Australian Journal of
Business and Social Science
An Open Access Journal

A blockchain-integrated framework for micro-credentialing: enhancing trust and engagement in vocational internship portfolios

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Abstract

Vocational internship and industrial attachment programmes require credible evidence of competence that can be interpreted by employers, verified by institutions, and carried by learners across contexts. Conventional paper certificates and ad hoc portfolio artefacts are vulnerable to loss, fragmentation, and credential fraud, while many digital badge initiatives struggle with verification, interoperability, and employer recognition. This paper reports a blockchain-integrated micro-credential framework implemented as a digital badge (D-badge) pilot in a Hong Kong vocational education context. The framework combines (i) Open Badges 2.0-compliant badge assertions with embedded evidence, (ii) an institutional issuance workflow with identity validation, and (iii) blockchain anchoring of badge assertion hashes to provide tamper-evident integrity without storing personal data on-chain. Using a design-science and formative evaluation approach, we describe the system architecture and workflow and report descriptive findings from a post-deployment survey of stakeholders who used the pilot (students, employers/mentors, and teachers; n=143). Respondents reported high perceived value for internship portfolio verification and career signalling, with 79% of employers/mentors indicating trust in the platform for reviewing student skills and 80% of teachers reporting satisfaction for verifying student profiles. Students reported strong perceived usefulness for presenting internship achievements and maintaining a lifelong learning record. Given the absence of invitation counts and a validated multi-item instrument, the empirical claims are limited to stakeholder perceptions. We conclude with implementation lessons and a balanced discussion of adoption risks (interoperability, employer awareness, equity, and sustainability) to inform future deployments and research.

Keywords: Blockchain, Digital badges; Internship portfolio. Micro-credentials, Vocational education

1. Introduction

In vocational and professional education and training (VPET), internship and industrial attachment experiences are central to demonstrating employability, workplace readiness, and applied competence. Yet the evidence of these experiences is often fragmented across paper certificates, supervisor comments, course transcripts, and informal artefacts (e.g., screenshots, photos, and employer emails). Paper-based credentials are also susceptible to loss and re-issuance burdens, while credential fraud has grown globally through diploma mills and falsified certificates. Digital badges and micro-credentials have emerged as an alternative form of portable, metadata-rich recognition that can capture granular skills and embed evidence (Gibson et al., 2015; Liyanagunawardena et al., 2017).

However, badge adoption faces persistent challenges: inconsistent badge quality, interoperability and standardisation issues, limited employer awareness, equity implications, and long-term sustainability of issuing platforms (Perkins, 2021; Roy, 2019; Varadarajan et al., 2023). In addition, the credibility of a badge depends on the verifiability of its issuer, the integrity of its underlying data, and the ability of third parties to validate claims. Blockchain technologies are often proposed as a mechanism for tamper-evident records and decentralised verification, but many studies provide limited detail on what is stored on-chain, what remains off-chain, and how blockchain improves upon conventional signing.

This paper addresses these gaps by presenting a concrete blockchain-integrated framework for internship portfolio micro-credentialing and reporting implementation lessons from a pilot deployment in the Hong Kong Institute of Vocational Education (IVE), part of the Vocational Training Council (VTC). The pilot system (D-badge) was designed to (1) support evidence-based internship portfolio tracking, (2) enable employers/mentors to verify badge assertions efficiently, and (3) give learners a portable, standards-aligned record of achievements that can be shared with prospective employers.

2. Related Work and Conceptual Framing

Open Badges define a standardised data model for digital badges as portable image or JSON-LD artefacts that contain structured metadata about the issuer, the earner, criteria, and evidence (IMS Global Learning Consortium, 2018; 1EdTech, n.d.). Research identifies several educational affordances: making learning visible, scaffolding progress, recognising informal learning, and supporting motivation (Abramovich et al., 2013; Jovanović & Devedžić, 2015). In vocational settings, the ability to associate credentials with concrete workplace evidence is particularly relevant for employability signalling.

At the same time, critical work highlights that badges are not inherently beneficial. Outcomes depend on badge design quality, the credibility of assessment, the interpretability of metadata, and social recognition by employers and professional communities (Perkins, 2021; Stefaniak, 2019). Systematic reviews report common risks: credential inflation, inconsistent standards across issuers, limited industry buy-in, and inequitable access when

badges depend on resources or social capital (Roy, 2019; Varadarajan et al., 2023).

Blockchain has been proposed for education credentialing to provide integrity, persistence, and reduced dependence on a single issuing platform (Grech & Camilleri, 2017; Sharples & Domingue, 2016; Turkanović et al., 2018). However, privacy constraints and institutional governance requirements typically make it inappropriate to store personal data or rich evidence on public ledgers. Practical designs therefore tend to anchor a cryptographic hash of the credential on-chain while keeping the credential body and evidence off-chain or use permissioned ledgers with role-based access. The present study adopts the former approach.

Conceptually, our framework is informed by two complementary lenses. First, technology acceptance perspectives emphasise perceived usefulness and ease of use as determinants of adoption in educational systems (Davis, 1989). Second, trust is central to credential ecosystems: employers must trust that a credential was issued by an authorised institution and has not been tampered with, while learners must trust that their data is protected and portable. We therefore treat perceived usefulness, perceived ease of use, and perceived trust as formative evaluation dimensions rather than as causally tested hypotheses in this pilot.

3. Blockchain-Integrated Framework and System Design

This section specifies the proposed blockchain-integrated framework and clarifies what is anchored on-chain versus managed off-chain. The framework is designed to (i) remain compatible with widely adopted badge standards, (ii) support evidence-based assessment in internship contexts, and (iii) provide tamper-evident verification for external stakeholders without exposing personal data.

3.1 Architecture overview

Figure 1 summarises the end-to-end architecture. The institutional badge issuer generates Open Badges 2.0 assertions that include criteria and evidence pointers. A cryptographic digest (hash) of each issued badge assertion is then recorded on a blockchain ledger as an integrity anchor along with a timestamp and issuer identifier. Employers and other verifiers can validate a badge by (1) verifying the issuer signature and badge metadata and (2) checking that the badge assertion hash matched the on-chain record.

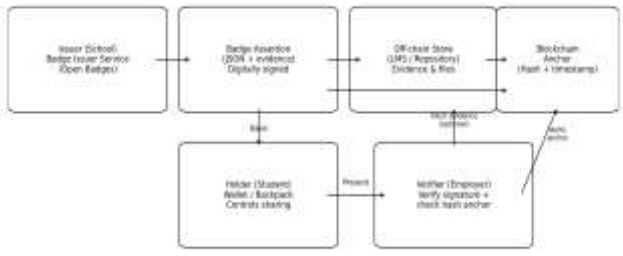

Figure 1: Reference architecture for blockchain-anchored Open Badges issuance and verification (personal data and evidence remain off-chain)

3.2 Issuance workflow and badge lifecycle

The D-badge lifecycle comprises issuer authorisation, learner identity validation, badge assertion creation, issuance, redemption, sharing, and verification. As shown in Figure 2, students earn badges after completing assessments, competitions, or internship evidence submissions. The institution validates the student identity and issues a tokenised badge claim that the student can redeem and share as a URL or portable badge file. Verifiers can confirm authenticity by accessing the badge assertion and performing integrity checks.

Figure 2: Core issuance and sharing workflow in the D-badge pilot

3.3 Trust model and governance controls

A credential ecosystem requires trust relationships among the institution (issuer), learners (holders), and employers/mentors (verifiers). Figure 3 illustrates the trust dependencies addressed by the system. The institution relies on the platform to enforce access control, audit trails, and integrity anchoring; employers rely on verifiability and credential authenticity; and learners rely on privacy and convenient portability. In this framework, blockchain is used only for integrity anchoring of non-identifying hashes; governance and identity management remain institutional responsibilities.

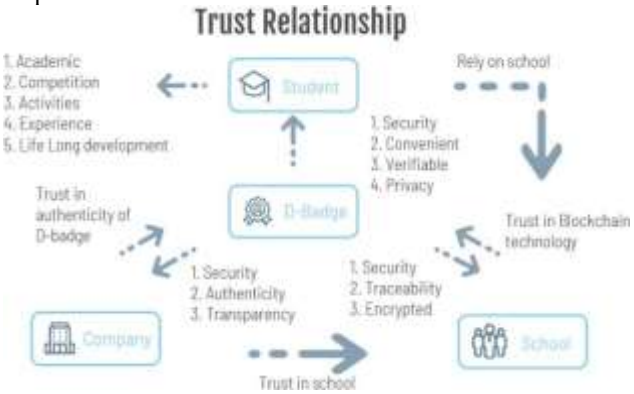

Figure 3: Trust relationship model between issuers, holders, and verifiers in the D-badge ecosystem.

3.4 Internship badge design: View-learn-earn

To align micro-credentials with internship learning outcomes, the pilot operationalised a View-learn-earn process (Figure 4). Students first review the badge requirements and recommend attachment pathways (View), then undertake learning and workplace activities aligned to criteria (Learn) and finally submit evidence for

mentor review and approval (Earn). This structure emphasises evidence-based recognition rather than simple participation badges.

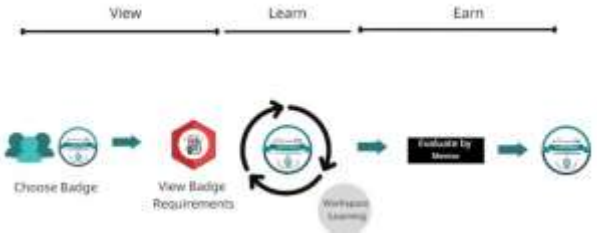

Figure 4: View-learn-earn process for internship-aligned badge acquisition.

3.5 Security and privacy considerations

The framework follows a minimisation principle: no personal data or detailed evidence artefacts are stored on-chain. Instead, the system records only a cryptographic hash of the badge assertion plus a timestamp and issuer identifier. Evidence is stored off-chain in an institutional repository referenced by the badge assertion. This approach provides tamper-evident integrity while reducing privacy risks and avoiding the irreversibility problems of storing personal data on immutable ledgers (Grech & Camilleri, 2017). Future iterations can align with W3C Verifiable Credentials data models for interoperability with emerging digital wallet ecosystems (W3C, 2022; W3C, 2025).

4. Methodology

Given the pilot nature of the deployment and limitations of the available survey instrumentation, this study is positioned as a design-science system description with formative evaluation. The objective is to document the framework and extract implementation lessons from authentic stakeholder use rather than to test causal hypotheses.

4.1 Context and setting

The pilot was deployed in a VPET internship and industrial attachment context at IVE/VTC in Hong Kong. IVE programmes include structured industrial attachment activities intended to develop workplace competencies and employability. The D-badge pilot aimed to provide a verifiable portfolio layer across course, competition, and internship experiences.

4.2 Participants and sampling

Stakeholders who used the pilot system were invited to provide feedback through an online questionnaire. Completed responses were obtained from 22 employers/mentors, 86 students, and 35 teachers (total n=143). The sampling approach was pragmatic and usage-based; therefore, the respondent set may over-represent individuals who were more engaged with the system. Invitation counts and response rates were not systematically recorded during the pilot, which limits generalisability and precludes non-response bias analysis.

4.3 Instrument

The questionnaire comprised of short items tailored to each stakeholder group. Items focused on perceived usefulness for internship-related tasks, satisfaction with the platform experience, and perceived trust in verification. Questions used a five-point satisfaction rating where applicable and included open-ended prompts for perceived advantages and improvement suggestions. Because the instrument primarily used single-item measures per construct, psychometric validation (e.g., internal consistency reliability) was not appropriate for this pilot; instead, the instrument was reviewed for face validity by the project team and aligned with the formative evaluation goals.

Table 1: Survey focus and indicative items by stakeholder group

Research focus	Stakeholder group	Indicative survey items (examples)
Employer verification and recruitment utility (RQ1)	Employers /Mentors	Satisfaction with using D-badge in recruiting IA students; perceived advantages for verifying qualifications.
Student career signalling and portfolio value (RQ2)	Students	Satisfaction with using D-badge to find IA jobs; intention to use D-badge for lifelong learning record.
Institutional verification and supervision support (RQ3)	Teachers	Satisfaction with using D-badge to verify prior qualifications and student profiles.

4.4 Procedure and data analysis

The pilot system was implemented using Open Badges infrastructure and configured for internship portfolio use. After stakeholder use, the online questionnaire was administered in May 2022. Quantitative responses were analysed descriptively using frequencies and percentages. Open-ended comments were reviewed and summarised thematically to identify recurring perceived benefits and concerns. Given the exploratory design, results are interpreted as stakeholder perceptions rather than evidence of causal impact.

4.5 Ethics and data protection

The evaluation focused on platform perceptions and did not require collection of sensitive personal data beyond role grouping. Badge evidence artefacts used within the platform were managed under institutional governance controls, with access limited to authorised supervisors and mentors. The blockchain anchoring approach records only non-identifying hashes and timestamps, supporting privacy-by-design.

5. Results

This section summarises descriptive survey findings. Because invitation counts and instrument validation were not captured in the pilot, findings should be read as indicative stakeholder perceptions.

5.1 Employer/mentor perceptions

Employers and mentors emphasised the value of verified skill evidence during candidate screening and internship supervision. Seventy-nine percent of employer/mentor respondents indicated trust in the D-

badge platform for reviewing student skills, citing the ability to view structured criteria and evidence aligned to internship outcomes. Qualitative comments highlighted perceived advantages in reducing time spent validating certificates and increasing confidence that claims were issued by the institution.

5.2 Student perceptions

Students reported that the platform supported clearer presentation of internship achievements and helped consolidate evidence across coursework, competitions, and attachment activities. A large majority reported high engagement with the badge workflow and expressed intent to continue using the system to record future qualifications and work experience as part of a lifelong learning record. Students also noted the usefulness of sharing a badge profile link in applications and professional networking contexts (e.g., LinkedIn).

5.3 Teacher perceptions

Teachers reported that the platform provided a convenient mechanism to verify student profiles and to track evidence submissions within the internship process. Eighty percent of teacher respondents reported satisfaction with using D-badge to help verify students' prior qualifications and profiles, particularly for matching students to appropriate attachment opportunities and monitoring progress.

5.4 Summary of key descriptive indicators

Table 2: Key descriptive indicators reported by stakeholders in the pilot evaluation

Indicator	Stakeholder	Result (pilot)	Interpretation boundary
Trust in platform for reviewing / verifying student skills	Employers / Mentors	79% reported trust	Self-reported perception; not compared to alternatives.
Satisfaction for verifying prior qualifications and profiles	Teachers	80% reported satisfaction	Perception only; no objective verification time measured.
High engagement with badge workflow and portfolio value	Students	Majority reported strong engagement	No validated engagement scale; descriptive only.

6. Discussion

The pilot findings suggest that stakeholders perceive practical value in a standards-aligned digital badge platform for internship portfolio verification. Employers/mentors highlighted benefits in credibility and efficiency when reviewing candidate evidence, while teachers valued streamlined verification of prior qualifications and progress tracking. Students perceived the platform as a convenient portfolio artefact that can support career signalling and ongoing professional development.

Importantly, the role of blockchain must be interpreted precisely. In this framework, blockchain does not replace institutional assessment or governance; rather, it provides a tamper-evident integrity layer by anchoring badge assertion hashes and timestamps on a distributed ledger. This adds value primarily in scenarios where a verifier needs confidence that a badge assertion has not been modified after issuance, or where long-term integrity assurance is required across platform migrations. This design aligns with broader work proposing blockchain anchoring for educational records while keeping personal data off-chain (Grech & Camilleri, 2017; Sharples & Domingue, 2016).

Nevertheless, blockchain anchoring alone does not guarantee trust. Trust in micro-credentials ultimately depends on issuer reputation, assessment validity, transparency of criteria, and verifiable evidence quality. Employer recognition remains a critical barrier; studies report that employers can be uncertain about how to interpret badge metadata and may have limited awareness of digital badges in recruitment workflows (Perkins, 2021). For vocational institutions, therefore, a badge strategy must combine technical verifiability with stakeholder engagement, guidance on interpretation, and quality assurance processes.

6.1 Practical implications

For VPET providers considering internship micro-credentials, the pilot suggests several implementation practices: (1) use standards such as Open Badges to maximise portability; (2) require evidence-based badges with explicit criteria and mentor review; (3) minimise on-chain data and adopt privacy-by-design; (4) provide employers with a simple verification interface and interpretation guidance; and (5) align badge taxonomies with occupational skills frameworks used by industry. Institutions should treat badges as part of an employability signalling ecosystem rather than as standalone technology artefacts.

6.2 Limitations and future research

The pilot evaluation has important limitations. First, invitation counts and response rates were not recorded, preventing assessment of representativeness and non-response bias. Second, the survey instrument used short, role-specific items and was not validated as a multi-item scale; therefore, results should be interpreted descriptively. Third, the study reports self-reported perceptions and does not include objective measures such as verification time reduction, error rates, or employment outcomes. Fourth, findings are based on a single institutional context. Future research should conduct larger multi-institution studies, use validated acceptance and trust measures, and compare blockchain anchoring to conventional digital signing solutions under equivalent governance controls. Longitudinal studies are also needed to evaluate employer recognition trajectories and equity impacts of badge ecosystems.

7. Conclusion

This paper specified and documented a blockchain-integrated micro-credential framework for vocational internship portfolios and reported lessons from a pilot deployment in a Hong Kong VPET setting. By combining Open Badges-compliant assertions with evidence-based mentor review and blockchain hash anchoring, the

framework supports portable, tamper-evident credentials while keeping personal data off-chain. Formative evaluation findings indicate that employers or mentors, students, and teachers perceive practical benefits for verification and portfolio presentation. However, claims are bound by the pilot's descriptive survey design and the absence of response-rate documentation. Future work should strengthen empirical validation and investigate adoption challenges including interoperability, employer awareness, and long-term sustainability.

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