AI-driven innovation within the ICT sector

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Abstract
Innovation is pivotal in the competitive landscape of the Information and Communication Technology (ICT) sector, particularly in the context of rapidly evolving technological advancements. This research examines the instrumental role of Artificial Intelligence (AI) in facilitating innovation within the ICT sector, explaining its significance amidst accelerating technological progress. Utilizing articles from reputable high-impact journals published between 2019 and 2024, this paper meticulously analyzes recent contributions to clarify the integration of AI into innovation processes. The study builds upon foundational concepts in innovation management and contemporary advancements in AI frameworks, including AI Centered Design Thinking, the AI Adaptive Three-Horizons Framework, the AI Enabled Open Innovation Paradigm, the AI Specific Stage-Gate Model, and the AI Optimized Lean Startup Methodology, thereby contributing to the ongoing discourse surrounding AI integration in organizations. Employing a comprehensive literature review, the research systematically interrogates peer-reviewed articles from relevant databases, focusing on empirical evidence and theoretical insights regarding the influence of AI on innovation. The findings reveal that the strategic application of these frameworks significantly enhances decision-making efficiency, promotes user-centered design, and mitigates risks associated with AI deployment. The implications of this research are multifaceted, offering critical insights for academics, practitioners, and policymakers within the ICT sector. By highlighting the necessity of ethical considerations such as bias reduction and transparency in AI initiatives, the study emphasizes the imperative of responsible innovation practices. Ultimately, this research uniquely contributes to the field by providing a comprehensive synthesis of existing frameworks and their applicability to AI driven innovation, advocating for the continuous evolution of these frameworks to align with emerging technological trends. This focus affirms the relevance and significance of the study in advancing both theoretical understanding and practical application within the ICT sector.

Keywords: artificial intelligence frameworks, innovation management, user-centered design, ethical implications of AI and collaborative innovation.

1. Introduction
The relentless evolution of Artificial Intelligence (AI), coupled with synergistic technological advancements, is redefining various sectors across the global economic landscape, with the Information and Communication Technologies (ICT) sector at the forefront of this transformative shift [1]. Encompassing telecommunications, internet services, software development, and hardware technologies, the ICT sector serves as a pivotal driver of digital transformation across industries [2]. AI, Natural Language Processing (NLP), and advancements in digital vision, as key innovations, have a significant impact on the ICT sector [3]. This paper examines the existing literature, analyzes the use of AI and related advancements within the ICT sector, and highlights their substantial role on driving innovation.

2. Literature review

This study integrates five key frameworks—Design Thinking, the Three-Horizons Framework, Open Innovation, the Stage-Gate Process, and the Lean Startup Methodology—to facilitate a comprehensive, user-centered analysis of AI-driven innovation within the ICT sector.

2.1. AI-centered design thinking

In the context of AI-Centered Design Thinking, the framework applicant commences by identifying key stakeholders within the ICT sector, including software developers, organizations, and end-users of AI solutions [4], [5]. This user-centric approach emphasizes the imperative of comprehensively understanding users' requirements, concerns, and their prior interactions with AI or AI-integrated solutions [6], [7], [8]. By underscoring the significance of target customers, AI-Centered Design Thinking necessitates extensive research to elucidate the diverse perspectives and motivations of potential users [2] [3]. Certain user segments may confront distinct challenges, particularly of a technical nature [9]. Simultaneously, organizations must prioritize critical financial metrics, including Return on Investment (ROI) and other operational expenditures [10], [11], [12]. Common concerns among users encompass privacy, transparency, and the usability of AI within ICT systems [1], [13], [14] . Addressing these concerns is paramount, underscoring the necessity for AI-Centered Design Thinking to not only devise innovative solutions but also to enhance the optimization of existing AI systems within the ICT sector [15], [16], [17].

2.2. AI-adaptive three-horizons framework

The AI-Adaptive Three-Horizons Framework represents a strategic methodology for managing the development of artificial intelligence across various temporal dimensions [18]. Within this theoretical construct, three distinct horizons of change are delineated: short-term, medium-term, and long-term [19], [20]. This framework offers a structured paradigm for navigating the evolution of AI, characterized as follows:

- Horizon 1: Focuses on advancing research and publication aimed at enhancing existing AI capabilities in diverse environments by prioritizing the optimization of current systems to elevate their performance, adaptability, and integration within multiple complex domains [21], [22], [23].
- Horizon 2: Expands the exploration of novel AI opportunities within emerging fields and niches, where the adoption of innovative business paradigms and technologies—still in their nascent stages—holds the potential to catalyze transformative changes in the ICT sector [24], [25], [26].
- Horizon 3: Advocates for continuous advancement of AI development, encouraging stakeholders to surpass current achievements in technological utilization by ideating new scenarios and methodologies for AI implementation and further evolution [27], [28], [29].

This framework implies that AI is a revolutionary technology capable of making a significant impact on the entire ICT ecosystem [30], [31], [32]. A comprehensive

understanding of the three-horizons framework, coupled with an ability to discern the qualitative distinctions among each horizon, will empower professionals in the AI domain to fully appreciate the significance of adopting multidimensional approaches [33], [34].

2.3. AI-enabled open innovation paradigm

AI-enabled open innovation drives technological progress by facilitating the strategic exchange of knowledge and resources across various domains [35]. Collaborative partnerships with academic institutions, industry consortia, open-source platforms, crowdsourcing efforts, and shared databases enable teams to accelerate the evolution of AI technologies in the ICT sector [36]. The transition from closed to open innovation not only expedites AI development but also reduces operational costs, enhances creativity, and increases competitiveness [37]. In the context of AI, open innovation manifests through joint research initiatives, open-source contributions, and the availability of public datasets [38], [39]. Prominent examples, such as collaborations between Google and academic institutions, contributions to AI frameworks like TensorFlow, and the use of platforms like Kaggle, showcase how external inputs can significantly enhance AI innovation efforts [40], [41].

The Scopus database is another illustration of AI-enabled open innovation, offering an extensive repository of research articles focused on AI integration [42]. Analyzing these sources requires gathering diverse perspectives through collaboration with professionals and institutions not directly involved in the projects but willing to contribute to dataset analysis [43]. Consequently, trends are identified through the examination of publications and their chronological distribution [44], [45]. Employing content analysis is essential for gaining deeper insights into the various methodologies, research findings, and innovative solutions [46], [47].

Organizations leveraging AI-enabled open innovation can map and categorize AI knowledge domains by assessing the progression of topics from established practices to state-of-the-art advancements and speculative future concepts [48], [49]. This approach not only enhances understanding of AI-driven innovation within the ICT landscape but also fosters a more diverse and resilient innovation ecosystem [50]. Ultimately, AI-enabled open innovation reshapes how organizations interact with external knowledge, driving the creation and application of cutting-edge intelligent technologies [51].

2.4. AI-specific stage-gate model

The Stage-Gate framework serves as a structured approach for analyzing technological and innovation development, particularly in the context of AI integration, by dividing the process into distinct phases known as gates [52]. These gates represent a sequence of steps, tasks, and expected outcomes, each concluding with a decision point [53], [54], [55]. At these decision points, the feasibility of the AI project is evaluated, determining whether it should proceed, undergo modifications, or be discontinued [56]. When applied to AI development, the Stage-Gate framework supports well-coordinated project management, effective risk mitigation, and optimal resource utilization [57], [58], [59]. The following

stages delineate the systematic process for integrating AI into team dynamics and innovation workflows:

- Stage 1: Identify and define areas for AI integration within team processes, ensuring alignment with the overarching project framework and grounding the exploration in an initial literature review, while applying filters to prioritize relevant research directions and use cases [60].
- Stage 2: Conduct a thorough initial screening and evaluation of AI tools to examine their potential impact on team dynamics and organizational innovation processes, guided by key insights from existing literature, including theoretical and empirical perspectives from recent studies [61], [62].
- Stage 3: Perform exploratory analyses on selected case studies to assess the real-world effectiveness of AI tools in enhancing team dynamics [63], [64].
- Stage 4: Present findings that illustrate how AI tools contribute to improvements in teamwork, and formulate conclusions based on these observations [65], [66].
- Stage 5: Review user feedback and incorporate it to refine AI applications, thereby encouraging further research and iterative improvements in AI's role in fostering collaboration and innovation [67].

The AI-Specific Stage-Gate framework offers a structured mechanism for AI development, facilitating comprehensive evaluation and decision-making at each stage while ensuring effective risk control and resource utilization, thereby increasing the likelihood of successful project outcomes [60], [56], [58], [68].

2.5. AI-optimized lean startup methodology

The Lean Startup methodology is characterized by a paradigmatic approach for generating value in product development, particularly within the domain of AI system development [69], [70]. Emphasizing the principles of knowledge validation, frequent testing, and continuous improvement, the framework ensures that all newly produced AI research provides not only valuable but also pertinent insights and data [71, 72, 73, 74]. Central to the AI-optimized Lean Startup methodology is the Build-Measure-Learn loop, where the initial minimally viable product (MVP) is meticulously designed to encompass only those features essential for rigorously testing hypotheses and eliciting actionable feedback from stakeholders [75], [76], [77]. This iterative approach proves particularly salient during the learning phase, facilitating critical decision-making regarding the trajectory of research and determining whether to advance, pivot, or implement necessary modifications [78], [79]. The Lean Startup framework emphasizes validated learning [80], [81], [82], ensuring that all underlying assumptions regarding the utility, originality, and potential contributions of AI innovations to the ICT sector are rigorously assessed [83], [84], [85].

3. Methodology

A comprehensive literature review was conducted to address the research objectives, involving a meticulous selection and in-depth analysis of relevant articles. The Scopus database was utilized to identify peer-reviewed studies across the domains of business

management, computer science and engineering, with Boolean operators employed to refine the search towards AI's role in driving innovation within the ICT sector. Articles published between January 2019 and April 2024 were considered, while non-ICT studies, non-English publications, and papers lacking full-text access were excluded. From an initial pool of 742 articles, 698 remained after duplicate removal. A subsequent title and abstract screening led to the exclusion of 613 articles that did not meet the criteria. A thorough full-text review of the remaining 85 articles resulted in 15 articles being categorized into each of the five analytical frameworks, thereby enabling a comprehensive, multi-dimensional assessment of AI's impact on innovation in the ICT sector across all frameworks. This structured approach ensured a nuanced and detailed understanding of AI's influence on driving innovation across diverse contexts within the industry.

4. Findings

The analysis reveals that integrating advanced strategic frameworks into AI-driven innovation offers significant benefits for organizational development within the ICT sector. Each framework contributes unique insights, forming a holistic approach to managing AI development, mitigating risks, and ensuring alignment with both organizational goals and stakeholder expectations. Central to these frameworks is the emphasis on user needs and experiences. AI-Centered Design Thinking prioritizes understanding users' concerns regarding privacy, transparency, and usability, allowing organizations to create effective and user-friendly technologies [1], [4], [5], [13], [14]. This user-centric approach enhances customer satisfaction and aligns with evolving expectations. Complementing this, the AI-Optimized Lean Startup Methodology promotes a rapid, iterative development process through the Build-Measure-Learn loop, enabling organizations to create Minimum Viable Products (MVPs) that can be refined based on stakeholder feedback. This iterative method minimizes the risk of costly failures while ensuring that AI innovations closely meet market demands [69], [70], [75].

The AI-Adaptive Three-Horizons Framework provides a strategic roadmap for phased AI development, categorizing initiatives into three horizons. Horizon 1 focuses on optimizing existing AI systems to address immediate operational needs, while Horizon 2 explores emerging AI technologies with disruptive potential [21], [23], [24], [25]. Horizon 3 facilitates forward-looking innovation, allowing organizations to anticipate trends and secure long-term competitive advantages through transformative AI solutions [27], [28]. This structured approach not only enhances current capabilities but also prepares organizations for future challenges.

Furthermore, the AI-Enabled Open Innovation Paradigm underscores the importance of collaboration across institutional boundaries to foster technological advancement. By leveraging external research partnerships, open-source technologies, and publicly available datasets, organizations can accelerate AI innovation while conserving resources [35], [38], [39]. This paradigm democratizes AI development, enhancing the diversity and inclusivity of technological progress, as demonstrated by partnerships like those between Google and academic institutions [40], [41]. Finally, the AI-Specific Stage-Gate Model introduces a structured project management approach that divides AI development into clearly defined

stages, each culminating in critical decision points [52]. This systematic framework allows organizations to evaluate the feasibility of AI initiatives, ensuring optimal resource allocation and effective risk mitigation [53], [54]. The emphasis on iterative analysis and user feedback supports continuous improvement, ensuring that AI innovations remain aligned with organizational goals [63], [65], [66].

To synthesize, the integrated application of these five frameworks forms a cohesive and robust strategy for managing AI-driven innovation within the ICT sector. The alignment of user-centered design, strategic planning, open collaboration, systematic evaluation, and iterative refinement empowers organizations to fully capitalize on the transformative potential of AI technologies. This comprehensive framework not only accelerates technological innovation but also strengthens the competitiveness and resilience of the ICT sector in an increasingly volatile and dynamic digital environment.

5. Analysis & discussion

The integration of multiple frameworks into AI development is instrumental in addressing diverse array of issues and concerns inherent in the field, thereby providing nuanced insights into the management of AI advancement. This section examines five critical dimensions in AI development, addressing both technical and strategic challenges. First, "Navigating Technical Complexity and Ethical Accountability in AI Development" underscores the need for transparency and user-centric design. Next, "Enhancing Creativity and Competitiveness through Open Innovation in AI" highlights how external collaborations can foster innovation and efficiency. The third dimension, "Systematic Planning and Execution using the AI-Specific Stage-Gate Model", presents a structured approach to align projects with strategic objectives. The fourth aspect, "Iterative Learning and Adaptation through AI-Optimized Lean Startup Methodology", stresses the significance of user feedback and adaptability. Finally, "Balancing Innovation and Risk Management in AI Development" emphasizes the necessity of frameworks that manage risks while promoting innovation. These dimensions collectively offer a comprehensive perspective on the intricate relationships among creativity, strategic vision, and ethical considerations, underscoring their vital contributions to the advancement of AI initiatives. This integrated view emphasizes the necessity of harmonizing these elements to effectively address the challenges and opportunities presented by AI development.

5.1. Navigating the confluence of technical complexity and ethical accountability in AI development

The incorporation of AI technologies introduces a spectrum of technical challenges, notably the imperative for algorithmic transparency, interpretability, and the mitigation of inherent biases. These challenges are particularly critical in domains including healthcare, finance, and justice, where AI systems increasingly replace human decision-makers [2], [3]. The AI-Centered Design Thinking approach effectively addresses these concerns by prioritizing user needs, thereby enhancing both the transparency and interpretability of AI systems while cultivating developers' empathy towards end-users [9]. However, reliance on this approach alone is insufficient for resolving the strategic dilemmas associated with AI deployment. A predominant focus on financial metrics, encompassing both cost and

revenue, frequently leads to a misalignment between AI initiatives and overarching organizational objectives [10], [11].

To align AI projects with strategic objectives, the AI-Adaptive Three-Horizons Framework emerges as a vital analytical instrument [34]. This framework categorizes AI technologies into three distinct horizons: Horizon 1—emphasizing incremental enhancements to existing technologies to address immediate operational needs; Horizon 2—investigating novel applications of current technologies; and Horizon 3—anticipating transformative innovations [21], [23]. By applying this framework, organizations can ensure that AI advancements not only fulfill user requirements but also align seamlessly with their strategic goals [24], [28]. Furthermore, the AI-Enabled Open Innovation Paradigm effectively addresses both technical and ethical challenges by engaging external stakeholders, including experts in AI ethics, thereby enhancing the credibility and accountability of AI systems [40], [41].

5.2. Enhancing creativity and competitiveness through open innovation in AI

The AI-Enabled Open Innovation Paradigm facilitates the integration of external inputs and partnerships into the development of AI, contrasting with traditional closed research and development processes. These contributions are particularly valuable in the AI domain, given the rapid pace of societal advancements that can be challenging for individuals to comprehend. The diverse intellectual and experiential resources within the ICT sector play a crucial role in addressing these challenges [35], [36]. Collaborative initiatives with universities, research institutions, and other enterprises can significantly accelerate AI progress, concurrently reducing research and development expenses while fostering more innovative approaches to problem-solving [38] [39]. This collaborative framework enhances organizational competitiveness by integrating contemporary innovations and research findings into AI policymaking, thereby positively influencing the future trajectory of AI [40].

5.3. Systematic planning and execution with the AI-specific stage-gate model

The innovative methodologies previously discussed are effectively supported by the AI-Specific Stage-Gate Model, which offers a structured framework for managing AI initiatives. As noted earlier, this model delineates development into discrete stages, at which specific deliverables and decisions are articulated, thereby systematically addressing both the technical and strategic dimensions of the development lifecycle [52], [60]. Commencing with the definition of the problem and initial exploration, the process aligns closely with the principles of AI-Centered Design Thinking. Subsequent phases encompass exploration, consolidation, and rigorous evaluation of project progress, alongside assessments of associated risks [61], [62]. The integration of AI-Centered Design Thinking and the AI-Enabled Open Innovation Paradigm within the AI-Specific Stage-Gate Model ensures the development of innovative, user-centered, and ethically sound AI solutions. This methodological approach facilitates a continual process of assessment and adaptation in response to emerging insights and evolving conditions [65], [66].

5.4. Iterative learning and adaptation within the AI-optimized lean startup methodology

The AI-Optimized Lean Startup Methodology, specifically the Build-Measure-Learn loop, proposes an iterative process for AI development, emphasizing the implementation of a MVP to test hypotheses and gather user feedback [71], [74]. This approach also serves to mitigate risk; through rapid idea validation, solutions can be refined more thoroughly if they fail to resonate with users [73], [75]. Grounded in principles such as validated learning—emphasizing the process of deriving insights from customers rather than simply increasing the quantity of products or features—this methodology aligns closely with AI-Centered Design Thinking. Consequently, AI projects evolve into innovative and dependable solutions by embracing systematic creativity and reflecting the iterative nature emphasized in this methodology [78], [79].

5.5. Balancing innovation with risk management in AI development

The development of AI is inherently fraught with technical, ethical, and market-positioning challenges. Consequently, effective risk management is paramount for sustainable advancement. The AI-Optimized Lean Startup Methodology aids in mitigating risks associated with uncertainty through a continuous cycle of creation and experimentation, thereby reducing the likelihood of failure and providing guidance for adaptation based on newly acquired insights. Risk management is further enhanced by the AI-Specific Stage-Gate Model, which segments the development process into distinct phases, each incorporating critical review points. This structured approach employs various planning tools and risk management instruments, such as scenario techniques and sensitivity analyses. Additionally, the AI-Adaptive Three-Horizons Framework balances short-term enhancements with an organization's resilience to future technological and regulatory changes. Moreover, the AI-Enabled Open Innovation Paradigm facilitates the management of risks that may not be adequately addressed internally, allowing organizations to leverage external insights and expertise.

Integrity concerns in AI development encompass critical issues such as bias, discrimination, and privacy. The AI-Centered Design Thinking approach effectively addresses these ethical dilemmas by actively engaging users and employing prototyping techniques to identify and mitigate concerns early in the development process. This framework also contributes to ethical development by directing attention to the social implications of advancements prior to the deployment of new technologies, ensuring that innovations are both responsible and ethically sound. Furthermore, the Open Innovation Paradigm empowers developers to access diverse virtual networks, ethics experts, and regulatory bodies, thereby enhancing the ethical accountability of AI systems.

Ethical considerations are integral to each advancement phase within the Stage-Gate Process, while the Lean Startup Methodology emphasizes the importance of soliciting user feedback to illuminate and address ethical dilemmas inherent in system development before the system is even built.

6. Conclusions and recommendations

This research presents a comprehensive review of AI-driven frameworks that foster innovation within the ICT sector, focusing on five critical models for integrating AI into innovation processes. Each framework offers unique strengths in addressing the challenges and opportunities in innovation management. For instance, AI-Centered Design Thinking enhances problem-solving capabilities, while the AI-Adaptive Three-Horizons Framework balances immediate operational needs with long-term innovation goals. The AI-Enabled Open Innovation Paradigm underscores the significance of collaboration and external partnerships in accelerating innovation.

The analysis reveals that these AI-centered frameworks enhance decision-making efficiency and agility, opening new avenues for product development in response to rapid technological advancements. AI's ability to process vast datasets, identify patterns, and provide predictive insights equips organizations to anticipate market changes and adapt strategies, thus gaining a competitive advantage. Additionally, the AI-Specific Stage-Gate Model and AI-Optimized Lean Startup Methodology offer tailored approaches, emphasizing iterative development, scalability, and customer feedback in an AI-enhanced environment.

However, the practical application of these frameworks presents challenges. The inherent complexity of AI technologies, along with diverse organizational capacities and market conditions, necessitates significant customization of these frameworks. Furthermore, the rapid pace of AI development requires that the frameworks be continually revised to maintain relevance and effectiveness. Ethical concerns surrounding AI—particularly regarding bias, transparency, and data protection—must also be addressed to ensure responsible integration. These ethical considerations are critical not only to the technology's success but also to its broader societal acceptance, as unresolved issues in these areas could undermine trust and hinder AI adoption.

Moving forward, further study should focus on data quality and accessibility, the integration of ethical AI practices, and enhancing human-robot interactions for effective teamwork. Particular attention should be given to developing ethical AI models tailored to the ICT industry, ensuring fairness, accountability, and transparency in AI operations. Additionally, data management regulations must clearly define processes for producing reliable and secure data. Addressing scalability and integration concerns will also be essential for aligning AI technologies with existing ICT frameworks.

This study concludes by recommending that practitioners within the ICT sector actively integrate AI into their innovation management strategies, focusing on enhancing agile decision-making processes and optimizing product development cycles. The AI-driven frameworks provide structured approaches to harnessing AI for innovation; however, their success hinges on organizations' commitment to continuously refine and adapt these frameworks to evolving market demands. Future research should empirically validate the effectiveness of these frameworks across different organizational contexts and industries and assess their long-term impact on innovation outcomes. Furthermore, exploring

advanced AI techniques—such as Machine Learning, NLP, and Generative AI—within these frameworks could yield groundbreaking innovations.

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Appendix A. Framework Summaries of Research Articles on AI Innovation Approaches

A.1. Summary of Research Articles on AI-Centered Design Thinking

Author	Title	Methodology	Findings
[1]	Principles and business processes for responsible AI	Conceptual analysis and review	Outlines principles and processes for implementing responsible AI in business.
[2]	Artificial intelligence-driven sustainable development: Examining organizational, technical, and processing approaches to achieving global goals	Qualitative analysis and case studies	Evaluates AI-driven approaches for achieving sustainable development goals.
[3]	Creating public value through smart technologies and strategies: From digital services to artificial intelligence and beyond	Literature review and case studies	Discusses the creation of public value through smart technologies and AI.
[4]	Educating software and AI stakeholders about algorithmic fairness, accountability, transparency, and ethics	Literature review and educational analysis	Discusses strategies for educating stakeholders on AI ethics and fairness.
[5]	Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	Literature review and expert analysis	Identifies challenges, opportunities, and research agendas for AI in various fields.
[6]	Drivers, barriers and social considerations for AI adoption in business and management: A tertiary study	Tertiary study analysis	Examines factors influencing AI adoption in business and management.
[7]	Artificial intelligence and business models in the sustainable development goals perspective: A systematic literature review	Systematic literature review	Analyzes the impact of AI on business models in the context of sustainable development goals.
[8]	Where responsible AI meets reality: Practitioner perspectives on enablers for shifting organizational practices	Qualitative interviews and case studies	Explores enablers and barriers for integrating responsible AI practices in organizations.
[9]	Corporate digital responsibility (CDR) in construction engineering—ethical guidelines for the application of digital transformation and artificial intelligence (AI) in user practice	Literature review and guideline development	Provides ethical guidelines for AI and digital transformation in construction engineering.

[10]	The global landscape of AI ethics guidelines	Systematic review of AI ethics guidelines	Reviews and categorizes global AI ethics guidelines.
[11]	A novel ICT framework for sustainable development goals	Framework development and analysis	Proposes an ICT framework for addressing sustainable development goals.
[12]	From knowledge and skills to digital works: An application of design thinking in the information technology course	Literature review	Reviews the transition of the economy to the digital sphere via design thinking implementation.
[13]	Assessing the fairness of AI systems: AI practitioners' processes, challenges, and needs for support	Surveys and interviews	Investigates AI practitioners' challenges and needs in assessing AI fairness.
[14]	Artificial intelligence and sustainable development	Literature review	Explores the relationship between AI and sustainable development.
[15]	AI adoption and diffusion in public administration: A systematic literature review and future research agenda	Systematic literature review	Reviews AI adoption in public administration and proposes a future research agenda.
[16]	Thinking responsibly about responsible AI and 'the dark side' of AI	Conceptual and empirical analysis	Discusses responsible AI practices and the potential negative aspects of AI.
[17]	Design thinking for innovation: Practices and intermediate outcomes	Systemic analysis	Examines practices for responsible AI through systemic analysis.

Source: Own Analysis

A.2. Summary of Research Articles on AI-Adaptive Three-Horizons Framework

Author	Title	Methodology	Findings
[18]	AI-based digital assistants: Opportunities, threats, and research perspectives	Literature review and expert opinions	Identifies opportunities, threats, and future research directions for AI-based digital assistants.
[19]	Towards sustainable textile and apparel industry: exploring the role of business intelligence systems in the era of industry 4.0	Case study analysis	Examines the role of business intelligence systems in promoting sustainability in the textile and apparel industry.
[20]	Embracing intelligent machines: a qualitative study to explore the transformational trends in the workplace	Qualitative study	Explores transformational trends in the workplace due to intelligent machines.
[21]	Extended service profit chain in telecom service industry in Oman–An empirical validation	Data analysis and case studies	Investigates engagement analytics techniques for managing customer churn in the telecom industry.

[22]	Artificial intelligence and marketing: Pitfalls and opportunities	Literature review and framework analysis	Analyzes challenges and opportunities in developing autonomous intelligent networks.
[23]	Sociotechnical envelopment of artificial intelligence: an approach to organizational deployment of inscrutable artificial intelligence systems	Qualitative research and case studies	Discusses approaches for the organizational deployment of complex AI systems.
[24]	Three horizons meets presencing for inclusive, just and equitable futures	Conceptual analysis	Critiques the three horizon's framework.
[25]	Digital platform-based ecosystems: The evolution of collaboration and competition between incumbent producers and entrant platforms	Literature review and case studies	Examines how new technologies disrupt business models and how incumbents adapt.
[26]	Designing, developing, and deploying artificial intelligence systems: Lessons from and for the public sector	Case studies and lessons learned	Provides insights and lessons for designing and deploying AI systems in the public sector.
[27]	Value creation and value capture for AI business model innovation: a three-phase process framework	Literature review and empirical research	Explores the transition from human to AI-supported virtual teams.
[28]	Prompting higher education towards AI-augmented teaching and learning practice	Literature review and case studies	Discusses how AI can enhance teaching and learning practices in higher education.
[29]	An overview of twenty-five years of augmented reality in education	Literature review	Reviews the use and development of augmented reality in education over 25 years.
[30]	A comparative evaluation of swarm intelligence algorithm optimization: a review	Literature review and conceptual framework	Proposes the use of quantum AI for enhancing the Internet of Things.
[31]	Artificial intelligence (AI) or intelligence augmentation (IA): what is the future?	Conceptual analysis	Discusses the future of AI versus intelligence augmentation.
[32]	Towards a deliberative framework for responsible innovation in artificial intelligence	Framework development and analysis	Proposes a deliberative framework for responsible AI innovation.
[33]	Towards an equitable digital society: artificial intelligence (AI) and corporate digital responsibility (CDR)	Literature review and analysis	Examines the role of AI and corporate digital responsibility in creating an equitable digital society.
[34]	Mapping archetype scenarios across the three horizons	Review	Critical analysis and application of the three horizons framework.

Source: Own Analysis

A.3. Summary of Research Articles on AI-Enabled Open Innovation Paradigm

Author	Title	Methodology	Findings
[35]	Information technology for supporting the development and maintenance of open innovation capabilities	Literature review	Proposes IT framework for developing and maintaining the innovative approach.
[36]	Artificial intelligence and knowledge management: a partnership between human and AI	Literature review and conceptual analysis	Explores how AI and human knowledge management can form a partnership.
[37]	The role of open innovation and value co-creation in the challenging transition from industry 4.0 to society 5.0: Toward a theoretical framework	Literature review and research agenda	Reviews the state of intelligent systems and their development from industry 4.0 to 5.0.
[38]	The AI-Based Cyber Threat Landscape: A Review	Literature review	Reviews the landscape of AI-based cyber threats and current countermeasures.
[39]	Trustworthy artificial intelligence: a review	Literature review and conceptual analysis	Reviews approaches to ensuring trustworthy AI.
[40]	Managerial overreliance on AI-augmented decision-making processes: How the use of AI-based advisory systems shapes choice behavior in R&D investment decisions	Experimental study	Investigates how AI-based advisory systems influence managerial decision-making in R&D investments.
[41]	AI-driven innovation: Towards a conceptual framework	AI-driven value chain framework analysis	Discusses the AI organization maturity model and an AI-driven maturity framework.
[42]	A framework of artificial intelligence augmented design support	Framework development	Proposes a framework for AI-augmented design support.
[43]	Deep learning for free-hand sketch: A survey	Literature review and survey	Surveys the use of deep learning techniques in cybersecurity.
[44]	The impacts of artificial intelligence techniques in augmentation of cybersecurity: a comprehensive review	Literature review	Reviews the impact of AI techniques on enhancing cybersecurity measures.
[45]	Challenges for open education with educational innovation: A systematic literature review	Literature review and assessment	Provides analysis of the challenges in education connected to open innovation and overall improvement.
[46]	Analysis of the use of artificial intelligence in software-defined intelligent networks: A survey	Systematic review	AI application in SDN algorithms: route optimization, software-defined routing, intelligent methods for network security, and AI-based traffic engineering.

[47]	Framework linking open innovation strategic goals with practices	Critical analysis	Analyzes the evolution of home automation technologies through patent data.
[48]	Deep learning approach for intrusion detection in IoT-multi cloud environment	Deep learning techniques and experiments	Proposes deep learning methods for intrusion detection in IoT multi-cloud environments.
[49]	Artificial intelligence-enabled sensing technologies in the 5G/internet of things era: from virtual reality/augmented reality to the digital twin	Literature review and technology analysis	Reviews AI-enabled sensing technologies in the context of 5G and IoT, including VR/AR and digital twins.
[50]	Artificial intelligence and the implementation challenge	Case studies and analysis	Discusses challenges and solutions in implementing AI technologies.
[51]	The culture for open innovation dynamics	Critical analysis	Delves deeper into the culture for open innovation dynamics.

Source: Own Analysis

A.4. Summary of Research Articles on AI-Specific Stage-Gate Model

Author	Title	Methodology	Findings
[52]	What is the state of artificial intelligence governance globally?	Literature review	Explores the current state of global AI governance.
[53]	SMEs and artificial intelligence (AI): Antecedents and consequences of AI-based B2B practices	Empirical study	Investigates AI-based B2B practices in SMEs and their antecedents and consequences.
[54]	Artificial intelligence and business value: A literature review	Literature review	Reviews the impact of AI on business value and organizational outcomes.
[55]	Technology, ICT and tourism: from big data to the big picture	Literature review	Examines the role of technology and ICT in tourism, focusing on big data.
[56]	Governance of artificial intelligence	Literature review and policy analysis	Examines the governance of AI, including policy and regulatory aspects.
[57]	On big data, artificial intelligence and smart cities	Literature review	Discusses the role of big data and AI in the development of smart cities.
[58]	Artificial intelligence applications for industry 4.0: A literature-based study	Literature review	Reviews AI applications relevant to Industry 4.0.
[59]	Stage-gate and agile development in the digital age: Promises, perils, and boundary conditions	Theoretical discussion	Proposes principles and practices for implementing responsible AI.
[60]	Transparency you can trust: Transparency requirements for artificial intelligence between legal norms and contextual concerns	Literature review	Discusses transparency requirements for AI in relation to legal and contextual factors.

[61]	Artificial intelligence for industry 4.0: Systematic review of applications, challenges, and opportunities	Systematic review	Reviews AI applications, challenges, and opportunities in the context of Industry 4.0.
[62]	Artificial intelligence and knowledge sharing: Contributing factors to organizational performance	Empirical study	Examines how AI and knowledge sharing contribute to organizational performance.
[63]	Artificial intelligence (AI) in strategic marketing decision-making: a research agenda	Literature review and research agenda	Proposes a research agenda for AI in strategic marketing decision-making.
[64]	AI lifecycle models need to be revised: An exploratory study in Fintech	Exploratory study	Discusses the need for revised AI lifecycle models, particularly in Fintech.
[65]	Future of Business Culture: An Artificial Intelligence-Driven Digital Framework for Organization Decision-Making Process	Framework development	Proposes an AI-driven digital framework for organizational decision-making.
[66]	The potential of generative artificial intelligence across disciplines: Perspectives and future directions	Literature review	Reviews the potential and future directions of generative AI across various disciplines.
[67]	Emerging challenges in AI and the need for AI ethics education	Literature review	Discusses emerging challenges in AI and the necessity of ethics education.
[68]	Ethical issues in big data analytics: A stakeholder perspective	Stakeholder analysis	Analyzes ethical issues in big data analytics from a stakeholder perspective.

Source: Own Analysis

A.5. Summary of Research Articles on AI-Optimized Lean Startup Methodology

Author	Title	Methodology	Findings
[69]	Power to the people? Opportunities and challenges for participatory AI	Conference paper	Explores the opportunities and challenges of participatory AI from a stakeholder perspective.
[70]	Large-Scale decision-making: Characterization, taxonomy, challenges, and future directions from an Artificial Intelligence and applications perspective	Literature review and taxonomy	Provides a taxonomy of large-scale decision-making in AI and discusses challenges and future directions.
[71]	Artificial intelligence explainability: the technical and ethical dimensions	Literature review and analysis	Examines both technical and ethical aspects of AI explainability.
[72]	Artificial intelligence ethics by design. Evaluating public perception on the importance of ethical design principles of artificial intelligence	Empirical study	Evaluates public perception of ethical design principles in AI.

[73]	Artificial intelligence in business: State of the art and future research agenda	Literature review and research agenda	Reviews the current state of AI in business and outlines future research directions.
[74]	Circular economy-based new products and company performance: The role of stakeholders and Industry 4.0 technologies	Empirical study	Investigates the impact of circular economy practices and Industry 4.0 technologies on company performance.
[75]	Intelligent automation systems at the core of Industry 4.0	Conference paper	Discusses the role of intelligent automation systems in Industry 4.0.
[76]	From technological development to social advance: A review of Industry 4.0 through machine learning	Literature review	Reviews the impact of Industry 4.0 and machine learning on technological and social advancements.
[77]	Distributed, decentralized, and democratized artificial intelligence	Literature review	Discusses the concepts of distributed, decentralized, and democratized AI.
[78]	The interaction between internet, sustainable development, and emergence of society 5.0	Literature review	Analyzes the intersection of the internet, sustainable development, and the emergence of Society 5.0.
[79]	Reporting guideline for the early stage clinical evaluation of decision support systems driven by artificial intelligence: DECIDE-AI	Guideline development	Proposes a reporting guideline for the clinical evaluation of AI-driven decision support systems.
[80]	AI-enabled adaptive learning systems: A systematic mapping of the literature	Systematic mapping	Maps the literature on AI-enabled adaptive learning systems.
[81]	Understanding the interplay of artificial intelligence and strategic management: Four decades of research in review	Literature review	Reviews four decades of research on AI and strategic management.
[82]	Investigating the influence of artificial intelligence on business value in the digital era of strategy: A literature review	Literature review	Investigates the impact of AI on business value in the digital strategy era.
[83]	Legal and human rights issues of AI: Gaps, challenges and vulnerabilities	Literature review	Explores legal and human rights issues related to AI, including gaps and challenges.
[84]	Hybrid collective intelligence in a human–AI society	Literature review	Examines hybrid collective intelligence in societies that integrate human and AI systems.
[85]	Study on artificial intelligence: The state of the art and future prospects	Literature review	Reviews the state of the art in AI and discusses future prospects.

Source: Own Analysis

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