Smarter Bridges: Leveraging Artificial Intelligence to Reshape University-Industry Technology Transfer

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***Abstract*—University-industry technology transfer (UITT) is essential for converting academic research into commercial use, yet traditional strategies often fail to address the knowledge gap. Literature suggests that institutional inertia, communication barriers, and ineffective marketing strategies hinder the commercialization of technology. This study proposes a conceptual framework that incorporates AI-driven marketing to enhance knowledge dissemination, market identification, and stakeholder engagement within the technology transfer process. This systematic literature review amalgamates insights from UITT, AI marketing applications, and knowledge management systems. A qualitative analysis of peer-reviewed literature from 2017 to 2025 identifies trends, deficiencies, and emerging patterns, leading to an integrated framework that assesses technology transfer strategies and the implementation of AI marketing across diverse sectors, leveraging the Technology-Organization-Environment (TOE) model and the Unified Theory of Acceptance and Use of Technology (UTAUT). The investigation demonstrates that AI-enhanced marketing can significantly bolster UITT through five AI-enhanced marketing capabilities: precise client segmentation, predictive analytics of market trends, tailored communication, improved knowledge management, and streamlined digital outreach. This methodology fosters reciprocal knowledge exchanges, positioning AI as a facilitator between market insights and university research aims while refining technology presentations for industry stakeholders. Moreover, the study highlights critical concerns regarding data privacy, implementation expenses, technical complexities, and the necessary proficiency in AI and technology transfer.**

***Keywords*—Collaboration; university-industry; technology transfer; AI-enhanced marketing; innovation; knowledge sharing; economic growth; strategic partnerships; research initiatives; entrepreneurial mindset**

I. Introduction

The integration of artificial intelligence (AI) into marketing strategies and the transfer of technology between universities and industry represent a rapidly advancing field of research with far-reaching implications for global innovation ecosystems [1], [2], [3]. In today's academic landscape, higher education institutions face growing pressure to effectively commercialize research outcomes while fostering collaborative industry partnerships through AI-driven marketing approaches [4], [5], [6]. Traditional technology transfer models, which have long relied on licensing agreements and spin-off ventures, now confront significant challenges in the era of digital transformation. These shifts necessitate more intelligent, data-driven strategies for industry engagement [7], [8], [9].

Recent advancements in artificial intelligence (AI) have revolutionized marketing practices across diverse industries, enabling unprecedented levels of personalization, predictive analytics, and automated decision-making [10], [11], [27]. However, the application of AI-driven marketing strategies to technology transfer between academia and industry remains underexplored, creating a significant gap in both theoretical frameworks and practical implementation guidelines [13], [14]. This research void is particularly concerning given the critical role that effective marketing plays in facilitating knowledge exchange between research institutions and commercial enterprises [15], [16].

The complex nature of partnerships between universities and industries encompasses a multitude of stakeholders, a variety of knowledge types, and a spectrum of organizational cultures, all of which necessitate the establishment of intricate coordination mechanisms to ensure the efficacy of collaborative endeavors, as articulated by [17], [18], [19]. Conventional technology transfer offices often face significant challenges, including resource constraints, a lack of comprehensive market intelligence, and ineffective communication channels, which can hinder successful commercialization outcomes, as discussed by [20], [21], [22]. The integration of AI-enhanced marketing strategies offers promising potential solutions to confront these pressing challenges by facilitating the development of intelligent matching systems, delivering predictive analytics capable of forecasting the probability of partnership success, and providing automated functionalities for the management of collaborative relationships, as noted by [23], [24], [25].

Artificial intelligence applied to marketing has made significant progress, but its role in knowledge transfer between universities and industry remains largely unknown. This lack of a clear theoretical framework calls for in-depth reflection, integrating both the possibilities offered by AI and the specificities of collaborations between academia and business.

This study aims to explore several key areas of research:

- How can AI enhance the effectiveness of technology transfer to industrial players?
- What algorithmic mechanisms can better connect academic innovations to the concrete needs of businesses?
- How is AI changing its functioning and strategic value?
- How can intelligent marketing mitigate cultural and informational differences between researchers and industrialists?
- What contextual elements favor the adoption of AI in research valorization?
- How can AI, marketing, and technology transfer be articulated within a coherent conceptual framework?
- What indicators can be used to assess the real effectiveness of these approaches on university-industry collaborations?

II. Theoretical Framework

A. University-Industry Technology Transfer Foundations

University-industry technology transfer encompasses a comprehensive array of activities aimed at facilitating the transference of knowledge, technologies, and innovations from academic institutions to commercial applications [8], [9], [30]. Conventional methodologies have predominantly focused on formal mechanisms, such as patent licensing, the establishment of spin-off enterprises, and the formulation of collaborative research agreements, as illustrated in Fig. 1 [6], [7], [4]. Nevertheless, contemporary scholarship suggests that effective technology transfer requires more nuanced methodologies that address institutional, interpersonal, and cultural barriers that often hinder commercialization endeavors [8], [22], [15].

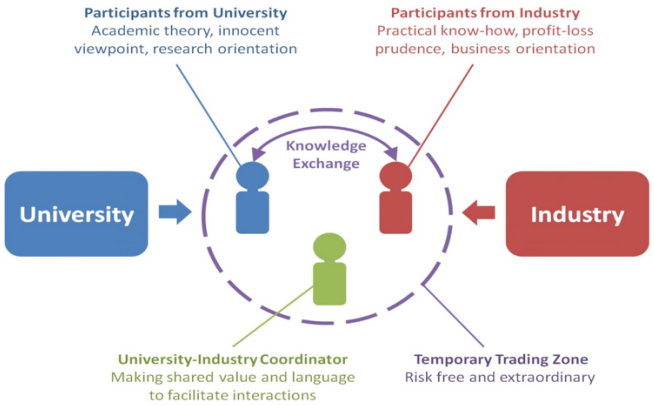

Fig. 1. University-industry collaboration for knowledge exchange.

The academic discourse delineates three principal categories of inhibitors that obstruct the successful commercialization of research-based inventions: institutional factors pertinent to organizational structures and policies, interpersonal dynamics that pertain to the relationship interactions between academic and industry stakeholders, and cultural disparities that shape collaboration methodologies [8], [20], [26]. Recent investigations underscore that relational inhibitors constitute the most prevalent challenges, while institutional and cultural factors frequently exacerbate these relational impediments [8], [7], [15]. These findings underscore the paramount importance of devising enhanced communication and engagement strategies that can overcome traditional barriers to the effectiveness of technology transfer.

Empirical investigations across diverse international contexts exhibit substantial discrepancies in technology transfer performance across various institutional and regional frameworks [6], [30], [22]. Collaborative networks between Chinese universities and industries manifest small-world phenomena characterized by distinct centrality patterns that influence innovation outcomes [30], [15]. Emerging economies in Africa face specific challenges stemming from resource limitations and inadequate technological infrastructure, which significantly impact the effectiveness of technology transfer [22], [38], [40]. These contextual variations underscore the need for adaptable frameworks that can accommodate diverse institutional environments while preserving the core principles of effectiveness.

B. Artificial Intelligence in Marketing Strategies

The incorporation of artificial intelligence within marketing methodologies signifies a profound transition from conventional techniques toward data-centric, automated, and individualized engagement frameworks [3], [2], [27]. Modern AI marketing implementations include machine learning algorithms for effective customer segmentation, natural language processing for content enhancement, predictive analytics for forecasting consumer behavior, and chatbot technologies for automated customer support [10], [36], [14]. These technological advancements collectively empower organizations to execute highly targeted, efficient, and scalable marketing initiatives that respond to the unique preferences of customers and the evolving market conditions. Table I delineates a comparison between conventional marketing approaches and those augmented by artificial intelligence [2], [1], [23]. Empirical research indicates that artificial intelligence substantially augments marketing efficacy through enhanced automation, personalization capabilities, and precision in forecasting [3], [2], [14]. Organizations that adopt AI-enhanced marketing methodologies report significant advancements in operational efficiency, customer engagement metrics, and competitive standing within their respective markets [1], [27]. Nevertheless, the existing literature also highlights significant challenges, including elevated implementation expenditures, ethical dilemmas related to data privacy, and the need for specialized technical proficiency, which may hinder widespread adoption [10], [36], [13].

Comparative analysis between developed and developing nations highlight notable discrepancies in AI marketing adoption trends, influenced by factors such as infrastructure preparedness, human resource competencies, and supportive policy frameworks, as illustrated in Fig. 2 [13], [46], [41]. Typically, developed countries exploit AI for advanced applications such as content personalization, predictive analytics, and marketing automation, whereas developing nations frequently encounter barriers associated with insufficient digital infrastructure and low technical literacy levels [13], [39], [45]. These

TABLE I. TRADITIONAL VS. AI-ENHANCED MARKETING

Aspect / Dimension	Traditional Approach	AI-Enhanced Approach	Benefits of AI
Market ID	Manual research, surveys, and conventional market studies	Predictive analysis, data mining, automated identification	Increased accuracy, emerging market detection, early identification of new opportunities
Lead Generation	Events, networking, mass marketing	Smart targeting, predictive scoring, process automation	Improved lead quality, increased efficiency
Content Personalization	Broad segments, generic messages	Hyper-personalization, dynamic and adaptive content	Higher engagement, better conversion rates
Communication Timing	Fixed schedules, sequential approach	Optimal timing based on behavioral data	Maximized receptivity, reduced intrusion
Success Measurement	Static indicators (KPIs), periodic reports	Real-time analytics, outcome prediction	Immediate adjustments, continuous campaign optimization
Resource Allocation	Fixed budgets, uniform distribution	Dynamic allocation based on performance	Maximized ROI, resource efficiency
Stakeholder Targeting	Static lists, demographic segmentation	Behavioral profiles, predictive targeting	Increased relevance, reduced acquisition costs
Technology Positioning	Standardized messages, one-size-fits-all	Adaptive positioning based on audience	Improved understanding, facilitated adoption
Follow-up Processes	Manual tracking, scheduled follow-ups	Automated nurturing, trigger-based engagement	Consistent engagement, reduced drop-offs
Decision Support	Experience-based, intuitive decisions	Data-driven recommendations, scenario modeling	Reduced bias, improved outcomes

findings underscore the importance of contextual elements in developing effective AI marketing implementation strategies.

The bibliometric assessment of AI marketing literature between 2021 and 2025 reveals an escalating scholarly interest in this research domain. The review was conducted following the PRISMA methodology to ensure a transparent, systematic, and reproducible article selection process. The analysis identified contributions from 82 nations and 1,292 authors across 281 sources, underscoring the global relevance and growing academic importance of AI-driven marketing research. Fig. 3 illustrates technology transfer approaches [1], [46], [41].

The literature selection process was based on predefined inclusion and exclusion criteria, focusing on peer-reviewed studies published in English between 2021 and 2025 and directly related to artificial intelligence applications in marketing. Core cognitive frameworks encompass consumer behavior analysis, brand management, marketing strategy formulation, and digital transformation initiatives, which collectively influence contemporary AI marketing practices [1], [38].

C. Digital Transformation in Higher Education

Digital transformation within the realm of higher education entails a holistic reorganization that integrates digital technologies across all facets of institutional functioning, significantly reshaping how universities provide education, perform research and interact with external constituents [16], [25]. This transformative endeavor requires strategic coherence between technological capabilities and institutional objectives, necessitating substantial investments in physical infrastructure, human capital, and procedural innovation [19], [31]. Institutions engaging in digital transformation are tasked with reconciling traditional academic principles with contemporary technological demands, all while preserving educational standards and research integrity [5], [47] . The various maturity levels of the Technologie Knowledge Transfer University Industrie (TKTUI) are delineated in the accompanying Table II.

Current digital transformation efforts in academic institutions emphasize various dimensions, including online learning environments, data analytics systems, cloud computing infrastructure, and AI-enhanced administrative frameworks [5]. The goal of these technological advancements is to boost operational efficiency, enrich student experiences, and fortify research capabilities while fostering enhanced collaboration with external entities [25], [31]. However, the realization of successful digital transformation transcends mere technological integration; it necessitates a cultural shift, unwavering leadership dedication, and a strategic vision that permeates all levels of the organization [16], [19], [47]. The emergence of the COVID-19 pandemic expedited the adoption of digital transformation across higher education institutions, compelling the swift deployment of virtual collaboration tools and online service delivery systems [48], [42]. This rapid transition uncovered both opportunities and challenges linked to digital transformation, such as enhanced accessibility and flexibility juxtaposed with concerns regarding barriers to technology adoption and issues of digital equity [32], [48], [35]. These occurrences provide valuable insights into the factors that influence successful digital transformation within the university context. The subsequent Table III enumerates the components associated with digital transformation in higher education institutions.

D. Knowledge Management and Transfer Mechanisms

Knowledge management within the domain of technology transfer encompasses intricate methodologies for the acquisition, structuring, dissemination, and utilization of both explicit and tacit knowledge across organizational frontiers [7], [17], [20] . Conventional technology transfer paradigms tend to prioritize formal intellectual property frameworks such as patents and licensing contracts; however, successful knowledge transfer necessitates holistic strategies that adequately address the considerable tacit knowledge elements intrinsic to academic technologies [7], [15], [20]. The tacit aspect can be particularly pronounced due to the nascent character of academic technologies and the specialized knowledge requisite for their practical application [7], [18], [24]. Contemporary studies underscore the essential function of human and institutional networks in facilitating the transmission of tacit knowledge between academic institutions and commercial entities [7], [15], [17]. Collaborative frameworks, consulting partnerships, sponsored research initiatives, proof-of-concept facilities, and university spin-offs represent vital mechanisms that foster direct interactions conducive to tacit knowledge

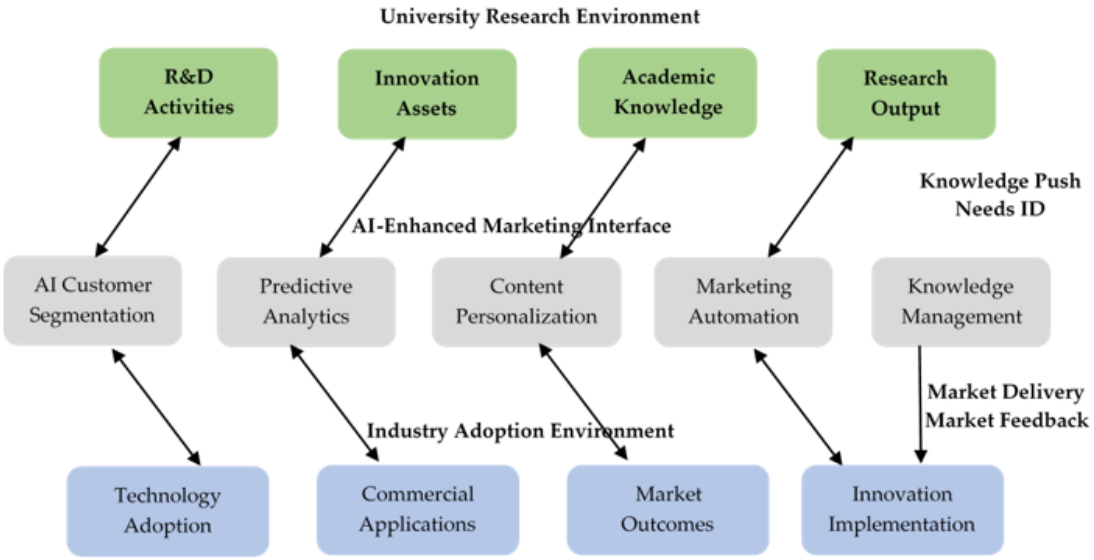

Fig. 2. Concept of AI-enhanced marketing for University-Industry Technology Knowledge Transfer.

TABLE II. DIGITAL TRANSFORMATION MATURITY LEVELS

Maturity Level	Characteristics	Technology Transfer Implications
Level 1: Basic	Limited digital infrastructure, manual processes, basic IT systems	Basic communication tools, limited market reach, manual relationship management
Level 2: Developing	Some digital tools implemented, inconsistent processes, emerging digital awareness	Enhanced communication, simple database management, emerging online presence
Level 3: Defined	Standardized digital processes, integrated systems, and clear digital strategy	Integrated CRM systems, digital marketing capabilities, structured knowledge management
Level 4: Managed	Data-driven decision-making, advanced analytics, performance monitoring	Predictive analytics for partnerships, automated matching systems, performance dashboards
Level 5: Optimized	AI-enhanced processes, continuous optimization, innovation leadership	AI-driven partner identification, intelligent knowledge transfer, adaptive learning systems

transfer [7], [19], [20]. These mechanisms enhance formal licensing agreements by offering avenues for prolonged collaboration and knowledge advancement that bolster successful commercialization endeavors [17], [18], [24]. The advent of AI-augmented knowledge management systems presents novel opportunities for enhancing knowledge discovery, alignment, and transfer processes [17], [25], [41]. Sophisticated algorithms are capable of scrutinizing substantial quantities of research outputs to uncover commercialization prospects, align university technologies with industry demands, and forecast probabilities of successful collaborations [18], [19]. Nevertheless, the incorporation of AI technologies into knowledge management frameworks necessitates meticulous attention to data integrity, algorithmic transparency, and human oversight to ensure efficacious and ethical application [39], [45]. The classification of mechanisms facilitating knowledge transfer, incorporating the influence of artificial intelligence, is illustrated in the subsequent Table IV.

The mechanism categories described in Table IV emerged from an integrative thematic synthesis of the research literature on university-industry technology transfer and knowledge management. Instead of using one of the existing taxonomies, the classification system draws together the transfer and collaboration practices documented in the studies reviewed. The mechanism categorization captures the dominant logic and institutional role. This was accomplished by identifying and grouping transfer practices, resulting in five mechanism categories: formal transfer of intellectual property, spin-offs, research collaboration, human capital transfer, and informal knowledge transfer. The categorization drew on the persistent themes in the literature on technology transfer, knowledge management, and innovation ecosystems (e.g., Lee, 2020; Yazdani, 2024; Sviatetskyi, 2020; Eidlisz et al., 2024). The AI enhancement dimension was added by recognizing the role of AI in enhancing each transfer mechanism, conceptualized as automation, prediction, intelligent matching, and knowledge discovery.

III. MATERIALS AND METHODS

This research utilized an integrative literature review methodology adhering to established protocols for systematic knowledge synthesis and the formulation of conceptual models [21], [33], [29]. The integrative review framework was chosen for its ability to amalgamate various research methodologies, theoretical frameworks, and empirical evidence into a holistic comprehension of the phenomenon being examined [34], [28]. This methodology facilitates the discernment of patterns, discrepancies, and interconnections across multiple domains while fostering the creation of innovative theoretical frameworks that synthesize existing knowledge [37]. The systematic search approach employed the Scopus database as the principal resource owing to its extensive coverage of high-quality,

TABLE III. DIGITAL TRANSFORMATION ELEMENTS IN HIGHER EDUCATION

Element	Description	Role in Technology Transfer
Digital Infrastructure	Hardware, software, and network systems that support digital operations	Enables efficient information exchange and communication
Data Analytics Capabilities	Tools and expertise for analyzing and interpreting large datasets	Provides insights into research trends and market opportunities
Virtual Collaboration Platforms	Platforms that enable remote collaboration and knowledge sharing	Facilitates engagement between university and industry stakeholders
Cloud Computing Technologies	Scalable computing resources accessible via the internet	Offers scalable resources for data-intensive research and applications
AI-Enhanced Administrative Systems	Automated systems for administrative tasks and decision support	Streamlines administrative processes in technology transfer
Digital Content Management	Systems for creating, storing, and distributing digital content	Supports effective knowledge dissemination and documentation
Cybersecurity Framework	Protocols and systems for protecting digital assets and privacy	Protects intellectual property and sensitive information

TABLE IV. KNOWLEDGE TRANSFER MECHANISMS TAXONOMY

Mechanism Type	Specific Mechanisms	AI Enhancement Potential
Formal IP Transfer	Patent licensing, technology licensing, copyright transfer	Automated IP matching, valuation algorithms, smart contract management
Spin-off Creation	Academic entrepreneurship, university spin-offs, startup incubation	Market opportunity identification, funding source matching, risk assessment
Collaborative Research	Joint research projects, industry-sponsored research, research consortia	Partner matching algorithms, research trend analysis, collaboration optimization
Human Capital Transfer	Student internships, faculty consulting, staff exchange programs	Skill matching, expert identification, knowledge gap analysis
Informal Knowledge Exchange	Conferences, workshops, networking events, publications	Intelligent networking, content recommendation, knowledge discovery

peer-reviewed literature pertinent to technology management, marketing, and artificial intelligence scholarship. The search methodology employed various keyword combinations, including "artificial intelligence marketing", "university-industry technology transfer", "digital marketing strategies", "knowledge transfer mechanisms", and "innovation ecosystems", to ensure thorough coverage of the pertinent literature. Boolean operators and controlled vocabulary terms were utilized to enhance search accuracy while ensuring sensitivity to emerging research domains (see Table V).

The study selection process consisted of multiple screening phases, including title and abstract examination, full-text analysis, and quality evaluation based on predefined inclusion and exclusion criteria. The inclusion criteria encompassed peer-reviewed articles published in English, as well as empirical investigations and theoretical contributions related to AI, marketing, or technology transfer, and publications from 2017 to 2025 to capture contemporary advancements. Exclusion criteria ruled out conference proceedings, books, editorial notes, and studies not directly pertinent to the research objectives.

Data extraction and synthesis methodologies adhered to systematic protocols for identifying key themes, concepts, methodological approaches, and theoretical contributions across the selected studies. Thematic analysis techniques were employed to identify patterns and relationships within and between studies, facilitating the development of comprehensive conceptual frameworks that integrate diverse perspectives. Quality assessment procedures appraised methodological rigor, theoretical contributions, and practical relevance to ensure the reliability and validity of the synthesized outcomes.

The results section has been organized as per the sequential workflow illustrated in Table V. More specifically, findings are organized in relation to the various methodological phases of the study, namely study selection, bibliometric classification, thematic synthesis, analytical mapping, and the construction of the conceptual model. This was done to achieve a consistent methodology, enhance readability, and offer a clear link between the review process and the resultant conceptual framework.

IV. RESULTS AND DISCUSSION

Research articles were considered eligible for inclusion if they met the following criteria: 1) published in peer-reviewed scholarly journals or reputable conference proceedings, 2) focused on AI-enhanced marketing, technology transfer between universities and industry, or the intersection of these domains, 3) published between 2017 and 2025, and 4) written in English. The exclusion criteria included: 1) non-academic publications, 2) research lacking methodological rigor, 3) duplicate publications, and 4) studies beyond the defined area, as shown in PRISMA Flow Diagram (see Fig. 3).

A. Study Selection and Temporal Distribution

This subsection addresses the methodological foundation underlying RQ1 through RQ7 by establishing the evidentiary basis from which answers to all seven research questions are

TABLE V. RESEARCH METHODOLOGY

Phase	Description	Key Activities	Expected Outcomes
Phase 1: Systematic Search	A comprehensive search of Scopus, Web of Science, IEEE Xplore, Google Scholar, SpringerLink, Emerald Insight, and peer-reviewed databases using systematic keywords	Database search; Keyword optimization; Search strategy development	Comprehensive literature corpus relevant to AI-enhanced marketing for technology transfer
Phase 2: Study Selection	Application of inclusion/exclusion criteria, screening abstracts, and full texts	Duplicate removal; Title/abstract screening; Full-text evaluation	High-quality studies meeting inclusion criteria for detailed analysis
Phase 3: Data Extraction	Extraction of key data elements, themes, and concepts from selected studies	Data coding; Theme identification; Concept mapping	Structured data matrix with key themes, concepts, and relationships
Phase 4: Quality Assessment	Assessment of study quality using established criteria and frameworks	Bias assessment; Methodological evaluation; Evidence grading	Quality-assessed evidence base for reliable synthesis
Phase 5: Data Synthesis	Thematic analysis and synthesis of findings using an integrative approach	Pattern identification; Cross-case analysis; Framework development	An integrated understanding of the current state and research trends
Phase 6: Model Development	Development of a conceptual model based on synthesized evidence	Model construction; Component integration; Relationship mapping	Novel conceptual model integrating AI, marketing, and technology transfer

derived. The temporal trend of publication growth corroborates the growing scholarly relevance of the questions posed.

The systematic selection process was designed to ensure transparency and reproducibility in the identification and screening of relevant studies. The search encompassed publications addressing AI-mediated university-industry marketing strategies over the preceding decade. A total of 48 papers met the final inclusion criteria. The temporal distribution of included studies revealed an increase in publication output beginning in 2022, with the highest annual output recorded in 2024 (18 publications). This trend corresponds to the growing body of research at the intersection of university-industry technology transfer (UITT) and artificial intelligence (AI) [43].

B. Bibliometric Classification of Included Studies

This subsection primarily addresses RQ3 (How is AI changing its functioning and strategic value?) by quantifying the thematic distribution of the literature and documenting the dominant trajectory of AI adoption in marketing. It also provides foundational evidence for RQ1 by establishing the volume and focus of AI-enhanced marketing research. To provide the highest level of transparency and reproducibility, a systematic manual coding approach was applied to the bibliometric classification. The 48 selected studies were independently analyzed and classified based on two different dimensions: 1) the main research theme, and 2) the research methodology. The thematic classification was based on a constructivist approach and was an outcome of the inductive analysis of the main objectives of the reviewed articles and the main research questions, key concepts, and main contributions. The first phase of the coding process was open and resulted in a number of key concepts related to the implications of artificial intelligence, the university-industry technology transfer, the process of digital transformation, the management of knowledge and the innovation management ecosystem. These related concepts were combined to form larger categories, which represented the main focus of each of the studies.

In the classification of the research methodology, studies were differentiated based on the main research method that formed the basis of the studies, which included the case study method, the formulation of a conceptual/theoretical paper, empirical quantitative research, qualitative research, bibliometric research, and modeling and predictive research. The classification was based on the explanation of the research methodology that was included in each study.

The manual classification relied on the fact that a number of the studies addressed themes that were multiple and interrelated, and that a context was necessary in order to explain the interrelated aspects of each of the studies. To strengthen the consistency of the classification, a coding scheme that was derived from the objectives of the review and the research questions, that is, RQ1-RQ7, was used to provide guidance as to the classification. For studies that focused on numerous themes, the main analytical focus was the primary theme to which the study was assigned, and the remaining themes were recorded in the process of thematic synthesis.

The 48 included studies were classified according to their primary thematic focus and methodological approach. AI-driven marketing strategies constituted the largest thematic category (47.8%), followed by studies addressing institutional barriers to information and communication technology adoption (30.4%). Studies focused on methodological advancements represented a smaller proportion (6.5%), indicating limited coverage of standardized analytical frameworks in the existing literature. Within the AI-focused subset, studies were further classified by technology application type: personalization (40.9%), automation (27.3%), and predictive analytics (18.2%). Case study designs were the most prevalent methodology among the included papers (58.7%), particularly in marketing-related studies, while mathematical modeling approaches were underrepresented.

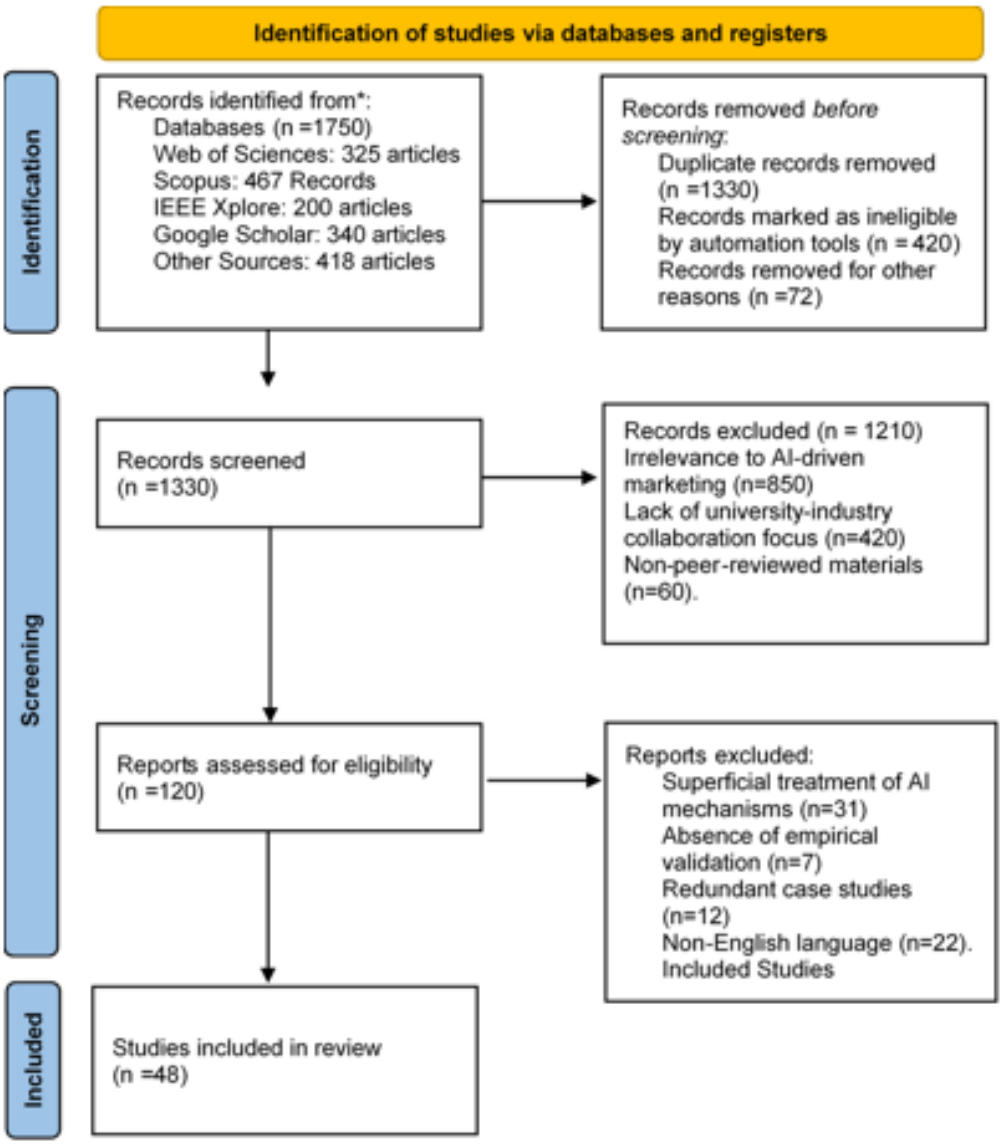

Fig. 3. PRISMA flow diagram

While examining the literature, the specified capabilities of segmentation, predictive analytics, personalized messaging, intelligent knowledge management, and automated digital engagement, were frequently observed within the context of the thematic synthesis process. The listed capabilities were also the primary functional contributions that the marketed enhancements attributed to the technology transfer activities of higher education institutes. These capabilities of AI are distinct from the marketing mechanisms of knowledge transfer. The former articulates the operational mechanisms that artificial intelligence augments within marketing and collaboration, while the latter describes the pathways of institutional and organizational knowledge transfer mechanisms, such as patent licenses, spin-offs, partnerships in research, and consultancy.

C. Thematic Synthesis Procedure

This subsection provides the analytical bridge connecting the raw literature findings to the answers for all seven research questions. The identification of seven major thematic categories directly maps onto the seven research questions, as each theme constitutes the evidential basis for one or more framework components developed in Section V.

To bridge the gap between descriptive bibliometric results and the development of a conceptual framework, a thematic synthesis was conducted following established qualitative synthesis procedures. This approach involved three stages: 1) line-by-line coding of key findings from each of the 48 included papers; 2) the organization of codes into descriptive themes; and 3) the generation of analytical themes informing

framework component development.

A total of 131 theme assignments were recorded across 48 papers, yielding an average of 2.73 themes per paper. This multi-dimensional coding reflected the interconnected nature of the concepts addressed in the literature and informed the identification of seven major thematic categories.

D. Analytical Principles for Theme-to-Component Mapping

This subsection supports RQ6 (How can AI, marketing, and technology transfer be articulated within a coherent conceptual framework?) by establishing the transparent methodological criteria used to translate thematic evidence into discrete, justifiable framework components. Three analytical principles guided the mapping of synthesized themes to the proposed framework components:

- Principle 1 – Frequency-Based Prominence: Themes with literature coverage exceeding 30% were designated as candidates for dedicated framework components.
- Principle 2 – Functional Differentiation: Themes with moderate coverage were retained as framework components when they served functionally distinct roles not addressed by higher-frequency themes.
- Principle 3 – Integration of Cross-Cutting Insights: Findings from multi-dimensional papers (i.e., those coded under multiple themes) were used to identify interdependencies and inform the relational architecture of the framework.

V. Conceptual Model Development

The proposed AI-enhanced marketing Framework for University-Industry Technology Knowledge Transfer integrates eight interconnected components that collectively optimize collaboration effectiveness and commercialization outcomes.

A. Framework Component Derivation

This subsection directly addresses RQ6 in its entirety, and provides evidence for RQ1 and RQ2 through the derivation of the AI Technologies (Component 1) and Marketing Strategies (Component 2) components. The bilateral treatment of University Factors (Component 3) and Industry Factors (Component 4) addresses RQ4 by explaining the structural sources of cultural and informational differences between academic and industrial stakeholders (see Table VI).

The application of the above principles to the thematic synthesis results yielded eight framework components. The derivation procedure for each component is described below, including the supporting literature base, thematic evidence, and justification for inclusion.

1) Component 1 - AI Technologies: This component was derived from 23 papers (47.8% of the corpus). The thematic coding identified AI-enhanced marketing as the most frequently addressed theme. Sub-theme analysis revealed three distinct capability clusters: personalization (40.9%; [1], [27], [23]), automation (27.3%; e.g., [2], [14]), and predictive analytics (18.2%; e.g., [10], [36]). The high frequency of this theme, combined with the differentiated capability clusters, justified its inclusion as a foundational component. The sub-element structure (machine learning, natural language processing, predictive analytics, chatbots, automation) directly mirrors the identified clusters. Technical capabilities were distinguished from strategic applications to warrant separate treatment from Component 2. This component constitutes the primary answer to RQ1 by identifying the specific AI mechanisms (machine learning, NLP, predictive analytics, chatbots, and automation) through which technology transfer effectiveness is enhanced.

2) Component 2 - Marketing Strategies: This component was informed by 18 papers (37.5%). The thematic evidence encompassed the strategic deployment of AI in university-industry contexts, digital transformation in marketing, stakeholder engagement optimization, and content personalization for industry partners. While thematically adjacent to Component 1, these papers addressed strategic deployment rather than technical capabilities, and the specialized marketing approaches required for the UITT context differed from conventional B2B models (e.g., [12], [16], [3], [13], [24]). This component answers RQ2 by specifying the algorithmic and strategic mechanisms — including intelligent matching, predictive partner scoring, and behaviorally-driven content personalization — that connect academic innovations to concrete industry needs.

3) Component 3 - University Factors: This component drew on 19 papers (39.6%). The thematic coding aligned with the UITT Barriers theme, where institutional factors accounted for 30.4% of the literature. Three sub-themes emerged: organizational structures, research capabilities, and intellectual property management. The identification of institutional barriers as the second most frequent theme, combined with the decomposition into actor-specific factors, justified dedicated component status (e.g., [8], [9], [4], [6], [7], [20]). This component contributes to answering RQ4 by identifying the institutional sources of informational gaps and cultural barriers on the academic side, including misaligned incentive structures, limited industry-facing communication, and inadequate IP commercialization capacity.

4) Component 4 - Industry Factors: This component was supported by 15 papers (31.2%). The thematic evidence addressed industry readiness, absorptive capacity, technology readiness, collaborative willingness, and trust mechanisms. Inclusion was justified on the basis of bilateral representation, balancing the university-side factors in Component 3. The synthesis revealed absorptive capacity, technology readiness, and collaborative willingness as distinct yet interrelated dimensions (e.g., [17], [30], [36], [22], [18]). In conjunction with Component 3, this component completes the answer to RQ4 by characterizing the industry-side cultural and informational barriers — particularly low absorptive capacity and insufficient trust in academic partners — that AI-enhanced marketing strategies must actively mitigate.

5) Component 5 - Knowledge Transfer Mechanisms: This component was derived from 17 papers (35.4%), corresponding to the Knowledge Management theme. The coding distinguished between tacit and explicit knowledge transfer modes, as well as formal mechanisms (patents, licensing, spin-offs) and informal mechanisms (consulting, collaborative research,

TABLE VI. DETAILED MAPPING TABLE

Component	Sub-elements	Primary Themes	Supporting Evidence	Key Citations	Analytical Justification
1. AI Technologies	Machine Learning, NLP, Predictive Analytics, Chatbots, Automation	AI Marketing; Personalization; Automation	Nuță (2024), Gabelaia (2024), Potwora et al. (2024)	23 papers (47.8%)	Nearly half of studies focus on AI, especially personalization and automation.
2. Marketing Strategies	Digital Marketing, Content Personalization, Segmentation, Social Media	AI marketing; Digital communication	Nektarios (2022), Ahmad et al. (2024)	18 papers (37.5%)	Shift to AI-driven strategies.
3. University Factors	Research, TTOs, Expertise, IP	Institutional barriers; Capacity	Battaglia et al. (2024); Blankesteijn et al. (2021)	19 papers (39.6%)	Internal factors affect knowledge transfer success.
4. Industry Factors	Market needs, Capacity, Readiness	Market dynamics; Collaboration	Yazdani (2024); Jiang et al. (2022)	15 papers (31.2%)	External factors complement university capabilities.
5. Knowledge Transfer Mechanisms	Licensing, Spin-offs, Consulting	Knowledge transfer	Lee (2020); Yazdani (2024)	17 papers (35.4%)	Bridge between university and industry.
6. Digital Transformation	Infrastructure, Data, Platforms	Digital transformation	Nektarios (2022); Ahmad et al. (2024)	16 papers (33.3%)	Enables AI and marketing.
7. Innovation Ecosystem	Networks, Partnerships, Policy	Ecosystems	Fadeyi et al. (2019)	12 papers (25.0%)	Impacts scalability.
8. Performance Outcomes	Commercialization, Innovation	Metrics	Singh et al. (2023)	11 papers (22.9%)	Supports evaluation.

networking). This component emerged as a conceptual bridge between university and industry actors. The comprehensive taxonomy of transfer mechanisms identified across 17 papers provided both theoretical and empirical grounding (e.g., [7], [20], [17], [15], [19], [24]). This component addresses RQ1 and RQ2 by identifying the specific pathways through which AI-augmented tools — such as partner-matching algorithms and AI-assisted IP valuation — optimize the operationalization of knowledge transfer.

6) Component 6 - Digital Transformation elements: This component was informed by 16 papers (33.3%). Digital transformation appeared as a cross-cutting theme encompassing infrastructure requirements, data analytics capabilities, cloud computing, and virtual collaboration platforms. This component was distinguished from AI Technologies (Component 1) as it represents broader digital readiness rather than specific AI capabilities. The inclusion of maturity level progression provided a developmental dimension (e.g., [12], [5], [31], [47], [16]). This component addresses RQ5 by identifying the enabling contextual conditions — digital infrastructure maturity levels, cloud adoption, and platform readiness — that govern the feasibility and effectiveness of AI adoption in research valorization activities.

7) Component 7 - Innovation Ecosystem: This component drew on 12 papers (25.0%). The thematic evidence addressed external contextual factors, including policy frameworks, funding mechanisms, regional contexts, and collaborative network structures. Inclusion was justified by the Frequency-Based Prominence principle (meeting the 25% threshold) and by the finding that comparative analyses across studies revealed ecosystem-level moderators that significantly affect technology transfer effectiveness, particularly in emerging economy contexts (e.g., [22], [6], [40], [38], [44]). This component further addresses RQ5 by documenting the broader ecosystem-level elements — government support, incubation infrastructure, and international networks — that determine the contextual readiness for AI adoption in technology transfer, particularly in emerging economy contexts.

8) Component 8 - Performance Outcomes: This component was supported by 11 papers (22.9%), with performance measurement addressed explicitly in these papers and implicitly throughout the broader corpus. The thematic evidence covered technology commercialization metrics, knowledge transfer efficiency, innovation performance indicators, and competitive advantage evaluation. Inclusion was justified by the component's feedback function, which enables continuous improvement and empirical validation of framework effectiveness (e.g., [21], [41], [30], [18], [19], [38]). This component constitutes the direct answer to RQ7 by specifying the indicators — including commercialization rates, collaboration success scores, knowledge transfer efficiency indices, and innovation impact metrics — that can be used to assess the real effectiveness of AI-enhanced marketing approaches on university-industry collaborations.

B. Framework Validation Criteria

This subsection supports RQ6 by providing a systematic validation of the proposed framework against four criteria that confirm its suitability as a coherent theoretical articulation of the relationships among AI, marketing, and technology

transfer. The resulting eight-component framework was assessed against four validation criteria to confirm its systematic derivation from the literature:

- Empirical foundation: Each component was supported by 11 to 23 papers (22.9%–47.8% coverage).
- Functional distinctiveness: Each component occupies a different structural role within the framework (enablers, actors, processes, moderators, or outcomes).
- Research integration: Each component synthesizes previously fragmented research streams into a coherent dimension.
- Research generativity: The framework structure provides testable propositions and clear boundaries for future empirical investigation. This thematic synthesis procedure, combined with the three analytical principles and the component derivation process, establishes an explicit evidence trail from the 48 included papers to the eight-component conceptual framework for AI-enhanced university-industry technology transfer.

C. Core Framework Components

This subsection integrates answers to RQ1, RQ2, RQ3, and RQ4. It describes how AI Technologies (RQ1, RQ3) and Marketing Strategies (RQ2, RQ4) interact with university and industry factors to generate the core capabilities of the proposed framework. This comprehensive framework integrates findings from the literature review to address recognized deficiencies in both theoretical understanding and practical implementation strategies. The model (Fig. 4) delineates Knowledge Transfer Mechanisms as the pivotal core around which all supplementary elements engage, underscoring the essential significance of efficient transfer processes in realizing fruitful collaborations between academia and industry. AI Technologies acts as the fundamental catalyst for intelligent automation and decision-making mechanisms within the technology transfer ecosystem [3], [2], [1]. This aspect includes machine learning models for recognizing patterns and making predictions, natural language processing for analyzing and generating content, predictive analytics for forecasting the success of collaborations, chatbot technologies for automating stakeholder interactions, and systems for optimizing processes [27], [36], [14]. The amalgamation of these AI technologies fosters opportunities for heightened efficiency, diminished manual labor, and enhanced precision in decision-making across the entirety of university-industry collaborations [10], [23].

In direct response to RQ1, these capabilities demonstrate how AI can enhance technology transfer effectiveness by automating partner discovery, accelerating IP matching, and enabling data-driven decision-making at every stage of the collaboration lifecycle.

Marketing Strategies signify the strategic communication and engagement methodologies that universities utilize to draw, engage, and sustain relationships with industry collaborators [12], [16], [25] . This dimension encompasses digital marketing initiatives designed explicitly for industry stakeholders, content personalization based on partner inclinations and requirements; customer segmentation approaches that pinpoint optimal collaboration prospects, social media platforms for fostering relationships, and data-informed marketing techniques that enhance resource distribution and campaign efficacy [3], [1], [13] . These strategies ought to be tailored to the distinctive attributes of technology transfer settings while capitalizing on AI functionalities for improved accuracy and influence [2], [14], [31]. In response to RQ2 and RQ3, these strategies illustrate how AI is transforming the strategic value of marketing from a static broadcast mechanism into a dynamic, predictive, and relationship-intelligent function. University Factors include the internal competencies, resources, and traits that affect the success of technology transfer initiatives [6], [5]. Research capabilities dictate the caliber and commercial viability of university technologies, whereas Technology Transfer Offices furnish the institutional framework for overseeing collaboration processes [20]. Academic expertise embodies the human resources requisite for efficient knowledge transfer, intellectual property portfolios lay the groundwork for commercialization endeavors, and an innovation-oriented culture impacts organizational preparedness for external collaborations [7], [15], [19]. These elements must be strategically cultivated and aligned to bolster AI-augmented marketing initiatives [17], [18]. This component contributes to answering RQ4 by identifying the academic institutional factors — particularly cultural resistance to commercialization and weak industry-facing communication infrastructure — that intelligent marketing strategies must specifically address.

Industry Factors exemplify the external market dynamics, organizational attributes, and collaboration readiness elements that affect the success of partnerships. Market demands to propel the necessity for university technologies and ascertain commercialization feasibility, while absorptive capacity denotes the capability of industry partners to comprehend, adapt, and execute university innovations [17], [19], [20]. Technology readiness influences the timing and practicality of collaborative initiatives, collaborative willingness affects the formation and sustainability of partnerships, and resource availability dictates the extent and scale of potential collaborative activities [15], [47]. A comprehensive understanding and addressing of these factors are crucial for the formulation of effective marketing strategies that resonate with industry collaborators [25], [44]. This component completes the answer to RQ4: intelligent marketing mitigates cultural and informational asymmetries by leveraging AI-driven profiling and adaptive communication tools that match academic outputs to the absorptive capacity and readiness level of each specific industrial partner.

The following Table VII synthesizes the university-industry collaboration process in the systematic literature review.

D. Integration and Interaction Mechanisms

This subsection further addresses RQ1 and RQ2 by specifying how each framework component interacts with the others to produce the operational conditions for effective AI-enhanced technology transfer. Kowledge Transfer Mechanisms represent the fundamental processes through which technological advancements and scholarly expertise from universities are disseminated to industry collaborators [7], [20], [15]. Patent licensing establishes formal frameworks for intellectual property transfer, spin-off enterprises facilitate extensive technology commercialization, consulting relationships promote

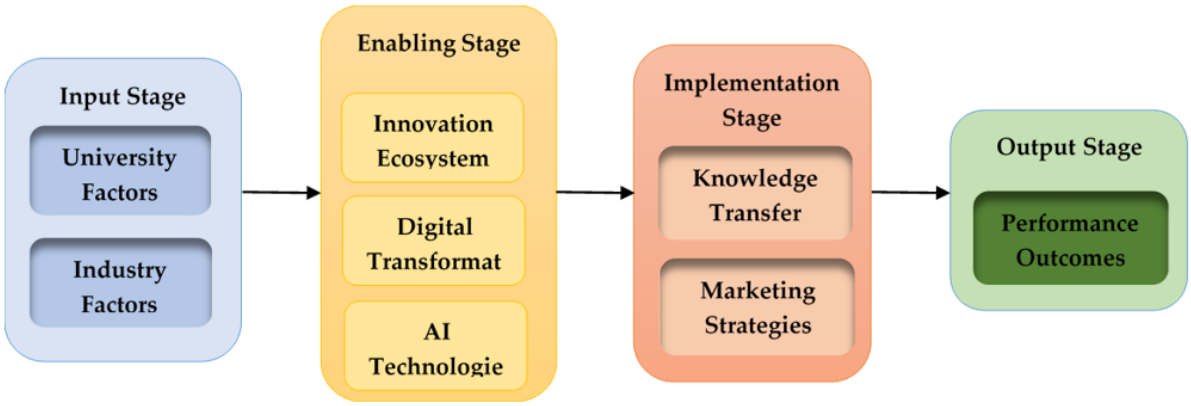

Fig. 4. Conceptual framework of AI-enhanced marketing for university-industry technology transfer.

TABLE VII. UNIVERSITY-INDUSTRY COLLABORATION PROCESS

Stage	Primary Activities	AI Enhancement Opportunities
Research Development	Basic and applied research, Innovation identification	Research trend analysis, Impact prediction
Technology Assessment	Feasibility analysis, Commercial potential evaluation	Automated assessment tools, Market potential algorithms
Market Analysis	Industry needs identification, Competitive landscape analysis	Real-time market intelligence, Predictive trend analysis
Partner Identification	Industry partner screening, Capability matching	Intelligent partner matching, Compatibility algorithms
Collaboration Framework	Agreement negotiation, Partnership structuring	Contract optimization, Risk assessment tools
Knowledge Transfer	Technology transmission, Expertise sharing	Personalized knowledge delivery, Learning optimization
Commercialization	Product development, Market launch	Launch strategy optimization, Success prediction
Performance Evaluation	Impact assessment, Success measurement	Automated performance tracking, Continuous improvement

direct expertise dissemination, collaborative research endeavors foster mutual innovation progress, and proof-of-concept facilities connect laboratory-based research with commercial viability [17], [18], [24]. These mechanisms must be augmented with artificial intelligence capabilities to enhance the efficiency, effectiveness, and scalability of technology transfer operations [19], [32]. Digital Transformation Elements offer the requisite technological framework and procedural modernization essential for the execution of AI-enhanced marketing initiatives [12], [31]. The digital infrastructure underpins data acquisition, analytical processes, and communication efforts, while data analytics competencies enable informed decision-making and performance enhancement [16], [25], [47]. Virtual platforms encourage online collaboration and relationship management, collaborative tools support distributed teamwork and knowledge exchange, and cloud computing technologies offer scalable and accessible computing resources [5], [42], [35]. Collectively, these elements establish a robust foundation for the implementation of advanced AI marketing strategies within technology transfer paradigms [41], [39]. This directly responds to RQ5: the maturity level of an institution's digital infrastructure — spanning cloud computing adoption, data analytics capacity, and virtual collaboration readiness — constitutes a critical contextual determinant of AI adoption success in research valorization. The Innovation Ecosystem encompasses the wider contextual factors that significantly affect the success of university-industry collaborations [22], [38]. Networks foster connections and opportunities for relationship development, partnerships establish formal collaboration frameworks, incubators assist in the advancement of nascent technologies, governmental support impacts policy and funding landscapes, and financial mechanisms dictate the availability of resources for collaborative ventures [6], [40], [44]. Adopting an ecosystem perspective acknowledges that effective technology transfer necessitates conducive environmental conditions that go beyond the capabilities of individual organizations [46], [45]. This extends the answer to RQ5 by situating AI adoption within an ecosystem logic: the presence or absence of supportive policy, regional networks, and funding infrastructures determines whether AI-enhanced marketing initiatives can be scaled and sustained.

Performance Outcomes signify the quantifiable results and effects of AI-enhanced marketing strategies within technology transfer contexts [21], [41], [30]. Metrics for technology commercialization evaluate the success of translating university research into marketable applications, knowledge transfer efficiency assessments gauge the effectiveness of transfer mechanisms, innovation performance indicators monitor the broader impacts of collaborative efforts, and evaluations of competitive advantage ascertain the strategic value generated through university-industry alliances [18], [38]. These outcomes furnish crucial feedback for the ongoing refinement and optimization of AI-enhanced marketing strategies [19], [40], [39]. This constitutes the direct operational answer to RQ7: the effectiveness of AI-enhanced marketing on university-industry collaborations can be assessed through a multi-dimensional

indicator system encompassing commercialization conversion rates, partnership formation speed, knowledge transfer efficiency scores, and long-term innovation impact metrics. The proposed conceptual model addresses several critical gaps identified in the current literature while providing a comprehensive framework for understanding and implementing AI-enhanced marketing in university-industry technology transfer contexts. The following Table VIII elucidates the framework of marketing augmented by artificial intelligence within the context of technology transfer between universities and industries.

The amalgamation of artificial intelligence technologies with marketing methodologies signifies a notable divergence from conventional technology transfer paradigms, presenting prospects for augmented efficiency, refined targeting, and enhanced relationship management [3], [2], [1]. Nevertheless, effective execution necessitates meticulous consideration of the organizational, technological, and environmental elements that impact adoption and efficacy [36], [13], [47].

E. Theoretical Contributions

This subsection addresses RQ6 from a theoretical standpoint by articulating the specific conceptual innovations introduced by the proposed framework in relation to the existing literature. The theoretical framework enhances the discourse on technology transfer by presenting the inaugural comprehensive amalgamation of artificial intelligence technologies, marketing methodologies, and mechanisms for knowledge transfer within a singular conceptual paradigm [20], [33], [29]. Prior investigations have predominantly examined these areas in isolation, which constrains the comprehension of their interrelated dynamics and synergistic capabilities [8], [7], [12]. The proposed framework elucidates how AI competencies can augment conventional marketing tactics while concurrently enhancing the efficacy of knowledge transfer via intelligent automation and data-informed decision-making [27], [14], [25]. These contributions collectively represent a direct and substantive answer to RQ6, establishing the conceptual architecture within which AI, marketing, and technology transfer can be coherently integrated.

Furthermore, the model propels the theory of digital transformation by delineating the technological and organizational prerequisites for the successful application of AI within academic settings [5], [31]. In contrast to generic frameworks of digital transformation, this model explicitly addresses the distinctive attributes of university-industry collaboration, which encompasses the significance of tacit knowledge transfer, the function of intellectual property management, and the impact of innovation ecosystem elements [7], [17], [19]. This specificity amplifies the practical significance and applicability of the framework for practitioners involved in technology transfer [15], [16], [32].

F. Practical Implications

This subsection primarily addresses RQ4 and RQ5 from a practitioner perspective. It specifies how intelligent marketing — operationalized through the proposed framework — can practically bridge the cultural and informational divide between academic and industrial actors, and what contextual investments are needed to enable AI adoption. For university administrators and professionals involved in technology transfer, the proposed framework offers practical directives for cultivating AI-driven marketing proficiencies that enhance industrial engagement and collaborative outcomes [4], [6], [18]. This model delineates particular technological investments, organizational capabilities, and strategic methodologies that institutions of higher education ought to prioritize to augment their effectiveness in technology transfer [20], [24]. Strategies for implementation should concentrate on fostering AI competencies within technology transfer offices, establishing digital infrastructures for data analytics and relationship management, and devising comprehensive training initiatives aimed at staff development [5], [12], [47]. Industry collaborators can employ the framework to gain insights into university capabilities and opportunities for collaboration while simultaneously enhancing their absorptive capacity for novel technologies [17], [30]. The model underscores the significance of forging dedicated partnerships with universities to facilitate AI-enhanced collaboration, investing in digital platforms to engage with universities, and cultivating internal capabilities necessary for assessing and implementing university technologies [18], [19], [42]. Such investments empower industry partners to optimize the benefits derived from university-industry collaboration while also contributing to the development of innovation ecosystems [15], [38]. Policymakers can utilize the framework to formulate conducive regulations, funding strategies, and infrastructural investments that promote AI-enhanced technology transfer [22], [40], [44]. The model identifies essential success factors warranting policy focus, including the advancement of AI infrastructure, regulatory frameworks that facilitate digital collaboration, and incentive structures that foster university-industry partnership development [16], [46], [41]. Policy interventions must tackle both technological and organizational obstacles while advocating for equitable access to capabilities associated with AI-enhanced technology transfer [25], [39], [45].

G. Limitations and Considerations

This subsection is relevant to RQ7, as the limitations acknowledged here define the boundary conditions under which the proposed performance indicators can be reliably applied. It also partially addresses RQ5 by acknowledging that contextual variability across institutional settings limits the generalizability of AI adoption prescriptions. The proposed framework is predicated on a synthesis of existing literature rather than empirical validation, thereby necessitating subsequent investigations to evaluate the model's efficacy in practical contexts [21], [37]. The swift advancement of artificial intelligence technologies may necessitate regular revisions to the framework to ensure its ongoing relevance and precision [2], [23]. Furthermore, the model may require modifications to suit diverse institutional frameworks, cultural landscapes, and industrial domains that present distinct characteristics and demands [13], [38], [40]. Challenges in implementation encompass the considerable resource allocations essential for the development of AI infrastructure, the necessity for specialized technical competencies that may be scarce within academic institutions, and potential resistance from stakeholders who are accustomed to conventional technology transfer methodologies [10], [36]. Organizations must meticulously evaluate their preparedness

TABLE VIII. CONCEPT OF AI-ENHANCED MARKETING FRAMEWORK FOR UNIVERSITY-INDUSTRY TECHNOLOGY TRANSFER

Theme	Key Concepts	Research Gaps	Future Directions
University-Industry Technology Transfer	Patent licensing; Spin-offs; Collaboration barriers; Technology commercialization	Limited AI integration in TT processes; Need for digital marketing strategies	AI-enhanced TT processes; Digital collaboration platforms; Smart matching systems
AI in Marketing Strategies	Personalization; Predictive analytics; Automation; Data-driven strategies	Insufficient application in TT context; Limited university-industry focus	AI-powered university marketing; Intelligent partnership platforms; Predictive TT analytics
Digital Transformation	Digital infrastructure; Virtual collaboration; Cloud technologies; Online platforms	Lack of comprehensive frameworks; Missing integration with marketing strategies	Comprehensive digital TT ecosystems; AI-driven transformation models
Knowledge Management	Knowledge sharing; Tacit knowledge transfer; Organizational learning; Absorptive capacity	Underexplored AI enhancement; Limited digital transformation integration	AI-enhanced knowledge discovery; Intelligent knowledge matching systems
Innovation Ecosystems	Networks; Partnerships; Incubators; Government support; Funding mechanisms	Missing AI-enhanced networking; Insufficient digital ecosystem models	Smart innovation networks; AI-powered ecosystem orchestration
Conceptual Models & Frameworks	Theoretical frameworks; Structural models; Process models; Integration models	Absence of AI-marketing-TT integration models; Limited comprehensive frameworks	Integrated AI-marketing-TT models; Multi-dimensional frameworks

for AI integration while formulating comprehensive change management frameworks that cater to both technological and cultural transformation imperatives [31], [47], [35].

The literature points out both the benefits and the limitations of using AI marketing in traditional university-Industry technology transfer (UITT) models. Many argue that the digital transformation and the use of artificial intelligence (AI) can contribute to better collaboration, but only if the institution has an adequate digital infrastructure and is able to absorb new knowledge. In the absence of such characteristics, collaboration may not improve, especially with an internal resistance to change. Some cite the over-dependence on automated tasks, which may eliminate trust and the dynamics necessary for university–industry collaboration.

The existing literature reflects major differences between developed and emerging markets in terms of the level of technology, support for artificial intelligence (AI) integration, and funding. While some authors describe improved matching of partners, the efficiency of communication, and results of the commercialization process, increased AI integration can require the complexity of the organization and substantial resource investments with no guaranteed return on the investment. As a result, there are significant operational contradictions in AI marketing in UITT models. These inconsistencies reinforce the requirement for an integrative and context-sensitive conceptual framework.

H. Future Research Directions

This subsection most directly addresses RQ7 by specifying the empirical and methodological approaches needed to develop and validate the performance indicators through which the effectiveness of AI-enhanced marketing on university-industry collaborations can be rigorously assessed. It also opens new avenues for RQ2 and RQ5 by identifying algorithmic and contextual research priorities. The proposed theoretical framework lays the groundwork for extensive future investigations across various disciplines and methodological paradigms. Empirical validation initiatives represent the most pressing research focus, necessitating systematic evaluations of the framework's efficacy within diverse university-industry collaboration environments [21], [41]. Such studies ought to utilize stringent experimental or quasi-experimental methodologies that can elucidate causal links between AI-enhanced marketing interventions and technology transfer results while effectively controlling for extraneous variables [19], [38], [37]. Longitudinal research methodologies possess particular significance for comprehending the dynamic interactions among the components of the framework and their progression over time [37]. Such investigations can monitor the advancement of AI capabilities, the evolution of marketing strategies, and the enduring effects of technology transfer programs while pinpointing essential success determinants and potential pitfalls [18], [46]. Cross-sectional comparative analysis may scrutinize the framework's effectiveness across various university classifications, industry categories, and national settings to elucidate boundary conditions and necessary adaptations [13], [40], [39].

Methodological advancements should investigate the amalgamation of sophisticated analytical techniques, including network analysis for deciphering collaboration patterns, machine learning methodologies for forecasting partnership success, and natural language processing for evaluating communication efficacy [30], [42]. Mixed-methods research frameworks can integrate quantitative outcome assessments with qualitative insights regarding stakeholder experiences, organizational dynamics, and cultural elements that affect implementation success [20], [37].

Research on technology development should concentrate on the creation of specialized AI instruments and platforms tailored explicitly for university-industry technology transfer applications [27], [14], [25]. These innovations may encompass intelligent matching systems that align university technologies with industry demands, predictive analytics platforms that estimate collaboration success probabilities, and automated relationship management systems that enhance stakeholder engagement [19], [23]. Such technological advancements necessitate close cooperation among computer science scholars,

marketing professionals, and technology transfer specialists [12], [17].

In direct response to RQ7, future research should prioritize the operationalization and validation of the Performance Outcomes component (Component 8), developing standardized indicator sets — including composite AI-effectiveness scores, collaboration conversion dashboards, and longitudinal innovation impact indices — that can be applied across diverse institutional and geographic contexts to provide replicable, benchmarkable measures of AI-enhanced marketing effectiveness.

VI. Conclusion

This integrative literature review and conceptual model development investigation addresses a significant deficiency in understanding how artificial intelligence can enhance marketing strategies for transferring technology knowledge between universities and industries. The proposed AI-enhanced marketing framework provides a comprehensive theoretical foundation that encompasses eight interrelated components essential for the effective implementation of technology transfer initiatives. The framework illustrates the potential of AI technologies to revolutionize conventional marketing methodologies while concurrently enhancing the efficacy of knowledge transfer through intelligent automation, data-informed decision-making, and improved stakeholder involvement.

The literature review uncovers substantial prospects for progressing both theoretical insights and practical applications of AI-enhanced marketing within university-industry collaborative environments. Nonetheless, the successful execution necessitates meticulous consideration of organizational preparedness, technological infrastructure, and ecosystem-level support factors that affect adoption and overall effectiveness. The identification of research voids and prospective avenues delineates a pathway for scholars and practitioners endeavoring to advance this nascent domain, while tackling pivotal challenges in the efficacy of technology transfer.

The practical ramifications of this inquiry extend beyond singular organizations to include policy recommendations, strategies for ecosystem development, and frameworks for international collaboration that can bolster global innovation capacity. As AI technologies continue to progress and mature, the amalgamation of these capabilities with marketing strategies signifies a transformative shift in how universities interact with industry partners and commercialize research outputs. Future research and implementation initiatives should prioritize empirical validation, technological advancement, and practical directives that facilitate the widespread adoption of AI-enhanced marketing strategies in contexts of technology transfer.

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