ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)

Volume 13, Issue 09, September 2026

An AHP–Fuzzy–Machine Learning Approach for Selecting Project Management Methodologies and Digital PM Ecosystems

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***Abstract*— Modern projects operate under increasing levels of uncertainty, cross-functional dependency, regulatory complexity, and rapid technological evolution. Traditional predictive project management methodologies such as PRINCE2 and PMP continue to provide strong governance and planning capabilities for infrastructure and compliance-driven projects, while agile methodologies support adaptability and iterative delivery in innovation-oriented environments. Simultaneously, organizations face challenges in selecting appropriate digital project management ecosystems such as Primavera, Jira, cplace, and Concerto, each optimized for different operational contexts.**

***This paper proposes the Intelligent Project Agility Assessment Framework (IPAAF), a hybrid decision-support framework integrating Analytic Hierarchy Process (AHP), fuzzy logic, and machine learning to evaluate project agility requirements and recommend suitable project management methodologies and software ecosystems. Within IPAAF, a Project Agility Index (PAI) is developed using weighted multi-criteria analysis based on project characteristics including scope variability, stakeholder complexity, budget volatility, risk exposure, compliance intensity, innovation requirements, and cross-functional collaboration.**

***The framework combines AHP-derived criteria weighting, fuzzy inference systems for uncertainty handling, and supervised machine-learning models for methodology and software recommendation. Comparative analysis is performed across Primavera, Jira, cplace, and Concerto in relation to predictive and adaptive project environments.**

***The proposed framework demonstrates that governance-intensive infrastructure projects align more effectively with Primavera and Concerto under predictive methodologies, whereas innovation-driven and engineering R&D environments benefit from adaptive ecosystems such as Jira and cplace. The study contributes a quantitative and intelligent project governance framework capable of supporting organizational decision-making under uncertain and dynamic project conditions.**

Index Terms: Project Agility, AHP, Fuzzy Logic, Machine Learning, Agile Project Management.

I. INTRODUCTION

The increasing complexity of modern projects has fundamentally transformed project management practices across industries including infrastructure, manufacturing, software development, renewable energy, and engineering R&D. Organizations now operate in environments characterized by accelerated innovation cycles, evolving stakeholder expectations, budget uncertainty, and globally distributed teams.

Traditional predictive project management approaches such as PRINCE2 and PMP emphasize detailed upfront planning, schedule control, risk mitigation, and governance rigor. These approaches remain highly effective in infrastructure and compliance-intensive projects where scope stability and regulatory adherence are critical. However, highly dynamic project environments increasingly require adaptive methodologies capable of supporting iterative delivery, rapid feedback integration, and evolving requirements.

In parallel, digital project management ecosystems have emerged as critical enablers of organizational coordination and project visibility. Platforms such as Primavera, Jira, cplace, and Concerto provide distinct capabilities ranging from scheduling and governance to agile collaboration and enterprise portfolio management. Selecting an inappropriate methodology or software ecosystem can significantly reduce delivery efficiency, increase operational overhead, and limit organizational agility.

Despite extensive research on agile methodologies and project governance, limited research exists on intelligent frameworks capable of quantitatively aligning project characteristics with both project management methodologies and digital PM ecosystems.

This paper proposes the Intelligent Project Agility Assessment Framework (IPAAF), a hybrid decision-support framework integrating:

- Analytic Hierarchy Process (AHP)
- Fuzzy Logic
- Machine Learning
- Multi-criteria decision analysis

The framework introduces a Project Agility Index (PAI) capable of evaluating project agility requirements and recommending:

- Suitable project management methodologies
- Appropriate governance intensity

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- Optimal digital PM ecosystems

II. LITERATURE REVIEW

A. Predictive Project Management

Predictive project management methodologies focus on structured planning, governance, and control mechanisms. These methodologies are commonly applied in construction, aerospace, energy, and infrastructure sectors.

i. PMP Framework

The Project Management Professional (PMP) framework emphasizes:

- Scope management
- Schedule integration
- Cost optimization
- Stakeholder management
- Risk control

The PMBOK framework provides structured knowledge areas and process groups that support standardized project execution.

ii. PRINCE2 Methodology

PRINCE2 focuses on:

- Controlled stages
- Governance gates
- Business justification
- Accountability structures
- Exception-based management

PRINCE2 is particularly effective in highly regulated environments where governance transparency is critical.

B. Agile Project Management

Agile methodologies prioritize adaptability, customer collaboration, and iterative delivery. Agile principles are widely adopted in software engineering, digital transformation, and innovation-driven programs.

Common agile characteristics include:

- Incremental delivery
- Continuous feedback
- Iterative planning
- Cross-functional collaboration
- Adaptive scope management

While agile frameworks improve responsiveness, they may present governance challenges in compliance-intensive projects.

C. Digital PM Ecosystems

Primavera

Primavera P6 is widely used in large-scale infrastructure and capital projects due to its strengths in:

- Scheduling
- Resource allocation
- Earned value management
- Cost tracking

However, Primavera exhibits limited flexibility in highly adaptive environments.

Jira

Jira supports agile workflows through:

- Sprint planning
- Issue tracking
- Kanban boards
- DevOps integration

Jira is highly effective for software and product development teams but provides limited enterprise governance capability.

cplace

cplace provides:

- Enterprise portfolio visibility
- Cross-functional collaboration
- Dependency visualization
- Innovation management

The platform is increasingly adopted in automotive and engineering R&D environments.

Concerto

Concerto focuses on:

- Asset-linked project management
- Facilities governance
- Infrastructure project tracking
- Maintenance integration

The platform is suitable for governance-intensive operational projects.

III. RESEARCH METHODOLOGY

A. Intelligent Project Agility Assessment Framework (IPAAF)

The proposed framework consists of four integrated layers:

- Project Characteristic Assessment
- AHP-Based Weight Optimization
- Fuzzy Agility Evaluation
- Machine Learning Recommendation Engine

The framework architecture enables dynamic decision-making under uncertain project conditions.

B. Project Agility Parameters

The Project Agility Index (PAI) evaluates projects using eight primary parameters:

Table 1: Parameters for Project Agility Index

Parameter	Description
Scope Change Frequency	Degree of evolving requirements
Stakeholder Complexity	Number and diversity of stakeholders
Innovation Intensity	Extent of technological uncertainty
Regulatory Rigidity	Compliance and governance requirements
Budget Volatility	Financial uncertainty

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International Journal of Science, Engineering and Management (IJSEM)
Volume 13, Issue 09, September 2026

Parameter	Description
Schedule Criticality	Sensitivity to delays
Cross-Functional Dependency	Inter-team coordination intensity
Risk Exposure	Overall project uncertainty

Projects are scored on a scale of 1–5 for each parameter.

IV. ANALYTICAL HIERARCHY PROCESS (AHP)

A. Purpose of AHP

AHP is applied to determine optimized parameter weights through pairwise comparisons. Unlike manually assigned weighting methods, AHP improves:

- Consistency
- Objectivity
- Decision transparency

B. Pairwise Comparison Matrix

An illustrative pairwise comparison matrix is shown below:

Table 2: Pairwise Comparison Matrix

Criteria	Scope Change	Innovation	Compliance
Scope Change	1	3	5
Innovation	1/3	1	3
Compliance	1/5	1/3	1

Normalized eigenvectors generate criteria weights.

Consistency Ratio (CR) is calculated to validate judgment consistency.

Acceptable condition: CR < 0.1

V. FUZZY LOGIC-BASED AGILITY EVALUATION

A. Need for Fuzzy Logic

Project environments contain uncertainty that cannot always be represented using precise numerical values. Terms such as:

- “moderate uncertainty”
- “high stakeholder involvement”
- “frequent changes”

are inherently linguistic and ambiguous. Fuzzy logic enables representation of such uncertainty.

B. Fuzzy Membership Functions

Each parameter is represented using: Low, Medium, High triangular membership functions.

Example:

Scope Change Frequency:

- Low: 0–2 changes/month
- Medium: 2–5 changes/month
- High: >5 changes/month

C. Fuzzy Rule Base

Example rules include:

IF
Scope Change is High
AND
Innovation Intensity is High
THEN
Project Agility Requirement is Very High
IF
Compliance Rigidity is High
AND
Schedule Flexibility is Low
THEN
Predictive Governance Requirement is High

D. Project Agility Index Calculation

Final Project Agility Index:
$PAI = \Sigma (Wi \times Fi)$
Where: Wi = AHP-derived weight
Fi = Fuzzy parameter score
The final PAI ranges between 0 and 5.

VI. MACHINE LEARNING RECOMMENDATION ENGINE

A. Objective

The machine-learning layer predicts:

- Project management methodology
- Governance style
- Software ecosystem based on historical project datasets.

B. Input Features

The ML model uses:

- Industry type
- Project budget
- Duration
- Compliance level
- Scope volatility
- Stakeholder count
- Schedule rigidity
- Risk level

C. Output Recommendations

Methodology Recommendations

- PRINCE2
- PMP
- Agile
- Hybrid Agile

Software Recommendations

- Primavera
- Jira
- Cplace
- Concerto
- Hybrid software ecosystems

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D. Proposed Algorithms

The following algorithms are proposed:

Table 3: Proposed Alogorithms

Algorithm	Advantages
Decision Trees	High interpretability
Random Forest	Improved classification accuracy
Gradient Boosting	Handles nonlinear relationships
Support Vector Machines	Effective for medium-sized datasets

Table 4: Comparative Analysis of PM Ecosystems (1-5)

Feature	Primavera	Jira	Cplace	Concerto
Governance Capability	5	3	4	5
Agile Support	2	5	4	3
Portfolio Visibility	4	3	5	4
Collaboration	3	4	5	3
Infrastructure Projects	5	2	3	5
Engineering R&D	3	4	5	3
Asset Integration	3	2	3	5
Scheduling Capability	5	3	4	4

VII. CASE STUDIES

A. Wind Turbine Blade Development Program

Project characteristics:

- Evolving engineering requirements
- Cross-functional dependencies
- Supplier coordination
- Compliance constraints

Calculated PAI: 3.2

Recommended methodology: Hybrid Agile

Recommended software ecosystem: cplace + Jira

The recommendation supports both portfolio visibility and execution-level agility.

B. Offshore Wind Farm Construction Project

Project characteristics:

- Fixed schedules
- Regulatory approvals
- Large budgets
- Governance intensity

Calculated PAI: 1.5

Recommended methodology: PRINCE2/PMP

Recommended software ecosystem: Primavera + Concerto

The recommendation emphasizes schedule control and governance rigor.

VIII. RESULTS AND DISCUSSION

The proposed framework demonstrates that:

- High-agility projects benefit from adaptive digital ecosystems
- Governance-intensive projects require predictive methodologies
- No single PM platform universally optimizes all project environments

The integration of AHP, fuzzy logic, and machine learning significantly improves:

- Adaptability
- Decision transparency
- Project-methodology alignment
- Software ecosystem selection

The framework also supports organizational digital transformation initiatives by enabling data-driven PM ecosystem decisions.

IX. CONCLUSIONS

This paper proposed the Intelligent Project Agility Assessment Framework (IPAAF), an integrated decision-support framework combining AHP, fuzzy logic, and machine learning for project methodology and software ecosystem selection.

The framework introduces a Project Agility Index (PAI) capable of quantitatively evaluating project agility requirements under uncertain project conditions. Comparative analysis across Primavera, Jira, cplace, and Concerto demonstrates that project success increasingly depends on alignment between project characteristics, governance intensity, and digital PM ecosystems.

Future work may include:

- Reinforcement learning-based adaptation
- Real-time project digital twins
- Predictive schedule risk analytics
- AI-driven PMO dashboards
- NLP-based stakeholder sentiment analysis

The proposed framework contributes both theoretical and practical value for engineering organizations operating in increasingly dynamic project environments..

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