



DIGITAL CHANGES IN NATIONAL QUALIFICATION SYSTEMS: LABOR MARKET INTEGRATION, STATISTICAL EVIDENCE

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Abstract. *This article examines the conditions under which the digital transformation of national qualifications systems (NCS) brings measurable benefits to the labor market, using a country-specific and comparative statistical system that incorporates analytical measurement. Based on administrative statistics published by the ILO, OECD, UNESCO, the World Bank, and national qualification bodies, the study examined statistical tables covering the results of the blockchain certification program, evidence on the implementation of AI-based assessment, econometric calculations of letter of credit employment rewards, microcredit policy scenarios, and investment cost and return profiles.*

Keywords: *national qualification system, digital reference books, platform interaction, blockchain, adaptive AI assessment, microcredits, labor market integration, employment remuneration.*

Annotatsiya. *Ushbu maqolada milliy malaka tizimlarining (MMS) raqamli o'zgarishi mehnat bozorida o'lchanadigan foyda keltiradigan sharoitlar mamlakat misolida va tahliliy o'lchovni qamrab olgan qiyosiy statistik tizimdan foydalangan holda o'rganiladi. XMT, IHTT, YUNESKO, Jahon banki va milliy malaka organlari tomonidan e'lon qilingan ma'muriy statistik ma'lumotlarga asoslanib, tadqiqot blokcheyn sertifikatlash dasturi natijalarini, sun'iy intellektga asoslangan baholashni joriy etish dalillarini, akkreditiv bandlik mukofotlarining ekonometrik hisob-kitoblarini, mikro kreditiv siyosati manzaralarini va investitsiya xarajatlari va daromadlilik profillarini qamrab olgan statistik jadvallar o'rganildi.*

Kalit so'zlar: milliy malaka tizimi, raqamli ma'lumotnomalar, platformalarning o'zaro ishlashi, blokcheyn, sun'iy intellektni adaptiv baholash, mikrokreditivlar, mehnat bozori integratsiyasi, bandlik mukofoti.

Аннотация. В данной статье рассматриваются условия, при которых цифровая трансформация национальных систем квалификаций (НСК) приносит измеримую выгоду на рынке труда, на примере страны и с использованием системы сравнительной статистики, охватывающей аналитические измерения. Основываясь на административной статистике, опубликованной МОТ, ОЭСР, ЮНЕСКО, Всемирным банком и национальными квалификационными органами, в исследовании были изучены статистические таблицы, охватывающие результаты программы сертификации блокчейна, доказательства внедрения оценки на основе искусственного интеллекта, эконометрические расчеты вознаграждений за аккредитивную занятость, картины микрокредитной политики и профили инвестиционных затрат и доходности.

Ключевые слова: национальная система квалификаций, цифровые справочники, взаимодействие платформ, блокчейн, адаптивная оценка искусственного интеллекта, микрокредиты, интеграция рынка труда, вознаграждение за занятость.

Introduction.

The digital transformation of national qualification systems has shifted in the policy discourse from an aspirational goal to a measurable governance challenge. As of 2024, more than 140 countries have adopted some form of national qualifications framework (NQF), yet fewer than a third have operationalised a fully digitised credential platform with machine-readable employer interfaces (UNESCO-UNEVOC, 2023). This gap between normative architecture and operational capability defines the central empirical puzzle of this paper.

In the context of globalization and the rapid development of the digital economy, national qualification systems (NQS) are becoming key institutions ensuring effective integration with labor markets. In particular, the widespread adoption of digital technologies such as artificial intelligence, blockchain, and platform-based management systems is fundamentally transforming the processes of skills assessment, certification, and recognition.

Currently, international organizations such as the International Labour Organization, the Organisation for Economic Co-operation and Development, the UNESCO, and the World Bank provide evidence that digital qualification systems significantly influence employment levels, labor productivity, and workforce adaptability.

At the same time, in many countries traditional qualification systems are increasingly unable to fully meet the evolving demands of labor markets, leading to a growing skills mismatch between formally obtained qualifications and actual competencies. This situation further highlights the urgency of implementing modern, transparent, and digitally enabled national qualification frameworks.

The relevance of this study lies in its examination of how the digital transformation of national qualification systems produces measurable economic and statistical effects on labor market integration, thereby providing an empirical basis for evidence-based policy making.

OECD data indicate that the average wage differential between workers holding a formally recognised vocational qualification and those without is 14.2 per cent across member states (OECD Education at a Glance, 2023). When that credential is digitally verifiable by an employer's HR system in near-real time, the premium widens by a further 7.9 percentage points on average a differential that is plausibly attributable to reduced employer search costs and a credible anti-fraud signal rather than to any underlying difference in worker productivity. The implication is economically significant: the architecture of the platform through

which a credential is issued and verified is itself a determinant of its labour market value, independently of the competencies it certifies.

Literature Review.

Grover and Berente (2020) develop a typology of digital credential ecosystems, distinguishing closed institutional systems, federated networks, and open blockchain protocols. Their central proposition that the labour market signalling value of a credential is proportional to the inverse of employer verification friction cost provides the theoretical foundation for the API-uptime dimension of Table 1. Where verification requires human action (downloading, emailing, telephoning an issuing institution), the information asymmetry between credential holder and employer is only partially resolved; where verification is machine-triggered through a standardised API call completed in under two seconds, the asymmetry is eliminated and the credential's labour market signal approaches its theoretical maximum.

Autor (2022) updates his task-based model of labour market polarisation to incorporate credential signal quality as a determinant of occupational mobility. He shows that workers in middle-skill occupations who hold verifiable credentials experience 40 per cent lower occupational displacement rates during technology-driven restructuring events, suggesting that digital credential integrity functions as a form of human capital insurance.

Mikroyannidis, Third and Domingue (2022) evaluate the Blockcerts open standard across 41 countries and report that blockchain anchoring reduces credential fraud detection costs by 73 per cent and cuts verification time from an average of 4.2 days to under one minute. Critically, they show that the platform-governance model specifically, whether an open API standard accompanies deployment determines whether employer adoption scales: programmes with open APIs

achieved 61-92 per cent employer uptake; those without peaked at 22 per cent, regardless of credential volume.

Ziegler, Seeling and Sametinger (2021) conduct a systematic review of 84 studies on AI-mediated competency assessment and report an average assessment-time reduction of 41 per cent and psychometric validity relative to expert-panel scoring. Their finding that assessor acceptance not algorithmic performance is the binding constraint in vocational settings is supported by the Korea case, where acceptance rose from 41 per cent to 84 per cent over a 12-month parallel-run period

Chakroun and Keevy (2022) examine micro-credential architectures in 19 countries through the lens of UNESCO's 2021 Recommendation on Open Educational Resources, and establish that NQFs which fail to legislate stackable credit accumulation are structurally incapable of accommodating just-in-time digital skills acquisition. Their quantitative finding that legislated stackability is associated with a 340 per cent increase in micro-credential completion volumes within four years of enactment, as observed in the Australia case provides the most compelling cost-benefit argument for the micro-credential legislation.

Kim and Park (2023) analyse five years deployment data Korea and report that NLP scoring engines reduced per-candidate assessment costs by 38 per cent while maintaining score divergence from expert panels below four per cent. Their replication of this result across 22 occupational categories, including three in manufacturing that closely correspond to Uzbekistan's NTQTTC pilot scope

Research methodology.

This study employs a comparative statistical meta-analysis design. Six thematic statistical tables are constructed from primary statistical sources published by international organisations (ILO, UNESCO-UNEVOC, OECD, World Bank, ADB, Cedefop), national qualification authorities (SSG Singapore, HRD Korea, BIBB Germany, MMTRI Uzbekistan, NCVER Australia), and peer-reviewed

econometric studies. The selection criteria for included studies are: (i) publication between 2020 and 2025; (ii) availability of disaggregated statistics at the programme or country level; and (iii) use of a control or comparison group in causal inference studies.

Cross-country comparability is ensured by anchoring all platform readiness indicators to the definitions adopted in the OECD Digital Education Outlook (2023) and the UNESCO-UNEVOC Digital Skills for Work and Life framework (2022). Where national statistics use divergent definitions (for example, different definitions of 'digitally issued credential'), this is noted in table footnotes. The Digital Readiness Index (DRI) in Table 1 is an additive composite constructed on a 20-point scale, with six binary or quasi-continuous sub-indicators weighted equally. Investment cost and ROI estimates in Table 6 are converted to USD at 2023 PPP-adjusted exchange rates to permit cross-country comparison.

Results and discussion.

The digital transformation of national qualification systems (NQS) represents a structural shift from traditional credential-based frameworks toward data-driven, interoperable, and competency-based ecosystems. This transition is increasingly supported by administrative and statistical evidence collected by international databases and national labor market observatories.

Empirical observations indicate that countries implementing digital qualification infrastructures such as blockchain-based certification, AI-driven skills assessment, and interoperable digital credential platforms tend to demonstrate improved labor market matching efficiency. In particular, the reduction in verification time for qualifications and the increased transparency of credential recognition contribute to lower transaction costs for both employers and job seekers.

Data synthesized from the International Labour Organization and the World Bank suggest that labor markets with digitally integrated qualification systems

exhibit higher rates of workforce mobility and faster transitions from education to employment. Similarly, OECD-based comparative analyses highlight that digital credentialing systems enhance cross-border recognition of skills, thereby supporting international labor mobility and reducing structural unemployment.

Table 1 presents the comparative Digital Readiness Index across seven countries and the OECD average. The six dimensions NQF digitalisation level, digital credential issuance rate, employer portal activity, API standard presence, platform uptime, and real-time labour market intelligence feed capture the full technology stack from issuance to intelligence integration.

Table 1.

NQS digital platform development: cross-country statistical benchmarking (2024–2025)

Country	NQF Level Digitised	Digital Cred. Issuance (%)	API Standard	Platform Uptime (%)	
Singapore	Full (1–8)	97	OpenAPI 3.0	99.7	202
South Korea	Full (1–9)	91	HRD- NET API	99.1	202
Estonia	Full (1–8)	88	X-Road	99.4	202
Germany	Partial (4–8)	62	ELMO standard	98.6	
Poland	Partial (3–8)	48	None formal	97.2	202
Kazakhstan	Partial (1–8)	39	Pilot REST	94.2	

OECD Average	Mostly full	71	Partial	98.0	Skil 202
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Sources: MOM/SSG Singapore 2024; HRD Korea 2024; Cedefop 2023; BIBB Germany 2023; OECD Skills Outlook 2023;

The data reveal a tripartite stratification. Singapore, South Korea, and Estonia form a leading cohort with full-stack digitalisation: all three combine complete NQF digitisation, digital issuance rates above 88 per cent, active employer portals, formally specified API standards, platform uptime exceeding 99 per cent, and real-time labour market intelligence feeds. These countries treat the qualification platform not as an HR document archive but as a living labour market intelligence infrastructure.

Germany and Poland form an intermediate cohort constrained by federal governance complexity and legacy system fragmentation respectively. Kazakhstan, despite a comparable reform timeline to Uzbekistan, scores substantially higher due to its three-year head start in interoperability investment under the ADB-supported skills system reform programme (OECD, 2023).

Table 2 aggregates published statistics from six operational blockchain credential programmes spanning 2016–2025. The evidence base spans from the global Blockcerts open standard to national programmes in Malta, Singapore, the EU, South Korea, and Kazakhstan.

Table 2.
Blockchain credential adoption programme-level statistics (2016–2025)

Programme / Country	Launch Year	Credentials Issued (000)	Verification Time (min)	Frau Reduction (%)
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Malta DLQI National Blockchain Certs	2019	320	2.1	91
Singapore OpenCerts Platform	2019	1,840	0.8	98
EU Europass Digital Credentials	2021	2,100	1.3	87
MIT Blockcerts Open Standard (global)	2016	4,200+	<1	96

Kazakhstan NQS Blockchain Pilot	2023	28	3.5	N/A
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Sources: EQF report 2022 (Malta); SSG Singapore 2024; Cedefop 2023 (EU Europass); HRD Korea 2024; Mikroyannidis et al. 2022 (Blockcerts); OECD 2023 (Kazakhstan);

Three regularities emerge from the cross-programme data. First, employer adoption rates correlate strongly with API openness rather than credential volume: Malta (78% employer adoption) and Singapore (92%) achieved high uptake precisely because their blockchain platforms were accompanied by documented API standards that permitted employer HR systems to query credential status without human intermediation. Kazakhstan's pilot (22% adoption) lacks this API layer despite its blockchain infrastructure, producing a pattern consistent with Afonso and Santos's (2021) finding that blockchain deployment without API standardisation peaks at low employer adoption regardless of credential volume.

Second, verification time is the most consequential operational metric: across all programmes with active employer portals, verification time of under two minutes correlates with employer adoption rates above 60 per cent, while programmes requiring three minutes or more (Kazakhstan at 3.5 minutes, manual systems) cluster below 25 per cent adoption. Third, fraud reduction rates (87–98%) are consistently high across all blockchain programmes irrespective of governance model, confirming that the anti-fraud dividend is a reliable co-benefit rather than a primary driver of adoption.

Within the package, OpenAPI standardisation and the LMI dashboard offer the most favourable cost-efficiency profiles: combined cost under USD 2.5 million,

implementation period under 12 months, and break-even in under two years. These two interventions can be implemented within existing legislative authority without new law, making them immune to the regulatory lag that constrains micro-credential legislation and cross-border recognition. The sequencing logic is therefore: API standard and LMI dashboard in year one (enabling technology layer); blockchain and AI assessment in years two–three (integrity and efficiency layer); micro-credential legislation and mutual recognition in years three–five (regulatory and international integration layer).

From a technological perspective, blockchain-based certification systems improve the reliability and immutability of educational and professional records, reducing the risk of credential fraud. Meanwhile, AI-based adaptive assessment systems enable real-time evaluation of competencies, allowing qualification frameworks to shift from static knowledge validation to dynamic skill measurement.

However, the implementation of such systems is not without challenges. UNESCO and other policy institutions emphasize that disparities in digital infrastructure, regulatory readiness, and institutional capacity may widen the gap between developed and developing economies. Additionally, issues related to data privacy, algorithmic bias, and interoperability standards remain significant barriers to full-scale adoption.

Overall, the analysis suggests that while digital NQS reforms have strong potential to improve labor market efficiency and integration, their success largely depends on coordinated policy frameworks, investment in digital infrastructure, and international standardization efforts.

Conclusions.

First conclusion, the statistical benchmarking across six analytical dimensions establishes that Uzbekistan's national qualification system is currently operating at the issuance layer of digital transformation while leaving the verification, integrity,

and intelligence layers structurally absent. A system that issues QR-coded credentials but provides no machine-readable API for employer verification, no blockchain anchoring for fraud prevention, and no real-time labour market intelligence feed is, from the employer perspective, functionally equivalent to a paper credential with a decorative digital appendage. The employer trust deficit (38% of employers, lowest in the regional comparator set) is not a cultural disposition to be overcome by awareness campaigns; it is a rational response to a system architecture that does not support machine-verified trust.

Second conclusion, The Cedefop (2023) finding that approximately half of the total credential wage premium is attributable to the digital verifiability layer specifically rather than the underlying competency certification is particularly important for investment prioritisation it implies that upgrading the platform architecture of an existing qualification system yields labour market returns comparable in magnitude to redesigning the competency standards themselves, at a fraction of the cost and timeline.

Third conclusion, the blockchain and AI assessment programme statistics, drawn from mature deployments in Singapore, South Korea, Malta, and the EU, are sufficiently consistent to support confident Uzbekistan-specific projections. The technology performance risk of these interventions is low; the residual risk is institutional specifically, assessor acceptance of AI scoring and employer adoption of blockchain verification. Both risks have documented mitigation protocols: the Korea parallel-run model for assessor acceptance and the Malta/Singapore open-API mandate for employer adoption.

Fourth conclusion, OpenAPI standardisation must precede blockchain and AI deployment, as neither technology can reach scale employer adoption without a machine-readable exchange standard. Micro-credential legislation and cross-border mutual recognition are the highest-impact long-term interventions but depend on legislative processes that cannot be compressed. The near-term action window API

standard and LMI dashboard in year one is both technically straightforward and institutionally unambiguous in its authority.

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