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PlacementEdge: A Multilayer AI and Blockchain Architecture for Reliable Student Recruitment

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Abstract: Campus recruitment connects students, educational institutions and employers, yet the process often relies on disconnected spreadsheets, manual resume screening, repeated document verification and limited feedback to applicants. These practices can cause delays, inconsistent shortlisting and difficulty establishing whether academic credentials are authentic. This paper proposes PlacementEdge, a multilayer architecture that combines artificial intelligence (AI) and blockchain to support reliable student recruitment. The AI layer extracts skills and education details from resumes, represents candidate profiles and job descriptions semantically, calculates explainable match scores and recommends suitable opportunities. The blockchain layer maintains tamper-evident records of credential fingerprints, verification events, consent and recruitment-stage audit references through permissioned smart contracts. Personal information and full documents remain in encrypted off-chain storage; only hashes and minimum transaction metadata are anchored on-chain. The proposed architecture includes student, placement-cell and employer interfaces, role-based access control, credential verification, candidate-job matching, explainability, audit logging and feedback. A weighted matching model is presented as a transparent baseline, while semantic similarity and fairness checks can improve ranking. The paper describes the design, algorithms, data model, security controls, evaluation plan, limitations and future scope. Since this is a proposed academic system, no experimental accuracy or deployment result is claimed.

Keywords: Artificial Intelligence, Blockchain, Student Recruitment, Campus Placement, Resume Parsing, Semantic Matching, Smart Contracts, Credential Verification, Explainable AI, Permissioned Blockchain, SHA-256

I. INTRODUCTION

Campus placement is an important activity for students, colleges and recruiting organizations. Students prepare resumes, submit academic records and apply for opportunities; placement cells coordinate eligibility checks, communication and interview schedules; employers screen candidates and make selection decisions. When these activities are performed using separate portals, email, spreadsheets and manual verification, information becomes fragmented. Students may miss relevant opportunities, recruiters may receive large volumes of poorly matched applications, and placement officers may spend substantial time checking records and updating status.

Keyword-based screening is often unable to recognise equivalent skills expressed in different ways. For example, a student describing "data cleaning with pandas" may be relevant to a role asking for "Python data preprocessing," even if the exact terms differ. At the same time, a resume score without an explanation can be difficult for a student or placement officer to interpret. Digital certificates introduce another challenge: a PDF can be altered or forged, while contacting issuing institutions for manual verification can delay recruitment.

PlacementEdge addresses these issues through two complementary technologies. AI supports extraction, semantic comparison, ranking and feedback. Blockchain provides a shared, tamper-evident record of credential verification and important workflow events. The proposed system does not treat blockchain as a place to store complete resumes or marksheets. Instead, it stores cryptographic fingerprints and verification references, while private documents remain encrypted off-chain.

The main contributions are: (i) a layered architecture connecting student, placement-cell and employer workflows; (ii) an explainable candidate-job matching method; (iii) a permissioned blockchain approach for credential integrity and auditability; (iv) a privacy-aware on-chain/off-chain data design; and (v) an evaluation framework covering matching quality, verification latency, security and fairness.

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II. LITERATURE REVIEW

Research on AI-based recruitment focuses on reducing the limitations of manual and keyword-driven screening. Recent semantic matching approaches use transformer-based language representations to compare resumes and job descriptions in context. A 2026 study on semantic job matching describes the use of BERT and Sentence-BERT representations to improve resume analysis beyond literal keyword overlap [1]. Other work combines transformer similarity, ensemble learning and explainable AI to provide more interpretable recommendations [2]. These directions are relevant to PlacementEdge because student resumes frequently contain projects, coursework and emerging skills that do not map cleanly to job-description keywords.

Blockchain has been studied for academic credential issuance and verification. A blockchain ecosystem for verifiable qualifications describes how higher-education institutions can register certificates and recruiters can verify their authenticity [3]. More recent work explores permissioned blockchain and decentralized storage for student credentials, including the use of IPFS for document addressing [4]. Such designs support integrity and traceability, but they must still consider privacy, revocation, access control and the cost of writing transactions.

Explainable AI is important in recruitment because a recommendation can influence access to employment opportunities. A system should expose the factors contributing to a match, distinguish required from preferred skills and allow human review. Research on explainable recruitment frameworks combines machine-learning predictions with techniques such as SHAP and LIME [5]. PlacementEdge therefore treats AI output as decision support rather than an autonomous hiring decision.

A. Existing System

Typical campus recruitment processes use a placement portal or spreadsheet to publish job notices, collect resumes, apply eligibility criteria, coordinate interviews and record outcomes. Some systems provide keyword-based resume filtering, while credential checks may be performed manually. These systems can be useful for basic administration but may not provide integrated semantic matching, tamper-evident credential verification and end-to-end auditability.

B. Research Gap

The identified gap is not the absence of AI or blockchain individually; it is the need to connect them carefully in a student-centred recruitment workflow. AI matching needs trustworthy profile inputs and explainable outputs. Credential verification needs privacy-preserving storage and a clear issuer-authority model. Recruitment decisions also require human oversight, consent, fairness monitoring and a traceable record of important actions. PlacementEdge proposes a single architecture addressing these connected requirements.

Capability	Conventional workflow	PlacementEdge proposal
Resume screening	Manual / keyword filter	Semantic AI matching with score breakdown
Credential checking	Manual email or document inspection	Hash-based verification against issuer record
Audit history	Scattered logs / spreadsheets	Permissioned ledger event references
Decision explanation	Often limited	Skill and eligibility contribution report
Privacy	Documents copied across systems	Encrypted off-chain documents; minimal on-chain data
Human oversight	Depends on process	Placement cell / employer review retained

III. PROPOSED SYSTEM AND ARCHITECTURE

3.1 Overview

PlacementEdge is organised into four logical layers: presentation, AI and application services, blockchain trust services, and data/integration. The student portal supports profile creation, resume upload, credential sharing, opportunity discovery and application tracking. The placement-cell dashboard manages student records, verifies issuer information, publishes opportunities and monitors recruitment progress. The employer portal creates job descriptions, views eligible candidates, reviews explanations and updates interview outcomes.

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Figure 1: Multilayer architecture of the proposed PlacementEdge system

3.2 Presentation Layer

The presentation layer contains role-specific interfaces. Students can maintain a profile, upload a resume, add projects and skills, select consent settings and track applications. Placement officers can validate student records, configure eligibility rules, approve job postings and monitor placement statistics. Employers can submit job requirements, request permissioned credential verification, view ranked candidates and record shortlist or selection decisions. Role-based navigation prevents users from accessing functions outside their responsibilities.

3.3 AI and Application Layer

The application layer coordinates authentication, resume ingestion, document parsing, skill normalisation, job-description processing, candidate-job matching, recommendation generation, explainability, notifications and workflow status. Resume files are parsed into structured fields such as education, skills, projects, certifications and experience. Extracted values are presented for student confirmation because OCR and language models may make mistakes. Job descriptions are similarly converted into required skills, preferred skills, education criteria, location and role information.

3.4 Blockchain Trust Layer

A permissioned blockchain is proposed because the participants are known organisations such as the university or college, placement cell and authorised employers. Smart contracts manage issuer registration, credential fingerprint registration, verification requests, consent references and recruitment audit events. The ledger stores no complete resume, marksheet, phone number, address or other directly identifying document content. It stores a cryptographic hash, issuer identifier, credential type, timestamp, status and a reference to the off-chain record. Access to the underlying file is controlled separately.

3.5 Data and Integration Layer

An encrypted relational database stores student profiles, job descriptions, application details, parsed resume fields and workflow states. Encrypted object storage or an IPFS-compatible content-addressed store may hold uploaded documents, subject to access-control and availability requirements. External integrations may include college ERP systems, university result services where authorised, email and notification services, and employer applicant-tracking systems. APIs connect these services without exposing private keys or database credentials to browser clients.

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IV. METHODOLOGY

4.1 Student Registration and Profile Creation

A student creates an account using a verified institutional identity. The system collects only fields required for placement activities. Academic information can be imported from an authorised institutional source or entered and reviewed by the placement cell. The student uploads a resume and supporting credentials, then confirms the extracted profile fields. Consent is obtained before sharing documents with an employer.

4.2 Resume Parsing and Skill Extraction

The resume ingestion pipeline accepts PDF or DOCX documents, extracts text and normalises whitespace, headings and common abbreviations. A named-entity or token-classification model identifies education, skills, projects, certifications and experience. A controlled skill dictionary maps equivalent terms to a canonical skill label; for example, "JS" may map to "JavaScript" when the context supports that interpretation. Uncertain extractions are flagged for student confirmation rather than silently accepted.

4.3 Job Description Processing

The employer submits a role description. The system extracts mandatory skills, preferred skills, education requirements, experience level, location and other constraints. The employer reviews the structured version before publishing it. Mandatory eligibility criteria are evaluated separately from the similarity score so that a high semantic score cannot override a required qualification or an explicit eligibility rule.

4.4 Candidate-Job Matching

The proposed baseline computes a weighted score from skill overlap, semantic similarity, education fit, project relevance and experience fit. Let S denote the normalised skill-overlap score, M the semantic similarity score, E the education-fit score, P the project-relevance score and X the experience-fit score. Each component is scaled from 0 to 100. The weights are configurable by role and should be validated with placement stakeholders.

$$\text{MatchScore}(c,j) = 0.35S + 0.30M + 0.15E + 0.15P + 0.05X$$

The weights above are an illustrative starting configuration, not experimentally optimised values. A separate eligibility function checks mandatory criteria. If a required criterion fails, the candidate is marked "not eligible under configured criteria," even if the numerical match score is high. The interface displays the score components and matched/missing skills so users can understand the recommendation.

4.5 Semantic Similarity

A sentence-embedding model converts the candidate skill/project text and job-description text into vectors. Cosine similarity estimates their semantic closeness:

$$\text{CosineSimilarity}(A,B) = (A \cdot B) / (\|A\| \times \|B\|)$$

The similarity value is mapped to a 0–100 display range only after validation on a representative dataset. Embedding models may encode language or domain bias; therefore, the system must evaluate performance across disciplines and student groups before operational use.

4.6 Explainability and Human Review

The explanation panel lists matched mandatory skills, matched preferred skills, missing skills, relevant projects, education fit and the factors that influenced the ranking. Where a model is used, local feature-attribution methods may be added. Explanations should be checked for stability and should not imply that a model score is a probability of being hired. Employers and placement officers remain responsible for interview and selection decisions.

V. BLOCKCHAIN DESIGN AND SMART CONTRACTS

5.1 Credential Fingerprinting

When an authorised institution issues a digital credential, the system computes a SHA-256 digest of the canonical document bytes. The issuer registers the digest and a minimum set of metadata on the permissioned ledger. During verification, the submitted document is hashed again. If the computed digest matches an active issuer record, the

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system reports that the file is consistent with the registered credential. A hash match does not prove that the original issuer was legitimate; issuer onboarding and key governance are therefore essential.

$$\text{CredentialHash} = \text{SHA-256}(\text{CanonicalCredentialFile})$$

5.2 On-Chain and Off-Chain Separation

On-chain (ledger)	Off-chain (encrypted storage)
Credential hash	Full certificate / marksheet PDF
Issuer organisation ID	Student name and personal details
Credential type and issue timestamp	Resume and project portfolio
Verification status / revocation reference	Contact information and application data
Consent and audit-event reference	AI embeddings, parsed text and explanations

This separation reduces unnecessary disclosure and avoids storing large files on the blockchain. A document hash can still be linkable to a person when associated with other information; the system must therefore treat hashes and transaction metadata as potentially sensitive and restrict access to ledger queries.

5.3 Smart Contract Functions

Function	Purpose	Authorised actor
registerIssuer()	Register an approved issuing institution	Consortium administrator
registerCredential()	Record credential hash and metadata	Approved issuer
verifyCredential()	Compare submitted digest with registered record	Student / authorised verifier
revokeCredential()	Mark a credential as revoked or superseded	Issuing institution
recordConsent()	Record consent reference and scope	Student / platform service
logRecruitmentEvent()	Record shortlist/interview/offer event reference	Placement cell / employer

5.4 Consensus and Network Governance

The network is assumed to be permissioned, with participating institutions and approved consortium members operating validator nodes. A Byzantine fault-tolerant consensus protocol such as Practical Byzantine Fault Tolerance (PBFT) may be considered for a consortium with a known validator set. The final choice depends on validator count, governance model, throughput, fault assumptions and platform implementation. The consensus protocol is not the same as encryption: SHA-256 provides a cryptographic digest, while consensus helps participants agree on the order and validity of ledger updates.

5.5 Auditability

Every important state transition can generate a ledger event reference: credential issued, verification requested, consent granted or withdrawn, application submitted, candidate shortlisted, interview completed and offer recorded. The event should contain only the minimum metadata needed for audit. Detailed reasons and personal data remain in access-controlled off-chain systems. A transaction identifier allows an authorised auditor to verify that the recorded event has not been altered.

VI. ALGORITHMS AND WORKFLOW

6.1 Candidate Matching Algorithm

Input: Candidate profile C, job description J, eligibility rules R
Output: Eligibility result, match score and explanation
1. Parse and normalise resume fields for C.
2. Extract required skills, preferred skills and constraints from J.
3. Confirm uncertain extracted fields with the student or recruiter.
4. Evaluate mandatory eligibility rules R.
5. Compute skill overlap S and semantic similarity M.
6. Compute education fit E, project relevance P and experience fit X.
7. Calculate MatchScore = 0.35S + 0.30M + 0.15E + 0.15P + 0.05X.

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8. Generate matched-skill, missing-skill and score-component explanations.
9. Apply fairness and data-quality checks; flag low-confidence profiles.
10. Return ranked recommendations for human review.

6.2 Skill Overlap

A simple skill-overlap score can be calculated as the proportion of required skills found in the candidate profile, after synonym normalisation. Let R be the set of required skills and C be the candidate skill set. The baseline recall-style score is:

$$S = 100 \times |R \cap C| / |R|, \text{ for } |R| > 0$$

This metric is easy to explain but treats all required skills equally. A future version can assign importance weights to skills, distinguish proficiency levels and use a verified skill taxonomy. The system should avoid interpreting a missing resume keyword as proof that the student lacks the skill.

6.3 Credential Verification Workflow

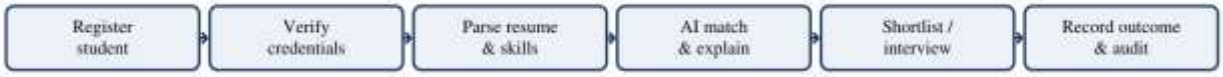


Figure 2: End-to-end student recruitment and verification workflow

The student uploads a credential and grants a defined verification permission. The platform computes the file digest and sends a verification request to the smart contract. The contract checks whether the digest is registered by an authorised issuer and whether the credential is active. The platform then retrieves the issuer and status information and displays a verification result. If no matching record exists, the system reports “not verified” rather than automatically declaring the document fraudulent. Manual escalation is available for legacy certificates or temporary network failures.

6.4 Application Status Model

State	Meaning	Permitted transition examples
Draft	Student profile/application incomplete	Draft → Submitted
Submitted	Application received	Submitted → Eligibility Checked
Eligibility Checked	Rules evaluated	Checked → Under Review / Not Eligible
Under Review	Employer or placement cell reviewing	Review → Shortlisted / Rejected
Shortlisted	Selected for next stage	Shortlisted → Interview
Interview	Interview process in progress	Interview → Offered / Rejected
Offered / Joined	Offer issued / joining confirmed	Terminal or closed state

VII. SECURITY, PRIVACY AND ETHICAL CONSIDERATIONS

7.1 Identity and Access Management

The system applies role-based access control for students, placement officers, employers, issuer organisations and platform administrators. Authentication establishes the user identity; authorisation checks the role, organisation and permitted action. Employers should access only candidates who have applied or explicitly consented to sharing their profile. Issuer privileges are limited to credential registration and revocation for records issued by that organisation.

7.2 Data Protection

All network traffic should use TLS. Sensitive documents and personal data should be encrypted at rest, with encryption keys managed outside the application source code. Access to documents should use short-lived authorisation tokens and be logged. Data retention periods should be defined for resumes, applications and verification logs. Students should be able to review consent scope and withdraw future access where legally and operationally possible.

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7.3 Blockchain Privacy

Blockchain immutability creates a design challenge when personal data must be corrected or deleted. PlacementEdge therefore avoids writing direct personal information to the ledger. Revocation is represented as a new state-changing event rather than erasing historical blocks. The system must still assess whether persistent hashes or metadata could identify a person, and should use access controls, minimal metadata and, where suitable, privacy-preserving proofs.

7.4 Fairness and Bias

AI ranking can reproduce historical inequalities if training data or labels reflect biased recruitment decisions. Sensitive attributes should not be used as ranking features. Proxy variables, such as institution name or location, may also create unfair effects and require review. The platform should report performance across relevant groups where lawful and appropriate, audit false-negative rates, allow human reconsideration and provide a route for students to correct inaccurate profile information. The model must not make final hiring decisions.

7.5 Threat Model

Threat	Potential impact	Mitigation
Forged credential	False qualification claim	Issuer registration, hash verification, revocation
Resume tampering after submission	Disputed application record	File digest, version history, event audit
Unauthorised profile access	Privacy breach	RBAC, consent checks, encryption, access logs
Compromised issuer key	Fraudulent credential registration	Key rotation, multi-party approval, revocation
AI ranking bias	Unfair candidate ordering	Bias testing, explanations, human review
Prompt / input manipulation	Incorrect parsing or recommendations	Input validation, model guardrails, review
Ledger outage	Verification delay	Availability monitoring and manual fallback

VIII. RESULTS, EVALUATION PLAN AND DISCUSSION

8.1 Evaluation Strategy

PlacementEdge is presented as a proposed architecture. The current paper does not claim a completed implementation, measured accuracy, reduced recruitment time or production deployment. These outcomes must be established through a prototype and controlled evaluation. The evaluation should use consented, de-identified student resumes and job descriptions, together with issuer-approved test credentials.

Evaluation area	Metric	Suggested validation
Resume parsing	Precision, recall, F1 by field	Manually labelled resume sample
Matching quality	Precision@K, Recall@K, NDCG@K	Placement expert relevance labels
Credential verification	Success rate, latency	Valid, altered, revoked and unknown files
Blockchain performance	Transaction latency, throughput	Increasing concurrent requests
Security	Unauthorised access success rate	Role and API penetration tests
Fairness	Group-wise error / selection-rate gaps	Appropriate lawful group analysis
Usability	Task completion, SUS score	Student, officer and employer testing

8.2 Functional Test Cases

ID	Test case	Expected result
TC-01	Student uploads a valid resume	Resume parsed; uncertain fields flagged
TC-02	Job description is published	Required and preferred skills displayed for confirmation
TC-03	Student applies to a job	Application state becomes Submitted

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ID	Test case	Expected result
TC-04	Credential digest matches issuer record	Verified status and issuer details returned
TC-05	Credential file is modified	Digest mismatch; status Not Verified
TC-06	Credential has been revoked	Revoked status shown
TC-07	Employer requests a non-consented profile	Access denied
TC-08	Student corrects an extracted skill	Profile updated with audit event
TC-09	AI recommendation generated	Score components and missing skills displayed
TC-10	Unauthorised user calls admin API	Request rejected and logged

8.3 Discussion

The proposed architecture links the trustworthiness of student records with the usefulness of AI recommendations. Semantic matching can identify relevant candidates whose resumes use different terminology, while a score breakdown helps users understand why a role is recommended. Blockchain can provide a shared integrity and audit mechanism across institutions and employers, reducing dependence on repeated manual checks. However, neither technology guarantees a reliable recruitment outcome on its own. Incorrect source data, incomplete resumes, weak issuer governance, biased labels and poorly configured eligibility rules can still produce misleading results.

The hybrid storage design is important. Storing complete personal documents on-chain would create unnecessary privacy and scalability risks. Storing document fingerprints and verification events on a permissioned ledger, while keeping documents encrypted off-chain, provides a more practical balance. Similarly, AI should prioritise relevance and explainability but preserve human judgement for shortlisting and final selection.

8.4 Limitations

The proposed score weights require empirical calibration and may vary by job family. Semantic models can misinterpret technical abbreviations, multilingual resumes and project descriptions. A blockchain network requires participating institutions to agree on governance, validator operation, issuer onboarding and revocation procedures. Credential verification is possible only when an authorised issuer has registered a corresponding record; legacy records may need manual verification. The system also depends on reliable APIs, secure key management, data quality and compliance with applicable privacy and employment regulations.

IX. FUTURE SCOPE

Future work can extend PlacementEdge in several directions. First, a larger and more diverse dataset can be used to calibrate matching weights and compare TF-IDF, Sentence-BERT and cross-encoder approaches. Second, skill ontologies can map related competencies and distinguish beginner, intermediate and advanced proficiency. Third, privacy-preserving credential presentation, such as verifiable credentials and selective disclosure, can reduce the amount of personal information shared with employers. Fourth, a multilingual resume parser can support students who prepare resumes in more than one language. Fifth, the platform can integrate interview scheduling, coding assessments, internship tracking, offer-letter verification and post-placement analytics.

A production implementation should also define a consortium governance model, incident-response procedure, key-recovery plan, smart-contract audit process and service-level targets. A pilot involving one institution, a limited set of employers and a small number of job roles would help validate usability and operational assumptions before expansion.

X. CONCLUSION

This paper proposed PlacementEdge, a multilayer AI and blockchain architecture for reliable student recruitment. The system combines student, placement-cell and employer interfaces with AI-based resume parsing, semantic candidate-job matching, explainable recommendations and permissioned blockchain-based credential verification. Its hybrid data model keeps complete personal documents in encrypted off-chain storage while recording credential hashes and minimum audit metadata on-chain. The design also includes role-based access, consent management, credential revocation, fairness checks and human review. The proposed weighted matching algorithm offers an interpretable baseline, while the evaluation plan defines how parsing quality, ranking relevance, verification performance, security, fairness and usability should be measured. The work is a design proposal and does not claim experimental results. A carefully governed prototype and real-world pilot are required to establish the system's effectiveness, scalability and compliance.

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