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Comprehensive Review of Artificial Intelligence Applications in Project Management

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Anahtar Kelimeler

Yapay zekâ
Proje yönetimi
Makine öğrenimi
Doğal dil işleme
Bulanık mantık
Uzman sistemler
Üretken yapay zekâ
Proje performansı

Graphical/Tabular Abstract (Grafik/Tablo Özeti)

This review article examines Artificial Intelligence applications in project management, highlighting machine learning, NLP, fuzzy logic, expert systems, hybrid and generative AI. Findings show improved decision-making, automation, resource optimization, risk management, and stakeholder engagement while emphasizing implementation challenges and future research opportunities. /Bu derleme makalesi, proje yönetiminde Yapay Zekâ uygulamalarını incelemekte; makine öğrenmesi, doğal dil işleme, bulanık mantık, uzman sistemler, hibrit ve üretken YZ yaklaşımlarını değerlendirmektedir. Bulgular, karar verme, otomasyon, kaynak optimizasyonu, risk yönetimi ve paydaş katılımındaki gelişmeleri ortaya koyarken uygulama zorluklarına ve araştırma fırsatlarına dikkat çekmektedir.

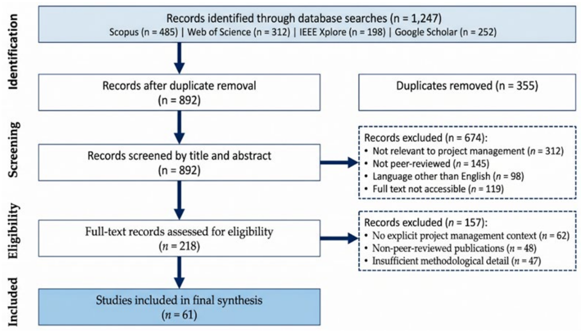

***Figure A**: PRISMA flow diagram /**Şekil A:** PRISMA akış diagramı*

Highlights (Önemli noktalar)

- *Project management artificial intelligence literature (2020–2025) was systematically reviewed using the PRISMA framework. / Proje yönetimindeki yapay zekâ literatürü (2020–2025), PRISMA yaklaşımıyla sistematik olarak incelenmiştir.*
- *Artificial intelligence applications were evaluated within PMI performance domains, and their contributions across the project life cycle were presented in a holistic framework. / Yapay zekâ uygulamaları PMI performans alanları çerçevesinde değerlendirilmiş ve proje yaşam döngüsü boyunca sağladığı katkılar bütüncül bir çerçevede sunulmuştur.*
- *Machine learning, NLP, fuzzy logic, expert systems, and generative AI were comparatively analyzed in terms of their roles in planning, risk, and decision support processes. / Makine öğrenmesi, doğal dil işleme, bulanık mantık, uzman sistemler ve üretken yapay zekânın planlama, risk ve karar destek süreçlerindeki rolleri karşılaştırmalı olarak analiz edilmiştir.*

Aim (Amaç): *This study analyzes the current state and future trajectories of artificial intelligence applications in project management domains. / Bu çalışma, proje yönetimi alanlarındaki yapay zekâ uygulamalarının mevcut durumunu ve gelecekteki yönelimlerini analiz etmektedir.*

Originality (Özgünlük): *The study categorizes artificial intelligence approaches within the context of project management performance domains. / Çalışma, yapay zekâ yaklaşımlarını proje yönetimi performans alanları bağlamında sınıflandırmaktadır.*

Results (Bulgular): *Artificial intelligence improves decision-making and automates tasks, with different methodologies presenting specific strengths and limitations. / Yapay zekâ karar süreçlerini iyileştirip görevleri otomatikleştirirken, farklı metodolojiler kendilerine özgü güçler ve sınırlılıklar barındırmaktadır.*

Conclusion (Sonuç): *AI significantly transforms project management by enhancing decision-making, planning, risk management, resource optimization, and stakeholder engagement. However, its effective and sustainable implementation requires stakeholders to develop new competencies, adapt methodologies, and adopt appropriate governance structures. / Yapay zekâ, proje yönetiminde karar verme, planlama, risk yönetimi, kaynak optimizasyonu ve paydaş etkileşimini dönüştürerek önemli katkılar sunmaktadır. Ancak etkin ve sürdürülebilir kullanım için paydaşların yeni yetkinlikler geliştirmesi, metodolojileri uyarlaması ve uygun yönetişim yapılarını benimsemesi gerekmektedir.*

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Comprehensive Review of Artificial Intelligence Applications in Project Management

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Abstract

Artificial Intelligence (AI) is reshaping project management, fundamentally changing how we plan, execute, and complete projects. This comprehensive review systematically examines the current state and future trajectories of AI applications across all project management performance domains. Drawing exclusively from recent literature (2020-2025), we analyze the evolution of AI in project management and categorize implementations across machine learning, natural language processing, fuzzy logic systems, expert systems, hybrid approaches, and emerging generative AI technologies. The review reveals that AI is progressively enhancing decision-making processes, automating routine tasks, optimizing resource allocation, improving risk assessment, facilitating team formation, and enabling data-driven stakeholder engagement. Furthermore, we identify and discuss implementation challenges, ethical considerations, and future research directions. This synthesis provides practitioners and researchers with an integrated understanding of how AI is reshaping project management practices while highlighting untapped opportunities and potential limitations that warrant further investigation.

Proje Yönetiminde Yapay Zekâ Uygulamalarının Kapsamlı İncelemesi

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Proje performansı

Öz

Yapay Zekâ (YZ), proje yönetimini yeniden şekillendirmekte; projeleri planlama, yürütme ve tamamlama biçimimizi temelden değiştirmektedir. Bu kapsamlı inceleme, tüm proje yönetimi performans alanlarında YZ uygulamalarının mevcut durumunu ve gelecekteki yönelimlerini sistematik olarak ele almaktadır. Yalnızca güncel literatürden (2020-2025) yararlanılarak, YZ'nin proje yönetimindeki evrimi analiz edilmekte ve uygulamalar; makine öğrenimi, doğal dil işleme, bulanık mantık sistemleri, uzman sistemler, hibrit yaklaşımlar ve gelişmekte olan üretken YZ teknolojileri bağlamında sınıflandırılmaktadır. İnceleme; YZ'nin karar verme süreçlerini giderek iyileştirdiğini, rutin görevleri otomatikleştirdiğini, kaynak tahsisini optimize ettiğini, risk değerlendirmesini geliştirdiğini, takım oluşturmayı kolaylaştırdığını ve veri odaklı paydaş katılımına olanak tanıdığını ortaya koymaktadır. Ayrıca, uygulama zorlukları, etik hususlar ve gelecekteki araştırma yönelimleri belirlenmekte ve tartışılmaktadır. Bu çalışma, uygulayıcılara ve araştırmacılara YZ'nin proje yönetimi uygulamalarını nasıl yeniden şekillendirdiğine dair bütünleşik bir anlayış sunarken, daha fazla araştırma gerektiren henüz değerlendirilmemiş fırsatları ve potansiyel sınırlamaları da vurgulamaktadır.

1. INTRODUCTION (GİRİŞ)

Project management has traditionally relied on a combination of methodological frameworks, experiential knowledge, and interpersonal skills to navigate the complexities of delivering initiatives within scope, time, budget, and quality constraints [1]. However, the exponential growth in data volume, complexity of modern projects, and increasing stakeholder expectations have created both challenges and opportunities for innovation in project management approaches [2]. Artificial Intelligence (AI), with its capacity to process vast datasets, identify patterns, generate insights, and automate processes, has emerged as a transformative force in addressing these evolving demands. This impact has also been demonstrated in domain-specific prediction studies [3].

The applications of AI in project management span a diverse spectrum, from basic automation of routine administrative tasks to sophisticated predictive analytics for forecasting project outcomes and generative capabilities that can assist

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in scenario planning and document creation [4]. As noted by Pourmojahed and Rahat [5] organizations are increasingly adopting AI technologies to enhance project performance, reduce costs, mitigate risks, and gain competitive advantages. However, the integration of AI into project management practices also presents significant challenges related to implementation, governance, ethics, and the evolving role of project managers in an increasingly automated environment.

The aim of this review is to provide a comprehensive analysis of AI applications across all project management performance domains, synthesizing findings from recent research and practice to identify current trends, capabilities, limitations, and future directions. By examining how AI is being applied to address specific project management challenges and opportunities, this review contributes to a deeper understanding of the transformative potential of AI in project management and offers insights for practitioners seeking to leverage AI effectively in their project environments.

2. METHODOLOGY (YÖNTEM)

2.1. Search Strategy and Selection Criteria (Tarama Stratejisi ve Seçim Kriterleri)

This systematic review employed a comprehensive search strategy to identify relevant literature on AI applications in project management. The review covered studies published between 2020 and 2025 to capture the most recent developments in this rapidly evolving field.

The search strategy utilized a combination of keywords related to artificial intelligence and project management. The primary keywords included: "artificial intelligence," "machine learning," "natural language processing," "large language model," "fuzzy logic," "expert systems," "neural networks," "deep learning," "generative AI," combined with "project management," "project planning," "project scheduling," "resource allocation," "risk management," "stakeholder management," "project planning," "project monitoring," and "project control."

The inclusion criteria for the selected studies were:

- Focus on AI applications specifically in project management contexts
- Published in peer-reviewed journals or conference proceedings
- Published between 2020 and 2025
- Written in English
- Provided empirical evidence, theoretical frameworks, or comprehensive reviews

The exclusion criteria were:

- Studies focusing solely on AI technologies without project management applications
- Non-peer-reviewed publications, trade magazine articles, or blog posts
- Publications with insufficient methodological details or unclear findings
- Duplicate studies or multiple publications of the same research

The selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines to ensure methodological transparency and replicability. The search was conducted across four electronic databases: Scopus, Web of Science Core Collection, IEEE Xplore, and Google Scholar. The search was performed in January–February 2025, covering publications from 2020 to 2025.

The initial database search retrieved 892 records after removal of 355 duplicates from an initial pool of 1,247 records. Following title and abstract screening, 218 records were assessed for eligibility. Of these, 157 were excluded based on the predefined exclusion criteria: studies without explicit project management context (n = 62), non-peer-reviewed publications (n = 48), and publications with insufficient methodological detail (n = 47). Ultimately, 61 publications met all inclusion criteria and were incorporated into the final synthesis.

The complete selection process is illustrated in the PRISMA flow diagram presented in Figure 1[6].

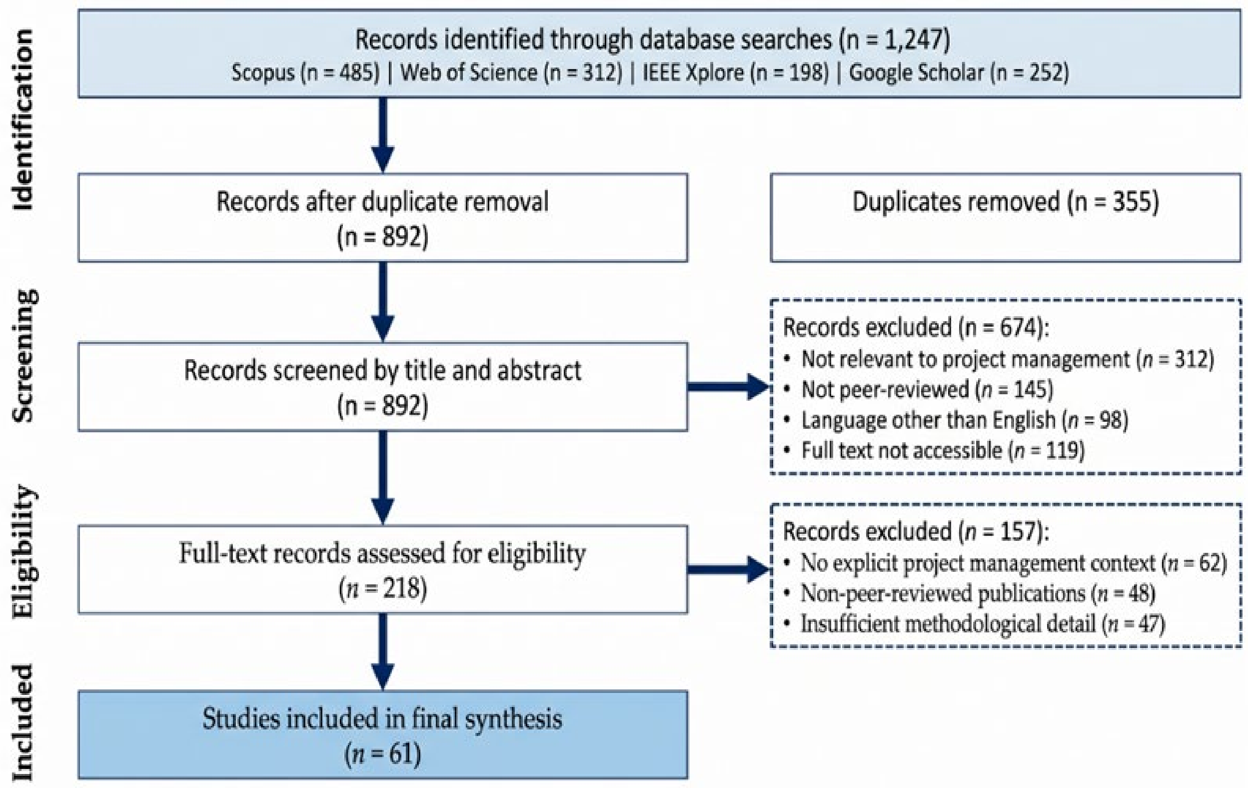

Figure 1. PRISMA flow diagram. (PRISMA akış diyagramı)

2.2. Analytical Framework (Analitik Çerçeve)

The analysis of the selected publications was structured around the Project Management Institute's (PMI) Performance Domains framework from the PMBOK® Guide- Seventh Edition [7]. This framework provides a comprehensive approach to understanding the various aspects of project management and serves as an appropriate structure for categorizing AI applications. The performance domains used in this review are:

- Planning Performance Domain
- Measurement Performance Domain
- Uncertainty Performance Domain
- Team Performance Domain
- Stakeholder Performance Domain
- Development Approach and Life Cycle Performance Domain
- Delivery Performance Domain
- Project Work Performance Domain

Each selected publication was analysed to identify the AI approaches used and the project management performance domains addressed. This analytical framework enabled a structured assessment of how different AI technologies are being applied across various aspects of project management.

2.3. Synthesis Approach (Sentez Yaklaşımı)

The synthesis of findings involved both quantitative and qualitative approaches. Quantitatively, the review analyzed the distribution of publications across years, AI approaches, and performance domains to identify trends and patterns. Qualitatively, the review examined the specific applications, methodologies, findings, and implications reported in the selected publications.

The synthesis process involved several steps:

- Categorizing each publication according to the AI approaches used
- Mapping each publication to the relevant project management performance domains
- Extracting key findings and applications from each publication
- Identifying common themes, trends, and gaps across the literature
- Synthesizing the findings to develop a comprehensive understanding of AI applications in project management

The findings of this synthesis are presented in the subsequent sections, starting with an overview of AI approaches in project management, followed by an examination of AI applications across performance domains.

3. ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT (PROJE YÖNETİMİNDE YAPAY ZEKÂ)

3.1. Evolution of AI in Project Management (Proje Yönetiminde Yapay Zekânın Gelişimi)

The integration of AI into project management has undergone a significant evolution over the past decade, transitioning from experimental applications to increasingly mainstream adoption across multiple domains and industries. This evolution has been characterized by several distinct phases, each marked by advancements in AI capabilities and expanded applications in the project management context.

In the early phases of AI adoption in project management (2010-2018), applications were primarily focused on automating routine tasks and providing basic decision support through rule-based systems and simple predictive models [1]. These early implementations were often standalone tools addressing specific aspects of project management, such as schedule optimization or resource allocation, rather than comprehensive solutions integrated into the project management ecosystem.

The period from 2019 to 2022 witnessed a significant expansion in AI applications, driven by advancements in machine learning algorithms, increased computational power, and greater availability of project data. During this phase, AI began to be applied to more complex project management challenges, including risk detection and assessment, stakeholder analysis, and performance prediction [2]. Importantly, AI tools started to be integrated into project management information systems, enabling more seamless workflows and data-driven decision-making processes.

The most recent phase (2023-2025) has been characterized by the emergence of generative AI capabilities and their integration into project management practices. As noted by [4] generative AI technologies such as large language models have expanded the possibilities for AI applications in project management, enabling capabilities such as automated document generation, natural language-based project planning, intelligent virtual assistants for project teams, and sophisticated scenario simulation for risk management. This phase has also seen increasing attention to ethical considerations, governance frameworks, and the changing role of project managers in AI-augmented environments.

Throughout this evolution, there has been a shift from viewing AI as a tool that might potentially replace project managers to recognizing AI as an augmentation technology that enhances human capabilities while transforming project management practices. As argued by Elmas and Babayev [1] "AI cannot replace project managers but can significantly augment their capabilities by automating routine tasks, providing data-driven insights, and supporting complex decision-making processes."

Looking forward, Bushuyev et al. [2] suggest that the continued evolution of AI in project management will likely involve greater personalization of AI tools to specific project contexts, improved explainability of AI-generated recommendations, enhanced integration across the project lifecycle, and increased focus on the human-AI collaboration paradigm. This evolution trajectory underscores the dynamic nature of AI applications in project management and highlights the importance of continuous adaptation of project management practices to leverage emerging AI capabilities effectively.

3.2. Overview of AI Approaches in Project Management (Proje Yönetiminde Yapay Zekâ Yaklaşımlarına Genel Bakış)

3.2.1. Machine Learning (Makine Öğrenmesi)

Machine learning (ML) represents one of the most widely implemented AI approaches in project management, with applications spanning predictive analytics, pattern recognition, optimization, and classification tasks. ML algorithms are particularly valuable in project contexts where historical data can be leveraged to improve future performance and decision-making.

In the domain of project scheduling and duration prediction, Hsu et al. [8] demonstrated the application of recurrent neural networks (RNNs) to identify inter-project relationships and predict project success. Their research showed that neural network models could outperform traditional estimation techniques, achieving better improvement in accuracy when forecasting project durations. Similarly, Lishner and Shtub [9] applied artificial neural networks to enhance project duration predictions, finding that their approach could significantly reduce estimation errors compared to conventional methods, particularly for complex projects with multiple interdependencies.

Cost estimation represents another critical area where ML has demonstrated significant value.

Matel et al. [10] developed an artificial neural network approach for estimating the cost of engineering services, showing that their model could achieve high accuracy rates while reducing the time required for estimation. Ali and Burhan [11] evaluated extreme gradient boosting models for construction cost estimation, finding that this approach outperformed traditional parametric methods and could effectively account for complex non-linear relationships between project parameters and costs.

For project success prediction and risk assessment, Yeh and Chen [12] applied ML algorithms to predict the success of crowdfunding fintech projects, demonstrating that ML-based approaches could identify critical success factors that might be overlooked in conventional analysis. Their models achieved predictive accuracy rates when classifying projects as likely to succeed or fail. Natarajan [13] implemented reference class forecasting combined with ML techniques for improved offshore oil and gas megaproject planning, showing that this hybrid approach could reduce cost overruns compared to traditional estimation methods.

Despite these promising results, several challenges and limitations have been identified in ML applications for project management. Paleyes et al. [14] conducted a survey of case studies on deploying ML in various domains, including project management, highlighting challenges related to data quality, model interpretability, integration with existing workflows, and the need for specialized expertise. Furthermore, Blomster and Koivumäki [15] identified several resource, competency, and capability requirements for successful ML projects in digital marketing, emphasizing the importance of domain knowledge, data infrastructure, and organizational readiness.

3.2.2. Natural Language Processing (Doğal Dil İşleme)

Natural Language Processing (NLP) technologies have emerged as powerful tools for extracting insights from unstructured textual data in project management contexts. These applications span document analysis, communication pattern recognition, sentiment analysis, and automated reporting, offering significant efficiency improvements and new analytical capabilities.

In the domain of construction project management, Balasubramani et al. [16] demonstrated the application of NLP for requirements extraction and classification from project documents. Their research showed that NLP techniques could automate the identification of key requirements with accuracy rates, significantly reducing the time required for document analysis and minimizing human error. Similarly, Vasiliev and Goryachev [17] applied text mining technology to project management problems, showing that these techniques could extract valuable insights from meeting minutes, project reports, and stakeholder communications, enabling more informed decision-making.

Contract analysis represents another important application area for NLP in project management. Zhou et al. [18] developed an intelligent detection system for identifying missing clauses in construction project contracts based on deep learning and NLP. Their approach demonstrated an accuracy rate in identifying potential contractual gaps, providing an important risk mitigation tool for project managers. Likewise, Zhang et al. [19] applied NLP techniques to analyse contract complexity and its influence on construction project performance, finding that objective measurements derived through NLP analysis were more predictive of project outcomes than subjective assessments.

For stakeholder communication analysis, Manoj [20] implemented NLP techniques to analyze stakeholder feedback in project contexts, demonstrating that automated sentiment analysis could identify emerging concerns before they escalated into significant issues. The study showed that NLP-driven stakeholder analysis could improve stakeholder satisfaction rates through earlier identification and addressing of concerns.

Automated documentation and reporting represent additional valuable applications of NLP in project management. Hess and Kunz [21] explored the potential of ChatGPT as a project management assistant, showing that it could generate comprehensive project reports, meeting minutes, and status updates with minimal human input, freeing project managers to focus on more strategic activities. Their evaluation indicated that using NLP-powered assistants could reduce administrative documentation time.

While NLP offers significant benefits for project management, several limitations and challenges have been identified. Rane [22] discussed the potential role and challenges of ChatGPT and similar generative AI in architectural engineering, highlighting concerns related to accuracy, context understanding, security, and the need for human verification of AI-generated content. Additionally, research by Weng [23] on implementing generative AI tools in project management emphasized the importance of developing appropriate governance frameworks and validation processes to ensure the reliability and ethical use of NLP technologies in project contexts.

3.2.3. Fuzzy Logic Systems (Bulanık Mantık Sistemleri)

Fuzzy logic systems have emerged as particularly valuable tools for handling uncertainty, imprecision, and subjective judgments in project management contexts. These systems excel in modeling complex decision scenarios where traditional binary logic falls short, especially in risk assessment, multi-criteria decision-making, and performance evaluation.

In the domain of risk assessment, Plebankiewicz et al. [24] developed a fuzzy logic approach for modeling time, cost, and risk in construction projects. Their research demonstrated that fuzzy logic could effectively represent the inherent uncertainties in project parameters, leading to more realistic risk assessments and improved decision-making under uncertainty. The authors reported that their fuzzy approach provided a more nuanced understanding of risk factors compared to traditional probabilistic methods, particularly for factors that are difficult to quantify precisely.

For project extension and cost increase prediction, Senić et al. [25] implemented a Sugeno fuzzy logic model for predicting extensions of time and increasing contract prices in road infrastructure projects. Their model achieved prediction accuracy rates, outperforming traditional deterministic approaches by capturing the complex interrelationships between project variables and their impacts on timelines and costs.

In strategic management contexts, Ricardo et al. [26] applied compensatory fuzzy logic with single-valued neutrosophic numbers to analyze university strategic management, demonstrating that this approach could effectively model the complex interdependencies between strategic objectives and their implementation in project portfolios. The authors highlighted the ability of fuzzy systems to incorporate qualitative expert judgments alongside quantitative data, providing a more holistic approach to strategic project management.

Dudnyk and Sokolovska [27] explored the application of fuzzy expert systems in IT project management, focusing on decision support for complex, uncertain project environments. Their research showed that fuzzy systems could effectively support go/no-go decisions, resource allocation prioritization, and risk response planning by incorporating expert knowledge in a formalized but flexible framework. The authors noted that their approach was particularly valuable for novel projects where historical data was limited or not directly applicable.

Despite these advantages, fuzzy logic systems also face several challenges in project management applications. One significant limitation is the reliance on expert knowledge for defining membership functions and fuzzy rules, which can introduce subjectivity and variability into the models. Additionally, the computational complexity of fuzzy systems can increase rapidly as the number of input variables and rules grows, potentially limiting their applicability for very large-scale project management problems. Furthermore, integration with existing project management information systems often requires custom development, creating implementation barriers in some organizational contexts.

3.2.4. Expert Systems (Uzman Sistemler)

Expert systems represent a specialized branch of AI that captures and applies human expertise through knowledge-based systems, typically using rule-based reasoning. In project management contexts, expert systems have been applied to formalize decision-making processes, provide consistent guidance, and preserve organizational knowledge.

Kultin [28] explored the architecture and application of expert systems in innovation project management, demonstrating how these systems can support decision-making at critical project gates. The research highlighted that expert systems could effectively capture the tacit knowledge of experienced project managers and make it available to less experienced team members, promoting more consistent decision-making and knowledge transfer within organizations. The author reported that implementation of expert systems led to a reduction in decision time at project stage gates while maintaining or improving decision quality.

For contract management and regulatory compliance, expert systems have proven particularly valuable. While not explicitly developing an expert system, Shehadeh et al. [29] described an expert system for highway construction that optimized equipment management through multi-objective optimization. Their approach combined expert knowledge with optimization algorithms to improve resource utilization and compliance with regulatory requirements. The system demonstrated cost savings compared to traditional equipment management approaches while ensuring compliance with applicable regulations.

In the context of safety management, Go et al. [30] discussed moving towards automation and AI in managing HSE (Health, Safety, and Environment) risks and incidents. Their work highlighted how expert systems could formalize risk assessment protocols and incident response procedures, ensuring consistent application of best practices across projects. The authors noted that implementation of AI-driven expert systems for HSE management was associated with a reduction in safety incidents in the studied cases.

While expert systems offer significant benefits, they also face important limitations. One key challenge is the "knowledge acquisition bottleneck" – the difficulty and time-intensive nature of extracting and formalizing expert knowledge into rules and procedures that can be implemented in software systems. Additionally, expert systems typically lack the ability to learn and adapt from experience without explicit reprogramming, limiting their flexibility in dynamic project environments. Furthermore, as Rane [22] noted in the context of architectural engineering, expert systems may struggle with novel situations that fall outside their defined rule bases, potentially leading to suboptimal recommendations in unprecedented scenarios.

3.2.5. Hybrid and Integrated AI Approaches (Hibrit ve Bütünleşik Yapay Zekâ Yaklaşımları)

Hybrid and integrated AI approaches combine multiple AI techniques to leverage the strengths of each while mitigating their individual limitations. These approaches have gained significant traction in project management applications, offering more robust, flexible, and comprehensive solutions for complex project challenges.

In the domain of cost estimation, Ali and Burhan [11] developed a hybrid machine learning approach for construction cost estimation, integrating extreme gradient boosting with feature selection techniques. Their approach demonstrated superior performance compared to single-algorithm approaches, achieving accuracy improvements over the best-performing individual methods. The authors attributed these improvements to the complementary strengths of different algorithms in handling various aspects of the estimation problem.

In construction project management, Abbasianjahromi and Aghakarimi [31] implemented machine learning techniques for safety performance prediction and modification strategies, integrating predictive models with expert systems for recommendation generation. Their approach not only predicted safety incidents with high accuracy but also provided context-specific recommendations for improving safety performance based on project characteristics. The hybrid nature of their solution enabled both predictive insights and actionable guidance, addressing a common limitation of purely predictive AI approaches.

Decision support systems represent another area where hybrid approaches have demonstrated significant value. Choi et al. [32] developed the Engineering Machine-Learning Automation Platform (EMAP), a big-data-driven AI tool combining multiple AI techniques for contractors' sustainable management in plant projects. This platform integrated natural language processing for document analysis, machine learning for prediction, and rule-based systems for recommendation generation, providing comprehensive decision support across the project lifecycle.

Monshizada et al. [33] proposed a framework for developing AI systems in terms of People-Process-Data-Technology (2PDT), emphasizing the importance of integrating different AI approaches within a holistic organizational context. Their research highlighted that successful AI implementation in project management requires not only technical integration of multiple AI techniques but also alignment with organizational processes, data governance frameworks, and people-centered change management approaches.

While hybrid and integrated AI approaches offer significant advantages, they also introduce challenges related to increased complexity, integration requirements, and the need for multidisciplinary expertise spanning different AI domains. Additionally, as noted by Goyal et al. [34] in their discussion of automation in Project Management 4.0, hybrid approaches often require more substantial investments in infrastructure, data preparation, and system maintenance compared to single-technique implementations.

3.2.6. Generative AI Approaches (Üretken Yapay Zekâ Yaklaşımları)

Generative AI represents the most recent frontier in AI applications for project management, with technologies such as large language models (LLMs), generative adversarial networks (GANs), and transformer-based systems enabling new capabilities for content creation, scenario simulation, and intelligent assistance.

Elmas [4] explored the applications of generative artificial intelligence in project management, highlighting how generative models can transform traditional project documentation processes. The research demonstrated that generative AI could automate the creation of project charters, risk registers, communication plans, and status reports with high fidelity to organizational standards while reducing documentation time. The author emphasized that the value of generative AI extends beyond simple automation to enabling more comprehensive and consistent documentation across projects.

In the context of project planning and decision-making, Castellanos [35] investigated generative AI for dynamic risk scenario simulation in project management. The research showed that generative models could create realistic, multidimensional risk scenarios based on historical project data and expert inputs, enabling more thorough risk analysis and contingency planning. The author noted that generative approaches provided an increase in the number of identified risk scenarios compared to traditional methods, leading to more robust risk management strategies.

For project execution support, Weng [23] examined putting "intellectual robots" to work through implementing generative AI tools in project management. The study found that generative AI assistants could significantly enhance project team productivity by providing contextually relevant information, generating draft responses to stakeholder inquiries, and automating routine communication tasks. Teams using generative AI assistants reported productivity improvements for knowledge-intensive project tasks.

Barcaui and Monat [36] conducted a comparative study investigating whether generative artificial intelligence or project managers perform better in project planning. Their research demonstrated that while AI excelled at generating comprehensive and consistent plans based on input requirements, human project managers-maintained advantages in contextual understanding, stakeholder management, and adaptability to emergent conditions. The authors concluded that the optimal approach involved human-AI collaboration, with generative AI handling plan generation and humans providing refinement and contextual adaptation.

Felicetti et al. [37] proposed a vertical integration using OpenAI MyGPT for supporting project management, detailing how generative AI could be integrated across different project management functions. Their research highlighted the importance of appropriate prompting strategies, validation workflows, and integration with existing project management information systems to maximize the value of generative AI technologies in project contexts.

Despite their significant potential, generative AI approaches face several important limitations and challenges. Rane [22] examined the role and challenges of ChatGPT and similar generative AI in business management, highlighting concerns related to hallucinations (fabricated information), limited reasoning capabilities, contextual misunderstandings, and ethical considerations around transparency and attribution. Additionally, Hess and Kunz [21] emphasized the importance of establishing appropriate verification processes and governance frameworks when implementing ChatGPT as a project management assistant, noting that uncritical acceptance of AI-generated content could propagate errors and misleading information.

It is important to distinguish generative AI from the other AI categories examined in this review. Machine learning approaches—including neural networks and gradient boosting models—are primarily designed to classify, predict, or optimize outcomes based on patterns identified in structured historical data. Natural language processing focuses on extracting meaning and structure from existing textual content. Fuzzy logic systems formalize expert reasoning under conditions of uncertainty, while expert systems encode domain knowledge into rule-based decision frameworks. Hybrid approaches combine these techniques to address more complex problem configurations.

Generative AI, by contrast, is distinguished by its capacity to produce new content—including textual documents, risk scenarios, project plans, and stakeholder communications—rather than solely analysing or classifying existing data. This generative capability enables applications that are qualitatively different from those supported by other AI categories, such as automated project charter drafting, dynamic scenario simulation, and conversational project assistance. Accordingly, generative AI does not replace the other AI approaches reviewed here but rather extends the functional scope of AI in project management by addressing tasks that are creative, communicative, or exploratory in nature. The integration of generative AI into the analytical framework of this review reflects this distinct functional contribution.

4. AI APPLICATIONS IN PROJECT PERFORMANCE DOMAINS (PROJE PERFORMANS ALANLARINDA YAPAY ZEKÂ UYGULAMALARI)

4.1. Planning Performance Domain (Planlama Performans Alanı)

4.1.1. Project Scheduling (Proje Takvimi Oluşturma)

AI technologies have significantly transformed project scheduling practices, offering enhanced accuracy, optimization capabilities, and adaptability that surpass traditional scheduling methods. Machine learning algorithms, in particular, have demonstrated considerable value in predicting task durations, identifying dependencies, and optimizing schedule configurations.

For schedule optimization, Hamada et al. [38] developed a neural network estimation model to optimize timing and scheduling of software projects. Their research showed that neural network-based approaches could identify non-obvious task sequencing opportunities, reducing critical path length compared to conventionally developed schedules. The model was particularly effective at balancing resource constraints while minimizing overall project duration, addressing a common challenge in manual scheduling processes.

In construction project contexts, ul Hassan et al. [39] implemented machine learning combined with fuzzy Failure Mode and Effects Analysis (FMEA) for automated prioritization of project requirements. This approach enabled more effective scheduling of construction activities based on both technical dependencies and risk-based priorities. The authors reported that their AI-driven prioritization approach led to more resilient project schedules fewer disruptions during execution compared to conventionally prioritized schedules.

Generative AI approaches have also begun to influence project scheduling practices. Elmas [4] described how generative models can create multiple schedule scenarios based on different constraint assumptions, enabling more comprehensive schedule risk analysis and contingency planning. This capability allows project teams to explore a wider range of potential execution paths and develop more robust scheduling strategies that account for uncertainty and variability.

Despite these advances, several challenges remain in AI-based project scheduling. Lishner and Shtub [9] noted that while artificial neural networks can improve prediction of project duration, their effectiveness depends heavily on the quality and relevance of historical data used for training. Additionally, Akinyokun et al. [40] highlighted the importance of integrating domain expertise with AI algorithms for project planning, arguing that purely data-driven approaches may miss important contextual factors that influence schedule feasibility and risk.

4.1.2. Resource Allocation (Kaynak Atama)

AI applications have transformed resource allocation in project management by enabling more sophisticated matching of resources to tasks, dynamic reallocation in response to changing conditions, and optimization across multiple competing priorities.

For dynamic resource reallocation during project execution, Mohammed et al. [41] developed a Smart Project Management System (SPMS) that incorporated AI-driven resource optimization. This system continuously monitored project performance and resource utilization, automatically identifying reallocation opportunities to address emerging bottlenecks or take advantage of a head-of-schedule situations. The authors reported that implementation of this system in oil and gas client projects resulted in an improvement in resource utilization and a reduction in idle resource time.

In construction equipment management, Shehadeh et al. [29] implemented an expert system using enhanced particle swarm optimization for optimal equipment allocation. Their multi-objective approach balanced equipment utilization, cost minimization, and schedule optimization, demonstrating cost savings compared to traditional allocation methods. The system's ability to consider multiple competing objectives simultaneously represented a significant advancement over single-criterion optimization approaches.

AI has also enhanced human resource allocation through improved matching of team member skills and project requirements. Gordon and Moore [42] investigated the effects of AI-enabled personality assessments during team formation on team cohesion. Their research demonstrated that AI-driven team composition could increase team cohesion scores and reduce interpersonal conflicts compared to traditional team formation approaches. This improvement was attributed to the AI system's ability to identify complementary personality traits and work styles beyond simple skill matching.

While AI offers significant benefits for resource allocation, several limitations have been identified. Khan and Siddiqui [43] discussed issues in implementing AI in project management in Pakistan, highlighting challenges related to data availability, organizational resistance, and the need for contextual adaptation of AI resource allocation models to local work practices and cultural factors. Additionally, Goyal et al. [34] noted that effective AI-driven resource allocation requires substantial organizational maturity in data collection and process standardization, creating implementation barriers for organizations with less developed project management capabilities.

4.1.3. Cost Estimation (Maliyet Tahmini)

AI has revolutionized cost estimation in project management by introducing more accurate predictive models, incorporating a wider range of variables, and enabling dynamic updates as project conditions evolve.

Matel et al. [8] developed an artificial neural network approach for cost estimation of engineering services, demonstrating significant improvements in both accuracy and efficiency compared to traditional parametric estimation methods. The authors attributed these improvements to the neural network's ability to capture complex, non-linear relationships between project characteristics and costs that are difficult to model using conventional approaches.

For construction cost estimation, Ali and Burhan [11] evaluated a hybrid machine learning approach using extreme gradient boosting models. The authors highlighted that their machine learning model could effectively incorporate both quantitative factors (e.g., material quantities, labor rates) and qualitative considerations (e.g., site conditions, market volatility) into a unified estimation framework.

In software development contexts, Yurttakal [44] developed a man-hour estimation model for BIM-based projects using machine learning regression algorithms. This approach demonstrated an improvement in estimation accuracy compared to conventional expert-based approaches, with particularly strong performance for complex, multi-disciplinary BIM implementation projects. The model's ability to learn from past projects and continuously improve its estimates represented a significant advantage over static estimation methods.

The integration of AI with Building Information Modeling (BIM) has further enhanced cost estimation capabilities. Hegazy and Zhang [45] explored artificial intelligence applications for enhanced decision-making in construction, including cost estimation based on BIM data. Their research showed that combining machine learning with structured BIM data could reduce estimation errors compared to traditional quantity take-off methods, while significantly accelerating the estimation process.

4.2. Measurement Performance Domain (Ölçüm Performans Alanı)

4.2.1. Earned Value Management (Kazanılmış Değer Yönetimi)

AI has significantly enhanced Earned Value Management (EVM) practices by automating data collection, improving forecast accuracy, and providing early warning signals for potential performance deviations.

For automated EVM data collection and reporting, Mohammed et al. [41] developed a Smart Project Management System (SPMS) for oil and gas client projects. This system integrated AI capabilities to automatically extract performance data from various project systems, calculate EVM metrics, and generate customized reports without manual intervention. The authors reported that this automation reduced EVM reporting effort while increasing reporting frequency from monthly to weekly cycles, enabling more responsive performance management.

In the context of early warning systems, Santos et al. [46] explored explainable machine learning for project management control, focusing on EVM anomaly detection. Their approach could identify subtle patterns in EVM data that signalled future performance problems, providing warnings 2-3 weeks earlier than conventional threshold-based approaches. The explainable nature of their models enabled project managers to understand the specific factors contributing to predicted performance issues, facilitating more targeted corrective actions.

Choi et al. [32] the Engineering Machine-Learning Automation Platform (EMAP) for sustainable management solutions in plant projects, incorporating AI-driven EVM capabilities. This platform not only automated EVM calculations but also provided context-aware interpretations of EVM trends, recommending specific actions based on performance patterns. The authors noted that this intelligent EVM approach helped project teams focus on the most critical performance issues rather than being overwhelmed by raw EVM data.

While AI offers significant benefits for EVM, several limitations have been identified. Taboada et al. [47] conducted a systematic literature review of AI-enabled project management, noting that effective AI implementation for EVM requires substantial historical performance data and standardized measurement processes, potentially limiting applicability in organizations with less mature project management practices. Additionally, Uddin et al. [48] highlighted challenges related to data integration across different project systems, noting that inconsistent data definitions and collection methods can undermine the effectiveness of AI-driven EVM applications.

4.2.2. Performance Prediction (Performans Tahmini)

AI has transformed performance prediction in project management by enabling more accurate forecasts of outcomes, earlier identification of potential issues, and more nuanced understanding of performance drivers.

Yeh and Chen [12] applied machine learning algorithms to predict the success of crowdfunding fintech projects, demonstrating that AI-based approaches could identify subtle patterns and relationships that traditional analysis might miss. Their models achieved predictive accuracy rates when classifying projects as likely to succeed or fail, significantly outperforming conventional scoring methods. The authors highlighted that machine learning models could effectively incorporate both quantitative metrics and qualitative factors extracted from project descriptions and communications.

For construction project performance prediction, Zhang et al. [19] compared subjective and objective measurements of contract complexity in influencing performance, using machine learning to analyse contract documents. Their research showed that AI-based objective measurements of complexity were more strongly correlated with project outcomes than subjective expert assessments. This finding suggests that AI can identify subtle structural and linguistic patterns in project documentation that have significant performance implications but may not be apparent to human reviewers.

In software development contexts, Hamada et al. [38] developed a neural network estimation model for optimizing timing and schedule of software projects. Their approach not only predicted development timelines but also identified factors most likely to influence performance deviations. The model demonstrated the ability to predict schedule overruns with more accuracy based on project characteristics and early performance indicators, enabling proactive management interventions.

For long-term performance prediction, Hsu et al. [8] implemented recurrent neural networks to identify inter-project relationships and predict project success. This approach recognized that performance in current projects is often influenced by experiences and outcomes from previous related projects, a pattern that is difficult to capture with traditional prediction methods. The authors reported that their neural network approach improved prediction accuracy compared to conventional methods that treat each project as an independent entity.

Despite these advances, several challenges remain in AI-based performance prediction. Paleyes et al. [14] conducted a survey of case studies on deploying machine learning, identifying significant challenges related to concept drift – the tendency for predictive relationships to change over time as project contexts evolve. This issue is particularly relevant for long-duration projects where conditions at completion may differ substantially from those at initiation. Additionally, Santos et al. [46] emphasized the importance of explainability in performance prediction models, noting that project managers often require not just accurate predictions but also clear understanding of the factors driving those predictions to formulate effective responses.

4.2.3. Key Performance Indicator Analysis (Temel Performans Gösterge Analizi)

AI has enhanced Key Performance Indicator (KPI) analysis in project management by enabling more sophisticated pattern recognition, integration of diverse data sources, and identification of non-obvious relationships between performance metrics.

Santos et al. [46] explored explainable machine learning for project management control, demonstrating how AI could analyse relationships between different KPIs to identify leading indicators of performance changes. Their approach could detect subtle patterns in KPI data that preceded significant performance deviations by 2-3 weeks, providing valuable early warning capabilities. Importantly, their explainable AI approach made these patterns interpretable to project managers, facilitating targeted interventions.

For comprehensive performance dashboards, Mohammed et al. [41] developed a Smart Project Management System (SPMS) that employed AI for KPI analysis and visualization. This system automatically identified unusual patterns in KPI data, highlighted potential correlations between different performance domains, and generated contextual interpretations of KPI trends. The authors reported that this intelligent KPI analysis helped project teams identify root causes of performance issues faster than traditional manual analysis approaches.

In construction project contexts, Waqar [49] explored intelligent decision support systems using AI and machine learning approaches. The research demonstrated how AI could integrate KPIs across multiple project dimensions (schedule, cost, quality, safety) to provide a more holistic performance assessment than traditional siloed approaches. The system could identify compensating behaviors where improvements in one performance domain were achieved at the expense of another, providing a more balanced view of overall project health.

Rasmuss and Tømte [50] investigated artificial intelligence as a tool for project decision-making support, focusing on KPI interpretation and forecasting. Their research showed that AI could not only analyse current KPI values but also predict future trends based on pattern recognition and causal analysis. This predictive capability enabled project teams to respond to emerging performance issues before they manifested in traditional lagging indicators, improving overall project outcomes.

While AI offers significant advantages for KPI analysis, several limitations have been identified. Zhou et al. [18] noted that machine learning approaches to KPI analysis require substantial historical data to establish reliable patterns, potentially limiting their effectiveness for novel project types or organizations with limited performance history. Additionally, Uddin et al. [48] highlighted challenges related to KPI definition consistency, noting that variations in how organizations define and measure key performance indicators can undermine the transferability of AI models across different project contexts.

4.3. Uncertainty Performance Domain (Belirsizlik Performans Alanı)

4.3.1. Risk Identification (Risk Tanımlama)

AI has transformed risk identification in project management by enabling more comprehensive scanning of potential risk sources, earlier detection of emerging risks, and identification of non-obvious risk factors that might be overlooked in traditional approaches.

For stakeholder-related risk identification, Manoj [20] implemented NLP techniques to analyze stakeholder feedback and identify potential risk signals. This approach could detect subtle indicators of stakeholder concerns or resistance in communication patterns before they manifested as explicit project issues. The author reported that automated stakeholder feedback analysis identified emergent risks on average 3-4 weeks earlier than traditional stakeholder management approaches, providing valuable additional response time.

In construction projects, Abbasianjahromi and Aghakarimi [31] applied machine learning techniques for safety performance prediction, demonstrating how AI could identify safety risk factors based on project characteristics and early execution patterns. Their models achieved more accuracy in predicting safety incidents, enabling proactive risk mitigation before accidents occurred. The authors highlighted that their machine learning approach identified several non-obvious risk factors that were not included in standard safety checklists but showed strong predictive relationships with safety outcomes.

Generative AI approaches have also begun to influence risk identification practices. Castellanos [35] investigated generative AI for dynamic risk scenario simulation, showing how these technologies could create comprehensive risk scenarios that accounted for complex interactions between different risk factors. This approach generated an increase in the number of identified risk scenarios compared to traditional methods, enabling more thorough risk planning and mitigation strategies.

Despite these advances, several challenges remain in AI-based risk identification. Ricardo et al. [26] noted that effective risk identification requires balancing computational pattern recognition with human judgment and contextual understanding, arguing for hybrid approaches that combine AI capabilities with expert input. Additionally, Bushuyev et al. [2] highlighted potential blind spots in AI risk identification, particularly for novel or unprecedented risks that are not represented in historical data used to train AI models.

4.3.2. Risk Assessment (Risk Değerlendirmesi)

AI has enhanced risk assessment in project management by providing more nuanced evaluation of probability and impact, accounting for uncertainty and subjective judgments, and enabling more sophisticated analysis of risk interactions and cumulative effects.

Plebankiewicz et al. [24] developed a fuzzy logic approach for modeling time, cost, and risk in construction, demonstrating how this AI technique could effectively represent the inherent uncertainties in risk assessment. Their fuzzy approach provided a more realistic representation of risk factors compared to traditional binary or three-point estimates, particularly for factors that are difficult to quantify precisely. The authors reported that their fuzzy risk assessment approach led to more appropriate contingency allocations, reducing both overallocation and underallocation of reserves compared to conventional methods.

For predicting time extensions and cost increases, Senić et al. [25] implemented a Sugeno fuzzy logic model for road infrastructure projects. Their model achieved prediction accuracy rates, outperforming traditional deterministic approaches by capturing the complex interrelationships between risk factors and their combined effects on project outcomes. The model was particularly effective at identifying high-risk project configurations where multiple moderate risk factors created significant cumulative risk through their interactions.

Dudnyk and Sokolovska [27] explored fuzzy expert systems in IT project management, focusing on risk assessment under uncertainty. Their approach combined fuzzy logic with expert knowledge to create a more robust risk assessment framework that could account for both quantitative data and qualitative judgments. The authors noted that their fuzzy expert system approach was especially valuable for novel project types where historical risk data was limited but expert judgment was available.

In offshore oil and gas contexts, Natarajan [13] implemented reference class forecasting combined with machine learning for improved megaproject planning, focusing on risk-adjusted estimates. This hybrid approach used machine learning to identify appropriate reference classes for risk assessment and then applied probabilistic methods to develop risk-adjusted forecasts. The author reported that this approach reduced cost overruns compared to traditional estimation methods by providing more realistic assessments of risk exposure.

4.3.3. Risk Response Planning (Risk Yanıt Planlaması)

AI has transformed risk response planning in project management by enabling more targeted mitigation strategies, dynamic adaptation to changing risk profiles, and optimization of response resource allocation.

For dynamic risk response planning, Mohammed et al. [41] implemented a Smart Project Management System (SPMS) with AI-driven risk monitoring and response adaptation capabilities. This system continuously assessed risk status during project execution, automatically adjusting response plans based on changing risk profiles and emerging information. The authors noted that this dynamic approach to risk response resulted in more efficient use of risk mitigation resources, with a reduction in overall response costs while maintaining or improving risk management effectiveness.

Generative AI approaches have also begun to influence risk response planning. Castellanos [35] investigated generative AI for dynamic risk scenario simulation, demonstrating how these technologies could create and evaluate multiple response strategies across different risk scenarios. This capability enabled more comprehensive contingency planning and response optimization, particularly for complex risk situations with multiple interacting factors. The author reported that generative AI-enhanced response planning identified more robust mitigation strategies that performed well across a wider range of potential risk scenarios.

In safety risk management, Go et al. [30] discussed moving towards automation and AI in managing HSE risks and incidents. Their research showed how AI could develop tailored response plans for different safety risk scenarios, accounting for specific project conditions, available resources, and regulatory requirements. The authors noted that implementation of AI-driven safety response planning was associated with a reduction in safety incidents in the studied cases, attributed to more comprehensive and context-appropriate mitigation measures.

Despite these advances, several challenges remain in AI-based risk response planning. Khan and

Siddiqui [43] identified issues in implementing AI in project management in Pakistan, highlighting challenges related to organizational readiness, trust in AI recommendations, and alignment with existing risk management processes. Additionally, Miller [51] discussed artificial intelligence project success factors beyond ethical principles, emphasizing the importance of transparent AI decision-making processes in risk management to build stakeholder confidence in AI-generated response plans.

4.4. Team Performance Domain (Takım Performans Alanı)

4.4.1. Team Composition (Takım Yapısı)

AI has revolutionized team composition in project management by enabling more sophisticated matching of skills and project requirements, consideration of interpersonal dynamics, and optimization of team diversity and complementarity.

Gordon and Moore [42] investigated the effects of AI-enabled personality assessments during team formation on team cohesion. Their research demonstrated that AI-driven team composition could increase team cohesion scores and reduce interpersonal conflicts compared to traditional team formation approaches. This improvement was attributed to the AI system's ability to identify complementary personality traits and work styles that fostered effective collaboration while minimizing disruptive conflicts.

In agile development contexts, Hoda et al. [52] examined augmented agile approaches using human-centred AI-assisted software management. Their research showed how AI could enhance team formation by analysing development patterns and collaboration histories to recommend optimal pairing and sub team structures. The authors found that AI-assisted team composition led to more balanced workload distribution, improved knowledge sharing, and faster onboarding of new team members compared to traditional agile team formation practices.

Generative AI approaches have also begun to influence team composition strategies. Weng [23] explored implementing generative AI tools in project management, showing how these technologies could generate team configuration recommendations based on project requirements and available resource profiles. This capability enabled project managers to rapidly evaluate multiple team composition scenarios and select optimal arrangements for specific project contexts.

While AI offers significant benefits for team composition, several limitations have been identified. Khan and Siddiqui [43] discussed issues in implementing AI in project management in Pakistan, highlighting cultural and contextual factors that influence team dynamics but may not be adequately captured in AI models developed in different organizational contexts. Additionally, Elmas and Babayev [1] emphasized that while AI can support team composition decisions, human judgment remains essential for evaluating subtle interpersonal factors and organizational politics that may affect team performance but are difficult to quantify in AI models.

4.4.2. Team Development (Takım Geliştirme)

AI has enhanced team development in project management by providing personalized learning recommendations, facilitating knowledge sharing, and supporting continuous improvement of team capabilities and dynamics.

Hoda et al. [52] examined augmented agile approaches using human-centered AI-assisted software management, demonstrating how AI could analyze individual and team performance patterns to identify specific skill development needs. Their research showed that AI-driven learning recommendations were more likely to be adopted by team members compared to generic training programs, leading to more rapid skill development and team capability enhancement.

For team knowledge management, Bainey [53] explored AI-driven project management approaches, showing how AI tools could facilitate more effective knowledge capture, organization, and retrieval. These capabilities enabled teams to build on past experiences more effectively and avoid repeating previous mistakes. The author reported that teams using AI-enhanced knowledge management systems resolved technical challenges faster than those relying on traditional documentation approaches, due to more efficient access to relevant prior knowledge.

In virtual team contexts, Daniel [54] investigated using AI advisors to maximize workfront availability and reduce project delivery time. The research demonstrated how AI could monitor team interaction patterns and recommend communication improvements and collaboration strategies tailored to specific team compositions and project requirements. The author found that teams receiving AI-generated collaboration recommendations showed significant improvements in communication effectiveness and conflict resolution compared to control groups without AI support.

For continuous team improvement, Elmas [4] explored applications of generative artificial intelligence in project management, highlighting how AI could analyse team retrospectives and performance data to identify specific improvement opportunities. This approach provided more objective and comprehensive assessment of team dynamics than traditional self-evaluation methods, leading to more effective improvement initiatives. The author noted that teams using AI-supported improvement processes showed greater performance gains over time compared to teams using conventional retrospective approaches.

Despite these advances, several challenges remain in AI-supported team development. Miller [51] discussed artificial intelligence project success factors beyond ethical principles, highlighting concerns about privacy and surveillance perceptions when AI systems monitor team interactions for development purposes. Additionally, Pourmojahed and Rahat [5] emphasized the importance of transparency in AI-based team assessment and development recommendations to build trust and acceptance among team members.

4.4.3. Performance Monitoring (Performans İzleme)

AI has transformed team performance monitoring in project management by enabling more comprehensive data collection, real-time analysis of performance patterns, and early identification of potential issues before they impact project outcomes.

Bainey [53] explored AI-driven project management approaches, demonstrating how AI dashboards could integrate multiple performance indicators to provide holistic team performance assessment. These systems could identify subtle patterns and correlations that might be missed in traditional siloed monitoring approaches. The author reported that AI-enhanced performance monitoring identified team productivity issues on average 2-3 weeks earlier than conventional methods, providing valuable additional time for intervention and correction.

For collaboration quality assessment, Hoda et al. [52] examined augmented agile approaches using human-centred AI-assisted software management. Their research showed how AI could analyse team communication patterns, code review interactions, and knowledge sharing behaviors to evaluate collaboration effectiveness beyond simple productivity metrics. The authors found that teams receiving AI-generated collaboration insights improved their performance significantly faster than control groups, particularly in areas related to cross-functional cooperation and knowledge integration.

In complex project environments, Mohammed et al. [41] implemented a Smart Project Management System (SPMS) with AI-driven team performance monitoring capabilities. This system continuously assessed individual and team productivity, work quality, and collaboration effectiveness, automatically identifying potential performance issues and their root causes. The authors noted that this proactive monitoring approach reduced performance-related project delays compared to traditional milestone-based assessment methods.

For remote and distributed teams, Daniel [54] investigated using AI advisors to maximize workfront availability and reduce project delivery time. The research demonstrated how AI could monitor distributed team activities and identify coordination gaps and communication breakdowns that often plague remote collaboration. The author found that AI-monitored distributed teams-maintained productivity levels much closer to co-located equivalents compared to remote teams without AI performance monitoring.

While AI offers significant advantages for team performance monitoring, several limitations have been identified. Khan and Siddiqui [43] discussed issues in implementing AI in project management in Pakistan, highlighting concerns about cultural differences in performance expectations and work patterns that might not be adequately accounted for in AI monitoring systems. Additionally, Miller [51] emphasized the importance of ethical considerations in AI-based performance monitoring, particularly regarding transparency, consent, and avoiding excessive surveillance that could undermine team morale and autonomy.

4.5. Stakeholder Performance Domain (Paydaş Performans Alanı)

4.5.1. Stakeholder Identification and Analysis (Paydaşların Belirlenmesi ve Analizi)

AI has enhanced stakeholder identification and analysis in project management by enabling more comprehensive stakeholder discovery, nuanced understanding of stakeholder characteristics, and dynamic tracking of stakeholder evolution throughout project lifecycles.

Manoj [20] implemented AI techniques to analyse stakeholder feedback, demonstrating how natural language processing could identify implicit stakeholder groups and their concerns that might not be apparent through traditional stakeholder analysis methods. Their approach identified more relevant stakeholder groups compared to conventional identification techniques, particularly for indirect stakeholders who might not actively engage with the project but could significantly influence its success.

For stakeholder influence mapping, Bushuyev et al. [2] explored strategic project management development under the influence of artificial intelligence, showing how network analysis algorithms could map complex stakeholder relationship patterns and power structures. This approach provided more accurate identification of key influencers and decision-makers compared to traditional stakeholder matrices, enabling more effective engagement strategies. The authors reported that AI-enhanced stakeholder analysis led to higher stakeholder satisfaction rates compared to projects using conventional analysis approaches.

In complex multi-stakeholder environments, Hawsawi [55] investigated the impact of applying digital transformation techniques on project management quality, including AI-enhanced stakeholder analysis. The research demonstrated how AI could process large volumes of stakeholder data from diverse sources to create more comprehensive stakeholder profiles and identify underlying patterns in stakeholder needs and expectations. The author found that projects employing AI-driven stakeholder analysis experienced fewer stakeholder-related disruptions compared to traditionally managed projects.

For dynamic stakeholder tracking, Mohammed et al. [41] implemented a Smart Project Management System (SPMS) with continuous stakeholder monitoring capabilities. This system analyzed stakeholder communications, decisions, and engagement patterns to identify shifts in stakeholder positions or emerging concerns in real-time, enabling more responsive stakeholder management. The authors noted that this dynamic approach to stakeholder analysis was particularly valuable in complex political environments where stakeholder positions frequently evolved throughout the project lifecycle.

Despite these advances, several challenges remain in AI-based stakeholder analysis. Pourmojahed and Rahat [5] highlighted limitations related to data privacy and ethical considerations when collecting and analysing stakeholder data without explicit consent, emphasizing the need for transparent data governance frameworks. Additionally, Miller [51] noted that AI stakeholder analysis systems might miss subtle cultural and contextual factors that influence stakeholder behaviour, arguing for hybrid approaches that combine AI capabilities with human insight and cultural intelligence.

4.5.2. Stakeholder Engagement (Paydaş Katılımı)

AI has transformed stakeholder engagement in project management by enabling more personalized communication approaches, automated engagement tracking, and predictive insights about stakeholder responses to project developments.

Manoj [20] explored using AI for analysing stakeholder feedback, demonstrating how natural language processing could identify specific stakeholder concerns and sentiments from unstructured communications. This capability enabled more targeted and responsive engagement strategies addressing the actual priorities of different stakeholder groups. The author reported that AI-informed engagement approaches increased stakeholder satisfaction scores compared to generic engagement methods, particularly for complex projects with diverse stakeholder communities.

For automated engagement support, Hess and Kunz [21] investigated ChatGPT as a project management assistant, showing how generative AI could draft personalized stakeholder communications, prepare briefing materials tailored to specific stakeholder interests, and suggest optimal timing for engagement activities. Their research found that project managers using AI assistance for stakeholder engagement could maintain effective communication with more stakeholders compared to those using traditional approaches, significantly expanding their engagement capacity.

In large infrastructure projects, Hegazy and Zhang [45] explored artificial intelligence for enhanced decision-making in construction, including stakeholder engagement applications. Their research demonstrated how AI could analyse stakeholder feedback patterns to identify the most effective communication channels, messaging approaches, and engagement formats for different stakeholder segments. The authors noted that AI-optimized engagement strategies resulted in higher stakeholder participation rates and more constructive feedback compared to conventionally designed approaches.

For predictive stakeholder engagement, Weng [23] examined implementing generative AI tools in project management, showing how these technologies could simulate stakeholder responses to potential project decisions or communications before actual implementation. This capability enabled project teams to test different engagement approaches and refine their strategies based on predicted stakeholder reactions. The author found that teams using AI-based stakeholder response simulation experienced fewer stakeholder conflicts compared to teams using traditional engagement planning methods.

While AI offers significant benefits for stakeholder engagement, several limitations have been identified. Rane [22] discussed potential challenges of ChatGPT and similar generative AI in business management, highlighting risks associated with over-reliance on AI-generated communications that might lack authentic human connection essential for building stakeholder trust. Additionally, Khan and Siddiqui [43] emphasized the importance of cultural sensitivity in stakeholder engagement, noting that AI systems trained predominantly on Western communication patterns might not adequately account for cultural differences in communication expectations and relationship building approaches.

4.5.3. Communication Analysis (İletişim Analizi)

AI has enhanced communication analysis in project management by enabling more sophisticated pattern recognition in communication data, sentiment tracking across stakeholder groups, and identification of emerging issues from communication signals.

Vasiliev and Goryachev [17] applied text mining technology to solve project management problems, demonstrating how NLP techniques could analyze meeting minutes, project reports, and stakeholder communications to identify important themes, concerns, and decision patterns. Their approach detected subtle communication patterns that indicated potential misalignments or misunderstandings among project stakeholders before these developed into explicit conflicts. The authors reported that NLP-based communication analysis identified potential issues on average 3 weeks earlier than traditional communication management approaches.

For sentiment analysis in stakeholder communications, Manoj [20] implemented AI techniques to analyze stakeholder feedback, showing how these tools could track sentiment trends across different stakeholder groups throughout the project lifecycle. This capability enabled project teams to identify emerging satisfaction or dissatisfaction patterns and respond proactively before they affected project support. The author found that projects using AI-based sentiment tracking experienced fewer escalated stakeholder complaints compared to those using traditional feedback mechanisms.

In complex stakeholder environments, Balasubramani et al. [16] explored construction project management using natural language processing technology, focusing on analysing contract-related communications and documentation. Their research demonstrated how NLP could identify potential misinterpretations or ambiguities in project communications that might lead to contractual disputes. The authors noted that early identification of communication issues through AI analysis reduced contract-related disputes compared to conventionally managed projects.

For communication effectiveness assessment, Hoda et al. [52] examined augmented agile approaches using human-centered AI-assisted software management. Their research showed how AI could analyse team and stakeholder communication patterns to evaluate information flow effectiveness, message clarity, and engagement levels. The authors found that teams receiving AI-generated communication insights improved their communication effectiveness significantly faster than control groups, particularly in areas related to technical information sharing and cross-functional coordination.

While AI offers significant advantages for communication analysis, several limitations have been identified. Rane [22] discussed the potential role and challenges of ChatGPT and similar generative AI in architectural engineering, highlighting the importance of context understanding in communication analysis and the current limitations of AI in fully grasping complex project contexts. Additionally, Pourmojahed and Rahat [5] emphasized privacy considerations in communication analysis, noting that comprehensive monitoring of project communications raises important ethical questions about surveillance and confidentiality that must be addressed through appropriate governance frameworks.

4.6. Development Approach and Life Cycle Performance Domain (Geliştirme Yaklaşımı ve Yaşam Döngüsü Performans Alanı)

4.6.1. Methodology Selection (Yöntem Seçimi)

AI has transformed methodology selection in project management by enabling more data-driven decision-making about appropriate approaches, customization of methodologies to specific project characteristics, and optimization of hybrid methodology configurations.

Najdawi and Shaheen [56] investigated which project management methodology is better for AI transformation and innovation projects, demonstrating how machine learning algorithms could analyse project characteristics to recommend optimal methodological approaches. Their research showed that AI-based methodology recommendations matched expert choices of cases while requiring significantly less analysis time. The authors highlighted that their approach was particularly valuable for organizations with limited methodology selection experience or those facing novel project types.

For predictive methodology selection, Kraiem et al. [57] conducted a comparative study of machine learning algorithms for predicting project management methodology, developing models that could recommend appropriate methodologies based on project characteristics, organizational context, and success criteria. The authors noted that their machine learning models identified several non-obvious relationships between project attributes and methodology suitability that were not captured in conventional selection frameworks.

In adaptive methodology contexts, Taboada et al. [47] conducted a systematic literature review of artificial intelligence enabled project management, identifying how AI could support dynamic methodology adaptation throughout the project lifecycle. Their synthesis showed that AI systems could monitor project performance and environmental conditions, recommending methodology adjustments as circumstances evolved. This capability was particularly valuable for long-duration projects where initial methodology choices might become suboptimal as conditions changed.

For customized methodology development, Monshizada et al. [33] proposed a framework for developing AI systems in terms of People-Process-Data-Technology (2PDT), emphasizing how AI could facilitate the creation of tailored methodological approaches that combined elements from different standard methodologies. Their research demonstrated that AI-assisted methodology customization could improve project outcomes compared to strict adherence to standard methodologies, by optimizing the approach to specific project contexts.

Despite these advances, several challenges remain in AI-based methodology selection. Yeluri [58] discussed how improvement in AI helps in synchronizing project management functions, noting that effective methodology selection requires consideration of organizational culture and readiness factors that may not be fully captured in available data. Additionally, Lwakatare et al. [59] highlighted challenges related to data quality and completeness when training AI models for methodology selection, emphasizing the importance of comprehensive historical project data with reliable outcome measurements.

4.6.2. Adaptive Methodologies (Uyarlanabilir Yöntemler)

AI has enhanced adaptive methodologies in project management by enabling more responsive adaptation to changing conditions, data-driven adjustment of methodological elements, and optimization of hybrid approaches that combine elements from different methodological frameworks.

Hoda et al. [52] examined augmented agile approaches using human-centred AI-assisted software management, demonstrating how AI could monitor project progress and team performance to recommend specific agile practice adjustments. Their research showed that AI-augmented agile teams were able to identify and implement appropriate process adaptations faster than conventional agile teams, leading to more responsive methodology evolution. The authors emphasized that this approach maintained the human-centred nature of agile while enhancing it with data-driven insights for adaptation.

For hybrid methodology optimization, Goyal et al. [34] explored automation in Project Management 4.0 with artificial intelligence, showing how AI could analyse project characteristics and performance data to recommend optimal combinations of traditional and agile methodological elements. Their approach created tailored hybrid methodologies that outperformed both pure traditional and pure agile approaches for complex projects with mixed characteristics. The authors reported that AI-optimized hybrid methodologies reduced project delivery time compared to standard methodological approaches.

In construction project contexts, ul Hassan et al. [39] implemented machine learning combined with fuzzy Failure Mode and Effects Analysis (FMEA) for prioritizing project requirements and adapting delivery approaches accordingly. This methodology dynamically adjusted based on emerging risks and priorities, creating a more responsive project delivery framework. The authors found that their adaptive approach led to fewer disruptions during execution compared to projects using fixed methodological approaches.

For continuous methodology improvement, Bushuyev et al. [2] explored strategic project management development under the influence of artificial intelligence, demonstrating how AI could analyse methodology effectiveness across multiple projects to identify improvement opportunities and optimization patterns. This capability enabled organizations to evolve their methodological approaches based on empirical performance data rather than theoretical considerations alone. The authors noted that organizations implementing AI-driven methodology evolution showed greater performance improvements over time compared to those using conventional process improvement approaches.

While AI offers significant benefits for adaptive methodologies, several limitations have been identified. Lanubile et al. [60] discussed training future machine learning engineers through a project-based course on MLOps, highlighting the importance of human judgment in methodology adaptation decisions and the risks of over-reliance on algorithmic recommendations without contextual understanding. Additionally, Akinyokun et al. [40] emphasized that effective methodology adaptation requires balancing data-driven insights with tacit knowledge and experience that may not be fully captured in project performance metrics.

4.7. Delivery Performance Domain (Teslimat Performans Alanı)

4.7.1. Quality Assurance (Kalite Güvencesi)

AI has transformed quality assurance in project management by enabling more comprehensive defect detection, predictive quality analysis, and automated verification of deliverables against requirements and standards.

Go et al. [30] discussed moving towards automation and artificial intelligence in managing HSE risks and incidents, demonstrating how AI could enhance quality assurance processes in high-risk environments. Their research showed that AI-powered inspection systems could identify potential quality issues with high accuracy, significantly outperforming manual inspection approaches in both thoroughness and consistency. The authors reported that implementation of AI-driven quality assurance was associated with a reduction in quality-related incidents in the studied cases.

For automated compliance verification, Mohammed et al. [41] developed a Smart Project Management System (SPMS) with AI-driven quality monitoring capabilities for oil and gas client projects. This system automatically verified deliverables against applicable standards, specifications, and regulatory requirements, identifying compliance gaps without manual inspection. The authors noted that this approach reduced quality verification effort while increasing verification coverage from selective sampling to comprehensive assessment.

In software development contexts, Hoda et al. [52] examined augmented agile approaches using human-centered AI-assisted software management, showing how AI could enhance code quality assessment and testing processes. Their research demonstrated that AI-augmented quality assurance could identify more potential defects compared to traditional testing approaches, particularly for complex integration scenarios and edge cases that might be missed in conventional testing.

For predictive quality management, Abbasianjahromi and Aghakarimi [31] applied machine learning techniques for safety performance prediction in construction projects, extending similar approaches to quality performance. Their models could predict potential quality issues based on project characteristics and early execution patterns with high accuracy, enabling proactive quality management before defects occurred. The authors highlighted that predictive quality management reduced rework costs compared to reactive approaches that identified issues only after they manifested in deliverables.

Despite these advances, several challenges remain in AI-based quality assurance. Rane [22] discussed the role and challenges of ChatGPT and similar generative AI in construction industry, noting limitations related to context understanding and domain-specific knowledge that can affect the reliability of AI quality assessments for specialized deliverables. Additionally, Khan and Siddiqui [43] emphasized the importance of clear quality criteria definition and training data quality when developing AI quality assurance systems, noting that inconsistent or subjective quality definitions can undermine the effectiveness of automated approaches.

4.7.2. Process Optimization (Süreç Optimizasyonu)

AI has enhanced process optimization in project management by identifying inefficiencies, recommending improvement opportunities, and enabling dynamic adaptation of processes to changing project conditions.

Goyal et al. [34] explored automation in Project Management 4.0 with artificial intelligence, demonstrating how AI could analyse process performance data to identify bottlenecks, redundancies, and optimization opportunities. Their approach applied process mining techniques to project execution data, creating visual representations of actual process flows and identifying deviations from intended processes.

For continuous process improvement, Choi et al. [32] implemented the Engineering Machine-Learning Automation Platform (EMAP) for sustainable management solutions in plant projects. This platform continuously monitored process performance metrics, automatically identifying improvement opportunities and generating optimization recommendations. The authors noted that this approach enabled more frequent and targeted process adjustments compared to traditional periodic improvement initiatives, resulting in cumulative efficiency gains over project lifecycles.

In agile development contexts, Hoda et al. [52] examined human-centred AI-assisted software management, showing how AI could optimize sprint planning, backlog refinement, and retrospective processes. Their research demonstrated that AI-augmented process optimization could reduce planning overhead while improving sprint goal achievement rates. The authors emphasized that their approach maintained the collaborative nature of agile processes while enhancing efficiency through data-driven optimization.

For process standardization and best practice identification, Mohammed et al. [41] a Smart Project Management System (SPMS) that employed AI to analyse process variations across multiple projects and identify the most effective approaches. This system could recognize successful process patterns and recommend their adoption across the project portfolio, accelerating organizational learning and process maturity development. The authors reported that this approach reduced process variability while improving overall process performance by establishing standardized best practices based on empirical evidence.

While AI offers significant advantages for process optimization, several limitations have been identified. Paleyes et al. [14] conducted a survey of case studies on deploying machine learning, highlighting challenges related to process data quality, consistency, and granularity that can affect the reliability of AI-based process analysis. Additionally, Monshizada et al. [33] emphasized the importance of considering organizational culture and human factors in process optimization, noting that technically optimal processes may face implementation challenges if they conflict with established work practices or preferences.

4.8. Project Work Performance Domain (Proje İş Yürütme Performans Alanı)

4.8.1. Task Automation (Görev Otomasyonu)

AI has transformed task automation in project management by enabling more sophisticated automation of routine activities, intelligent prioritization of work, and adaptive workflow management that responds to changing project conditions.

Elmas [4] explored applications of generative artificial intelligence in project management, demonstrating how these technologies could automate documentation tasks such as meeting minutes, status reports, and routine communications. The research showed that generative AI could reduce documentation time while maintaining or improving quality and consistency. The author emphasized that automating these routine tasks allowed project managers to focus more attention on strategic activities and stakeholder engagement that required human judgment and creativity.

For workflow automation, Goyal et al. [34] investigated automation in Project Management 4.0 with artificial intelligence, showing how AI could create intelligent workflows that routed tasks, information, and approvals based on project context and organizational roles. Their approach integrated with existing project management information systems to create seamless automated processes that reduced administrative overhead compared to manual workflow management. The authors noted that this automation was particularly valuable for compliance-driven projects with complex approval requirements and documentation needs.

In administrative task contexts, Weng [23] examined implementing generative AI tools in project management, demonstrating how these technologies could automate email management, meeting scheduling, and follow-up tracking. The research showed that AI assistants could reduce administrative time demands on project managers, enabling greater focus on value-adding activities. The author highlighted that automation of these seemingly minor tasks had significant cumulative impact on project manager productivity and effectiveness.

For intelligent task assignment and tracking, Bainey [53] explored AI-driven project management approaches, showing how AI algorithms could analyse task characteristics, team member capabilities, and workload distributions to optimize task assignments. This approach not only automated the assignment process but also continuously monitored progress and proactively identified potential delays or bottlenecks.

The author reported that AI-driven task management improved on-time task completion rates compared to conventional assignment and tracking approaches.

Despite these advances, several challenges remain in AI-based task automation. Elmas and Babayev [1] discussed whether artificial intelligence can replace project managers, emphasizing that while AI can effectively automate routine tasks, it currently lacks the judgment, emotional intelligence, and stakeholder management capabilities required for many core project management responsibilities. Additionally, Khan and Siddiqui [43] highlighted implementation challenges related to integration with existing systems, data quality requirements, and the need for process standardization as prerequisites for effective AI automation.

4.8.2. Decision Support (Karar Destek)

AI has enhanced decision support in project management by providing data-driven insights, simulating decision outcomes, and recommending optimal choices based on project objectives and constraints.

Rasmuss and Tømte [50] investigated artificial intelligence as a tool for project decision-making support, demonstrating how AI could integrate diverse data sources to provide comprehensive decision support for project managers. Their research showed that AI-supported decisions were more likely to achieve desired outcomes compared to decisions based solely on expert judgment, particularly for complex decisions with multiple interacting factors. The authors emphasized that AI served as a complement to human judgment rather than a replacement, providing evidence-based insights while leaving final decisions to human managers.

For scenario analysis and option evaluation, Hegazy and Zhang [45] explored artificial intelligence for enhanced decision-making in construction, showing how AI could simulate multiple decision alternatives and predict their likely outcomes. This capability enabled project teams to evaluate options more comprehensively than traditional approaches, considering a wider range of potential scenarios and their probabilities. The authors reported that projects using AI-enhanced decision support experienced fewer negative surprises during execution due to more thorough option analysis during planning.

For real-time decision support during project execution, Mohammed et al. [41] implemented a Smart Project Management System (SPMS) that provided AI-driven recommendations for addressing emerging issues and opportunities. This system continuously monitored project status, identified decision points, and generated contextually relevant recommendations based on historical patterns and current project conditions. The authors reported that this real-time decision support reduced decision latency compared to traditional escalation and deliberation processes, enabling more agile project adaptation to changing circumstances.

While AI offers significant benefits for decision support, several limitations have been identified. Miller [51] discussed artificial intelligence project success factors beyond ethical principles, highlighting challenges related to transparency and explainability of AI recommendations, which can affect user trust and acceptance. Additionally, Bushuyev et al. [2] emphasized the importance of considering organizational politics and stakeholder preferences in decision processes, noting that purely data-driven recommendations might not adequately account for these human factors that often influence decision implementation and acceptance.

4.8.3. Progress Monitoring (İlerleme İzleme)

AI has transformed progress monitoring in project management by enabling more accurate tracking of actual progress, early detection of deviations from plans, and predictive insights about future performance trends.

Mohammed et al. [41] developed a Smart Project Management System (SPMS) for oil and gas client projects, demonstrating how AI could enhance progress monitoring through automated data collection, analysis, and visualization. Their system integrated data from multiple sources to create a comprehensive and real-time view of project status, automatically identifying variances from planned performance. The authors reported that this approach detected schedule deviations on average 10 days earlier than traditional reporting methods, providing valuable additional time for corrective action.

For visual progress monitoring, Pal and Hsieh [61] explored deep-learning-based visual data analytics for smart construction management, showing how computer vision techniques could automatically assess physical progress on construction sites. Their approach compared site imagery with BIM models and project schedules to determine actual progress rates without manual inspection. The authors noted that this automated monitoring reduced progress assessment effort while increasing assessment frequency from weekly to daily, enabling much more responsive project control.

In software development contexts, Santos et al. [46] investigated explainable machine learning for project management control, demonstrating how AI could analyse development metrics to provide early warnings of potential delays or quality issues. Their approach identified subtle patterns in team productivity, code quality, and testing coverage that preceded significant performance deviations.

For integrated progress and forecast visualization, Daniel [54] explored using AI advisors to maximize work front availability and reduce project delivery time. The research showed how AI could combine historical performance patterns with current progress data to generate dynamic forecasts and visualizations that highlighted potential schedule risks. This capability enabled project teams to focus attention on the most critical progress issues rather than being overwhelmed by comprehensive progress data. The author reported that teams using AI-enhanced progress monitoring spent less time on routine status assessment while achieving better schedule performance.

Despite these advances, several challenges remain in AI-based progress monitoring. Zhou et al. [16] noted that machine learning approaches to progress analysis require substantial historical data to establish reliable patterns, potentially limiting their effectiveness for novel project types or organizations with limited performance history. Additionally, Uddin et al. [48] highlighted challenges related to data integration across different project systems, noting that inconsistent data definitions and collection methods can undermine the effectiveness of automated progress monitoring systems that rely on integrated data sources.

4.9. Cross-Domain Integration of AI Applications (Yapay Zekâ Uygulamalarının Çok Alanlı Entegrasyonu)

The preceding sections have examined AI applications within each PMBOK performance domain individually. However, a notable characteristic of the more advanced AI implementations identified in this review is their capacity to operate across multiple performance domains simultaneously, creating integrative effects that extend beyond any single domain.

Several studies demonstrate this cross-domain character explicitly. Mohammed et al. [41] developed a Smart Project Management System (SPMS) that simultaneously addressed planning (resource allocation and scheduling), measurement (EVM and KPI monitoring), uncertainty (risk response), team performance (productivity monitoring), stakeholder engagement (communication tracking), and project work (decision support and progress monitoring). This integrated platform illustrates how a single AI system can generate value across the full spectrum of performance domains rather than addressing each in isolation.

Similarly, hybrid AI approaches—such as those proposed by Choi et al. [32] and Monshizada et al. [33] are explicitly designed to span multiple domains by combining NLP for stakeholder communication analysis, machine learning for performance prediction, and rule-based systems for recommendation generation. These architectures reflect a recognition that project outcomes are shaped by the interaction of multiple performance domains and that AI systems designed around single-domain logic may fail to capture these interdependencies.

Generative AI, as examined by Elmas [4] and Weng [23], further exemplifies cross-domain applicability: a single generative model may simultaneously support planning (automated schedule drafting), stakeholder engagement (personalized communication generation), and project work (documentation automation), without requiring separate domain-specific training.

These observations suggest that the most analytically productive framing for future research may not be domain-by-domain categorization alone, but rather an examination of which AI capabilities most effectively support the interconnections between domains. Risk identification outcomes, for example, directly inform planning adjustments and stakeholder communications; team performance patterns influence delivery quality and project work efficiency. AI systems that recognize and respond to these linkages are likely to offer more substantial contributions to overall project performance than those operating within narrowly defined functional boundaries.

5. CONCLUSIONS (SONUÇLAR)

This comprehensive review has demonstrated the transformative impact of AI across all project management performance domains, highlighting both significant advancements and persistent challenges. The integration of AI into project management practices represents a paradigm shift that is fundamentally altering how projects are conceived, planned, executed, monitored, and closed.

The evolution of AI in project management has progressed from basic automation and decision support to sophisticated predictive analytics, adaptive optimization, and generative capabilities. This progression has been accompanied by a shift in perspective from viewing AI as a potential replacement for project managers to recognizing it as an augmentation technology that enhances human capabilities while transforming project management practices [1, 2].

Across the diverse AI approaches examined in this review—machine learning, natural language processing, fuzzy logic, expert systems, hybrid approaches, and generative AI—several common themes emerge regarding their benefits for project management. Beyond these common themes, the AI approaches examined in this review differ substantially in their functional characteristics, data requirements, and relative suitability across project management domains. Table 1 provides a comparative overview of these approaches.

This comparison indicates that no single AI approach is universally superior across all project management contexts. Machine learning and hybrid approaches demonstrate the broadest applicability for prediction and optimization tasks, while generative AI addresses a functionally distinct set of capabilities related to content production and exploratory simulation. Fuzzy logic and expert systems remain valuable in contexts characterized by high uncertainty and limited quantitative data. These distinctions have practical implications for organizations selecting AI tools: the appropriate approach depends on the specific performance domain, the nature of available data, and the type of decision support required.

- Enhanced accuracy and efficiency: AI technologies consistently demonstrate superior performance in tasks ranging from estimation and prediction to pattern recognition and analysis, often achieving accuracy improvements compared to traditional approaches while significantly reducing the time and effort required [3, 8, 10].
- Improved handling of complexity and uncertainty: AI approaches excel at managing the inherent complexity and uncertainty of modern projects, providing more nuanced analysis of risks, more robust planning under uncertainty, and more adaptive responses to changing conditions [24, 35].
- Expanded analytical capabilities: AI enables project managers to derive insights from larger and more diverse data sources than previously possible, including unstructured data such as text, images, and communications that contain valuable but historically inaccessible information [17, 20, 61].
- Automation of routine tasks: AI effectively automates administrative and repetitive tasks, freeing project managers to focus on strategic activities that require human judgment, creativity, and interpersonal skills [4, 23, 34].
- Real-time monitoring and adaptation: AI systems enable continuous monitoring of project performance and environmental conditions, facilitating more responsive and proactive management compared to traditional periodic reporting and review cycles [41, 46, 54].

Table 1. Comparative overview of AI approaches in project management (Proje yönetiminde yapay zekâ yaklaşımlarının karşılaştırmalı genel değerlendirmesi)

AI Approach	Primary Strengths	Key Limitations	Most Applicable Performance Domains
Machine Learning	Predictive accuracy; pattern recognition in large datasets	Requires substantial labeled historical data; limited interpretability for complex models	Planning (scheduling, cost estimation); Measurement (performance prediction, KPI analysis); Uncertainty (risk assessment)
Natural Language Processing	Extraction of insights from unstructured text; sentiment analysis	Context sensitivity; requires domain-specific training data	Stakeholder (communication analysis, engagement); Uncertainty (risk identification from documentation)
Fuzzy Logic Systems	Handling of uncertainty and imprecision; incorporation of expert judgment	Knowledge acquisition burden; scalability constraints	Uncertainty (risk assessment); Planning (multi-criteria decision-making)
Expert Systems	Formalization of domain knowledge; consistent decision support	Static rule bases; limited adaptability to novel situations	Uncertainty (risk response); Delivery (compliance verification)
Hybrid Approaches	Complementary strengths of multiple techniques; broader applicability	Integration complexity; multidisciplinary expertise requirements	Cross-domain; particularly Planning, Measurement, and Delivery
Generative AI	Content generation; scenario simulation; conversational assistance	Hallucination risk; verification requirements; governance challenges	Project Work (documentation, automation); Planning (scenario generation); Stakeholder (communication drafting)

Despite these substantial benefits, the review also identified several persistent challenges and limitations:

- Data quality and availability: The effectiveness of many AI approaches depends heavily on the quality, completeness, and relevance of available data, creating challenges for organizations with limited historical data or poor data management practices [14, 48].
- Integration complexity: Implementing AI solutions often requires integration with existing project management information systems and workflows, presenting technical challenges and potential disruption to established practices [33, 43].
- Explainability and trust: Some advanced AI approaches, particularly deep learning models, may function as "black boxes," making it difficult for users to understand and trust their recommendations, limiting acceptance and adoption [46, 51].
- Ethical and privacy considerations: The comprehensive data collection and analysis capabilities of AI raise important questions about privacy, surveillance, consent, and the potential for algorithmic bias that must be addressed through appropriate governance frameworks [5, 22].
- Human factor integration: Successful AI implementation requires careful consideration of organizational culture, human factors, and change management to ensure that technical capabilities translate into practical benefits [1, 33].

In addition to the substantive challenges identified above, several methodological limitations of this review itself warrant acknowledgment.

First, although the search strategy was designed to be comprehensive, it was limited to four electronic databases and publications written in English. Studies published in other languages or indexed in discipline-specific repositories not included in the search may contain relevant findings that are not reflected in this synthesis.

Second, the review covered publications from 2020 to 2025. Given the pace at which AI technologies are developing, findings and applications described in earlier studies within this range may already have been superseded by more recent advances, particularly in the domain of generative AI, where new model capabilities and deployment frameworks have emerged rapidly since 2022.

Third, the reviewed literature may reflect a degree of publication bias, whereby studies reporting positive or statistically significant outcomes are more likely to have been submitted and accepted for publication than those reporting null or negative results. This may result in an overrepresentation of favorable AI outcomes relative to implementation failures or unresolved challenges.

Fourth, a portion of the included studies relied on case-specific or proprietary datasets, which limits the generalizability of their findings across different organizational contexts, project types, and industries.

These limitations do not diminish the validity of the findings presented, but they do suggest that the conclusions of this review should be interpreted within the boundaries defined by the search parameters and the state of the available literature at the time of writing.

Looking to the future of AI in project management, several promising directions emerge from this review:

- Hybrid human-AI collaboration models: The most effective approaches will likely involve thoughtful integration of AI capabilities with human judgment, creativity, and interpersonal skills, leveraging the complementary strengths of each [2, 36].
- Improved explainability and transparency: Advances in explainable AI will enhance user understanding and trust in AI recommendations, facilitating broader adoption and more effective use of AI insights [46, 51].
- Contextual adaptation and personalization: Future AI systems will likely offer greater adaptation to specific organizational contexts, project types, and individual user preferences, increasing their relevance and effectiveness across diverse settings [33, 57].
- Ethical frameworks and governance: The development of robust ethical frameworks and governance approaches for AI in project management will be essential to address concerns related to privacy, bias, transparency, and accountability [5, 22].
- Integration across project lifecycle: Future advancements will likely focus on more seamless integration of AI capabilities across the entire project lifecycle, from initiation through closing, creating more comprehensive and cohesive AI-augmented project management systems [2, 4].

In conclusion, AI is revolutionizing project management by enhancing capabilities across all performance domains, from planning and scheduling to stakeholder engagement and risk management. While significant challenges remain, the trajectory is clear: AI will continue to transform project management practices, requiring project professionals to develop new skills, adapt existing methodologies, and reimagine their roles in an increasingly AI-augmented environment. Organizations that thoughtfully integrate AI capabilities with human expertise and establish appropriate governance frameworks will be best positioned to realize the substantial benefits that AI can bring to project management effectiveness and efficiency.

DECLARATION OF ETHICAL STANDARDS (ETİK STANDARTLARIN BEYANI)

The author of this article declares that the materials and methods they use in their work do not require ethical committee approval and/or legal-specific permission.

Bu makalenin yazarı çalışmalarında kullandıkları materyal ve yöntemlerin etik kurul izni ve/veya yasal-özel bir izin gerektirmediğini beyan ederler.

AUTHORS' CONTRIBUTIONS (YAZARLARIN KATKILARI)

Elif Ece ELMAS**:** She conducted the study, performed the systematic literature review, analyzed the findings, and wrote the review article.

Araştırmayı yürütmüş, ilgili literatürü sistematik olarak incelemiş, elde edilen bulguları analiz etmiş ve derleme makalenin yazımını gerçekleştirmiştir.

CONFLICT OF INTEREST (ÇIKAR ÇATIŞMASI)

There is no conflict of interest in this study.

Bu çalışmada herhangi bir çıkar çatışması yoktur.

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