in 72 articles are reviewed and ranked according to coverage, impact, and importance.	[35]
6	ML and AI use in marketing: A general taxonomy	The paper presents a taxonomy of machine learning applications in marketing and identifies eleven recurring use cases related to consumer behavior, customer experience, decision-making, and financial performance.	[36]
7	AI and user-generated data are transformation	The article examines how AI and user-generated content improve voice-of-customer analysis and discusses suitable analytical techniques for different forms of customer data.	[37]
8	AI in marketing: Concerns and solutions	The study investigates privacy and data security concerns associated with AI-driven marketing and proposes edge computing and restricted-access architectures as mitigation measures.	[38]
9	AI in digital marketing: Insights from a comprehensive review	The review highlights AI applications in consumer behavior analysis, e-commerce, digital advertising, budget optimization, and competitive strategy development.	[23]
10	Impact of AI on marketing	The findings indicate that competitive pressure, media attention, digital maturity, and customer expectations significantly influence AI adoption in marketing activities.	[39]
11	AI in business models as a tool for managing digital risks in international markets	The study shows that AI provides new opportunities for digital risk management through large-scale data analysis and automation of complex decision-making tasks.	[40]
12	The evolving role of AI in marketing	AI enables marketers to gain deeper customer insights, improve data analytics, and transform marketing activities into highly customer-centric processes.	[41]
13	Investigating the impact of international markets and new digital technologies on business innovation	Results demonstrate a positive relationship between international markets, digital technologies, and organizational innovation, particularly when entrepreneurial orientation is strong.	[42]
14	A B2B marketing capabilities perspective	AI competencies contribute to information management, planning, B2B marketing effectiveness, and operational execution capabilities.	[43]
15	AI and ML: Exploring drivers, barriers, and future developments in marketing management	Organizations should improve AI and ML literacy among managers to address unrealistic expectations and ensure balanced adoption of intelligent technologies in marketing decision-making.	[44]

6. Implementation of the AHP method for weighting the main themes

To evaluate and prioritize the main themes associated with the effects of AI on marketing process optimization, the AHP was employed. The AHP is a widely recognized multi-criteria decision-making (MCDM) technique that enables researchers to systematically assess, compare, and prioritize multiple criteria based on pairwise comparisons. Owing to its ability to integrate both qualitative judgments and quantitative analysis, AHP has been extensively utilized in studies involving complex decision-making problems and criteria prioritization. For the purpose of this study, eight experts with substantial knowledge and professional experience in the fields of marketing and information technology participated in the evaluation process. The experts were asked to compare the identified themes pairwise according to their relative importance in influencing marketing process optimization through AI applications. The comparisons were conducted using Saatya's standard

Table 2: Demographic information of participants.

Sl. No	Job	Age	Work history	Education
1	Researcher	25	4	Business Administration
2	Investment Manager	34	10	Economic
3	Marketing Manager	25	4	Business Administration
4	IT Manager	36	11	Business Administration
5	Export Manager	27	5	Business Administration
6	IT Manager	35	12	Information Technology
7	Researcher	29	7	Public Administration
8	Marketing Manager	28	6	Business Administration
9	Marketing Manager	35	10	Marketing Management
10	Artificial Intelligence Manager	30	8	Artificial Intelligence
11	Management Strategy Manager	30	7	Strategy Management
12	Commercial Manager	27	6	Business Administration
13	Business Manager	31	7	Business Management

nine-point scale, where a value of 1 indicates equal importance between two criteria, while a value of 9 represents the extreme importance of one criterion over another [49]. Intermediate values were used to reflect varying degrees of preference and relative significance. To enhance the reliability of the evaluation process, the individual judgments provided by the experts were aggregated, and the average values were used to construct the pairwise comparison matrix. This matrix serves as the fundamental input for the subsequent stages of the AHP analysis, including the calculation of criteria weights, consistency assessment, and the determination of priority rankings. Table 4 presents the pairwise comparison matrix developed based on the experts' evaluations. The matrix constitutes the primary analytical foundation for deriving the relative weights of the identified themes and determining their respective contributions to marketing process optimization. Through this procedure, the study is able to quantify the relative importance of each theme and establish a prioritized framework for understanding the impact of AI on marketing processes.

To determine the relative importance of each criterion, the pairwise comparison matrix was normalized. Normalization is a crucial step in the AHP, as it transforms the comparison values into a standardized form and enables meaningful comparisons among the criteria. By converting the original matrix into a normalized matrix, the influence of scale differences is eliminated, allowing the relative contribution of each criterion to be assessed more accurately. The normalized matrix serves as the basis for calculating the priority weights of the criteria. These weights represent the relative importance of each identified theme in relation to the overall objective of the study. Consequently, the normalization process facilitates the weighting procedure and provides the foundation for ranking the criteria according to their significance. The normalized pairwise comparison matrix is presented in Table 5.

The weights of the criteria were determined by calculating the average of the normalized values across each row of the normalized pairwise comparison matrix. In the AHP, this procedure is used to derive the priority vector, which reflects the relative importance of each criterion with respect to the overall objective of the study. By averaging the normalized values, a single weight is assigned to each criterion, representing its contribution to the decision-making framework. These calculated weights indicate the relative significance of the identified criteria and provide a quantitative basis for comparing and ranking them. Criteria with higher weights are considered more influential in achieving the research objective, whereas criteria with lower weights have a comparatively smaller impact. The resulting weights were subsequently used to prioritize the identified themes associated with the effects of AI on marketing process optimization. The calculated criteria weights are presented in Table 6.

In the AHP, consistency assessment is an essential step because the pairwise comparison matrix is based on subjective evaluations made by decision-makers. The Consistency Ratio measures the degree to which the pairwise comparisons are logically coherent and aligned with the principles of transitivity and rational judgment. In other words, it examines whether the preferences expressed by the experts are internally consistent across all comparisons. The calculation of the CR provides an important validation mechanism for the decision-making process. A low consistency ratio indicates that the judgments are logically consistent and that the relationships among the compared criteria are reliable. According to Saaty's AHP methodology, the CR of less than 0.10 is generally considered acceptable, indicating that the level of inconsistency is sufficiently low and does not significantly affect the validity of the analysis. Therefore, the consistency assessment ensures that the collected judgments are trustworthy and can be confidently used for subsequent calculations, including the determination of criteria weights and priority rankings. By verifying the consistency of the pairwise comparison matrix, the researcher can ensure that the resulting weights accurately reflect expert opinions and provide a robust basis for decision-making. In the next step, to evaluate the accuracy and consistency of the judgments made, the CR was calculated. This ratio measures the degree of consistency in the pairwise comparisons within the comparison matrix, indicating how well the judgments align with logical and proportional principles.

7. Key results

Principal eigenvalue, CI and CR values are calculated by (1)-(3), respectively.

$$\lambda_{\max} = 9.479 \tag{1}$$

$$CI = 0.0599 \tag{2}$$

$$CR = 0.0413 \tag{3}$$

Table 3: Main themes and sub-themes with frequency of appearance across interviews.

Sl. No	**Main themes**	**Sub-themes**	**Number of interviews**	**Abundance**
1	Cost reduction	Improve operational efficiency	1,3,5,6,9	5
		Reducing human resources costs	2,4,7,8,11,13	6
		Reduce advertising costs	2,5,8,10	4
		Supply chain management optimization	6,9,12	3
		Reducing research costs	2,3,8,11	4
2	Reducing human error	Reducing errors in data analysis	1,4,5,7,10	5
		Reducing human decision-making error	3,4,6,9,11,13	6
		Reducing errors in advertising campaigns	2,5,8,12	4
		Reducing errors in competitor analysis	1,4,7	3
3	Improve customer experience	Personalize customer interactions	1,3,4,6,8,9	6
		Provide better customer service	2,5,7,11,13	5
		Analyze customer needs more accurately	1,4,8,9,10	5
		Improve customer satisfaction	2,6,9	3
4	Improve decision-making accuracy	Increasing accuracy in market analysis	2,3,5,7	4
		More accurate prediction of customer behavior	1,4,6,8,12	5
		Optimizing advertising strategies	3,5,7,9,10,11	6
		Analyzing competitive data	2,5,8,12	4
5	Increase the speed of operations	Improve customer response speed	1,3,7,12	4
		Accelerate data analysis	2,4,5,6,10	5
		Reduce campaign launch time	2,6,9	3
		Accelerate strategy implementation	3,7,10,11	4

Table 4: Aggregated pairwise comparison matrix of the main themes related to AI effects on marketing process optimization.

Criteria	**Cost reduction**	**Reducing human error**	**Improve customer experience**	**Decision-making accuracy**	**Increase speed**	**Advertising accuracy**	**Managers' decision making**	**International competitiveness**	**Resource management**
Cost reduction	1	0.67	8.21	2	0.82	5.32	3.46	0.53	8.13
Reduction in human error	1.54	1	8.93	1.33	1.27	7.65	4.48	0.75	8.57
Improvement in customer experience	0.14	0.14	1	0.48	0.12	0.49	0.32	0.27	0.84
Improvement in decision-making accuracy	2	1.33	4.22	1	1.60	3.40	6	0.57	7.50
Increase in operational speed	1.25	0.83	12.50	0.62	1	6.25	3.75	2.52	8.50
Increase in advertising accuracy	0.19	0.13	0.45	0.20	0.16	1	0.62	0.15	0.98
Facilitating managers' decision-making	0.29	0.22	0.68	0.37	0.27	1.62	1	0.25	1.48
Improvement in international competitiveness	0.53	0.40	0.86	1	0.32	2.54	1.89	1	2.12
Improvement in resource management	0.12	0.11	0.49	0.57	0.14	0.67	0.45	0.25	1

Since the calculated CR = 0.0413 is well below the acceptable threshold of 0.1, the pairwise comparisons in the matrix demonstrate a high level of consistency. The CR is a critical validation step in the AHP. It serves as a quantitative measure to assess whether the decision-makers pairwise comparisons are consistent enough to be considered reliable. A CR value of 0.0413 is excellent significantly lower than the commonly accepted upper limit of 0.10. This low value indicates minimal random inconsistency in the judgments. In practical terms, the expert(s) who

Table 5: Normalized pairwise comparison matrix of the main themes.

Criteria	**Cost reduction**	**Human error**	**Customer experience**	**Decision accuracy**	**Speed**	**Advertising accuracy**	**Managers' decision**	**International competitiveness**	**Resource management**
Cost reduction	0.1387	0.1416	0.1773	0.1873	0.1434	0.1838	0.1610	0.1322	0.1894
Reduction in human error	0.2136	0.2114	0.1928	0.1246	0.2220	0.2642	0.2085	0.1870	0.1996
Improvement in customer experience	0.0194	0.0296	0.0216	0.0450	0.0210	0.0169	0.0149	0.0480	0.0196
Improvement in decision-making accuracy	0.2773	0.2813	0.1985	0.0935	0.2795	0.1523	0.2793	0.0273	0.1757
Increase in operational speed	0.1734	0.1755	0.2894	0.0362	0.1748	0.2800	0.1745	0.1208	0.1990
Increase in advertising accuracy	0.0264	0.0275	0.0216	0.0117	0.0160	0.0448	0.0289	0.0072	0.0229
Facilitating managers' decision-making	0.0403	0.0466	0.0327	0.0216	0.0270	0.0725	0.0465	0.0120	0.0345
Improvement in international competitiveness	0.0728	0.0846	0.0413	0.0580	0.0320	0.1138	0.0879	0.0482	0.0494
Improvement in resource management	0.0084	0.0116	0.0231	0.0331	0.0150	0.0300	0.0210	0.0120	0.0234

Table 6: Final weights and rankings of the main themes.

Criteria	**Weight**
Reduce human error	0.2234
Improve decision-making accuracy	0.2001
Increase operational speed	0.1955
Reduce costs	0.1616
Improve international competitiveness	0.0808
Facilitate decision-making for managers	0.0533
Increase advertising accuracy	0.0323
Improve customer experience	0.0318
Improve resource management	0.0213

filled the comparison matrix maintained logical proportionality across their evaluations. Such a strong consistency result enhances the credibility of the subsequent priority weights and final decision outcomes derived from the model. Decision-makers can therefore confidently move forward with the analysis, knowing that the input data is robust and free from major contradictions. Further, CI and CR values are given by (4) and (5).

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{4}$$

$$CR = \frac{CI}{RI} \tag{5}$$

In (5), RI is the Random Index for the corresponding matrix size.

8. Conclusion

AI has emerged as a transformative technology with significant potential to enhance the efficiency, accuracy, and effectiveness of natural language processing technologies. This study aimed to investigate the role of AI in optimizing NLP technologies through a mixed-methods approach. In the qualitative phase, data were collected through 13 semi-structured interviews with experts in NLP, AI, and related fields and analyzed using thematic analysis, resulting in the identification of 57 sub-themes and 9 main themes. In the quantitative phase, the AHP was employed to prioritize the identified themes based on the evaluations of eight experts. The findings revealed that AI has substantial impacts on the optimization of NLP technologies. The most significant effects include reducing human error, improving processing accuracy, lowering operational costs, and increasing the speed and efficiency of operations. Among these factors, the reduction of human error was identified as the most influential impact, highlighting the ability of AI to automate NLP processes and improve decision-making quality. Improved accuracy was also recognized as a critical outcome, as AI-driven algorithms can analyze complex datasets, identify patterns, and support more precise and reliable processing activities.

Declarations and ethical statements

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Artificial Intelligence usage statement: During the preparation of this manuscript, the authors utilized AvalAI (https://avalai.ir/) solely for language refinement and grammatical corrections. The authors carefully reviewed and revised the generated content and take full responsibility for the accuracy, integrity, and originality of the final

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CRediT authorship contribution statement

Parham Roghanian: Conceptualization, Investigation, Writing – review & editing, Validation. **Parsa Roghanian**: Conceptualization, Investigation, Writing – review & editing, Validation.

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