Credentials to Employment: The Last Mile

Digital Credentials Consortium Report
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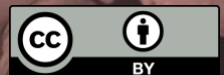
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Executive Summary

This report attempts to map the space that exists between the promise of digital credentials that represent skills, competencies and abilities and their widespread adoption in employment-related use cases. It is based on a set of semi-structured interviews with leading experts and decision makers in North America and Europe, desk research and expert analysis.

The research identifies a complex ecosystem of stakeholders that goes beyond simply dividing stakeholders into issuers, holders and validators or educational institutions, learners and employers. Each of these groups is diverse, and different sub-groups have different relationships with credentials—implying that they often will not face the same problems or require the same solutions.

It finds that employers see potential value in using digital credentials for a number of different reasons. These include using digital credentials to better match candidates to jobs by analyzing their skills, broadening the talent funnel by data-mining credential databases, ensuring the authenticity of credentials, and using credentials to manage the talent pathways in their organizations.

At the same time, adoption remains limited. Our conversations indicate that there is no one obstacle whose removal would suddenly supercharge digital credential adoption. Rather limited adoption is a function of a complex set of economic, political, technical and cultural factors. We make a series of recommendations that, together, can lead to more widespread adoption.

Key Findings

- Employers cannot be analyzed as a single group. Large employers, small and medium enterprises, as well as regulated professions, have different relationships with digital credentials and will respond to different incentives.

- The main use case for digital credentials from an employer perspective is that of better matching the skills held by job applicants to the positions being offered. However, there is a disconnect between the value digital credentials provide today and the expectations for skills-based hiring that employers place in them.

- Adoption of digital Verifiable Credentials by employers is directly related to the way they are integrated into Human-Resource Management Systems (HRMS). Such integration will require requests of employers or initiative of vendors.

- Employers do not consider improved verifiability a strong enough incentive to move from traditional credentials to digital versions of these credentials. Verification alone, which prevents fraud and misrepresentation, is not considered to generate sufficient business value to justify the cost of updating technology systems and workflows.

- Despite large numbers of digital credentials having been issued in a variety of formats and using different technologies, none of these have yet reached sufficient scale to drive adoption by the HRMS space.

- Digital credentials can store more granular information about learning outcomes or achievements, which is needed to make informed assessments of competence. Traditional credentials such as degrees, diplomas or letters of recommendation, even in digital form, lack this data. In order to transition to skills-based hiring processes, more detailed information, some of which institutions already track and store internally, will need to be included into the credentials.

- Most semantic standards to describe skills or competencies have been developed primarily for credentials issued by colleges and universities, with little input from employers. While these standards do not explicitly exclude skill acquisition at the workplace, their design does not encourage employers to adopt or support them.

- The trust model applied by many employers to evaluate applicants relies heavily on proxies such as accreditation bodies, ranking lists, licensed provider lists or social trust mechanisms. Up to this point, insufficient attention has been paid to working with stakeholders to digitize this information, or to link it to digital credentials.

- Employers who wish to understand the semantic context of credentials need to invest heavily in developing custom tools. The plethora of different semantic standards, and limited access to open-source libraries and Artificial Intelligence (AI) models, heavily favors large technology firms in this market.

- Resumes, paper and PDF, are still the lingua franca of most Human-Resource (HR) processes. Shifting to digital credentials does not imply replacing the resume, but would give applicants new ways of extending their employment profiles. This could enhance resumes, by making them more reliable and trustworthy.

- Skill-based hiring is held back by a lack of coordination. Currently, stakeholders in education, standardization, HR and skill startups consist of separate communities that only sometimes overlap. This significantly reduces the potential for taking a coordinated, integrated approach toward adoption of digital credential technologies.

Responding to these findings, and addressing some of the challenges listed, will require concerted action from all stakeholders.

Recommendations

Recommendations for Issuers

R1: Accelerate the Issuing of Verifiable Credentials at Scale

Issuers, especially colleges and universities, should start issuing digital versions of their current credentials at scale. Even though credential technologies are sufficiently mature, too many institutions remain focused on piloting or rolling out digital credentials gingerly and incrementally. The priority needs to be increasing the number of relevant digital credentials in the market.

R2: Add More Data on Skills and Competencies to the Credentials

Issuers should add more granular skill descriptors to their credentials, especially in cases where they already track some of the information related to skills, competencies and abilities of their students or employees.

R3: Choose Credential Solutions that Provide Interoperability

Issuers should establish requirements around technical interoperability and use of open standards as part of their selection process for technology solutions. Development of guidelines for issuers on how to evaluate technology solutions and highlighting options with better support for interoperability would assist issuers in making better choices.

Recommendations for Employers

R4: Pilot Employer-Based Credential-Issuing

Employers should pilot new types of credentials that can document the acquisition of new skills during employment. Such pilots should focus on adapting existing talent review processes to incorporate formal skills assessments and resolving any institutional barriers. The pilots also need to examine how to integrate such new processes with existing talent management systems.

R5: Invest in Sectoral Competence Frameworks

Employers should support the further development of sectoral competence or skill frameworks across all employment categories, and the publication of these as linked open data, will strongly increase semantic understanding of credentials. They will also allow both learners and educational organizations to better create flexible learning pathways that reflect employer skill needs.

Recommendation for Governments

R6: Support Innovation in Credentialing

Governments can accelerate adoption by stimulating innovation in the sector overall. From a legislative standpoint they can remove barriers to recognition and transfer of credentials in the education system, and create incentives for companies to share data. From an executive standpoint they can support innovation programs and act as pioneers by accepting and/or issuing credentials as part of their own hiring and promotion processes. Governments can also mandate institutions use Verifiable Credentials as a condition for eligibility to student financial aid programs.

Recommendations for Trust Providers

R7: Publish Trust Information as Linked Open Data

The value of a credential is related to the trust placed in the issuing organization. In many cases Trust Providers, such as accreditation or licensing bodies, should publish their registries of authorized organizations in open data formats, engage with the credentials community to help set standards, and develop software tools that make it possible to link Verifiable Credentials to these established sources of trust.

R8: Develop Credential Quality Guidelines and Processes

Quality standards for Verifiable Credentials that recognize the achievements of students or employees should be developed and integrated in existing quality management systems and accreditation processes.

Recommendations for Joint Action

R9: Create a Roadmap for an Integrated Skills Ecosystem

Major employers, credential-issuers, trust providers, HRMS & Student Information Systems (SIS) vendors, as well as standardization bodies, should create mechanisms that can coordinate the development of the sector in an integrated way. This could be operationalized through the creation of a 5-year ecosystem roadmap that integrates the various stakeholder perspectives.

R10: Enhance the Evidence-Base around Employer Benefits

Additional research is needed to quantify the benefits of adopting digital credentials in integrated 'end-to-end' use cases that cover issuing, sharing and acceptance of credentials by employers. These pilots will be most effective when focused on specific industry sectors.

R11: Support Development of Tools for Validation of Abilities and Achievements

Significant effort needs to be made to improve software that evaluates the content of credentials (which describes the abilities or achievements of a credential holder). This might include developing open-source software libraries linked to major semantic standards for learning outcomes, publishing directories of such software, or the creation of networks of validators who are able to validate different types of credentials.

Introduction

Objectives

The objective of this report is to consider ways of bridging the gaps between credentials and employment. It identifies challenges in the current system that prevent more widespread adoption, suggest possible solutions, and considers three perspectives:

1. **Credentialing platforms**
   Focusing on interoperability and incentives for open standards
2. **Employers**
   Focusing on features and integration with existing products, and processes
3. **Colleges and universities/Issuers**
   Focusing on issuing workflows and student experience

Methodology

This study was conducted by a team of researchers at the Knowledge Innovation Centre and the Massachusetts Institute of Technology. Anthony F. Camilleri acted as lead researcher and author, supported by Katja Kamšek and Simone Ravaioli. Brandon Muramatsu and Philipp Schmidt provided additional insight and acted as editors. Philipp Schmidt was the principal investigator (PI) on the project.

The research methodology involved:

- Stakeholder analysis for identification of the research cohort, and understanding of the networks around digital credentials
- Desk research on technical standards for digital credentials, as well as support for digital credential standards by major HRMS, SIS and e-portfolio platforms
- Semi-structured interviews, conducted individually or in thematically focused groups, with key actors in the credentialing ecosystem

This study was completed with the help of interviews with the following panel of individuals (referred to as "panelists" throughout the report):

- Brandon Carson, Vice President, Learning and Leadership at Walmart
- Ian Davidson, Chief Growth Officer, SmartResume/iDatafy
- Angeliki Dedopoulou, Public Policy Manager AI & Fintech, Meta
- James Glapa-Grossklag & Harriet Happel, Deans, College of the Canyons

- Dror Gurevich, Chief Executive Officer, Velocity Career Labs
- Jake Hirsch-Allen, Workforce Development Lead, LinkedIn
- Keith Howall, Director Product Management Engineer, Workday
- Angela Jeantet, Senior Academic Director at the Division of Continuing Education at the University of California, Irvine
- Phil Komarny, Vice President Innovation, Salesforce
- Tracy Korsmo, Enterprise Architect, ND Information Technology
- Mark Leuba, Vice President of Product Management, 1EdTech (formerly IMS Global)
- Phil Long, LER Network Facilitator, T3 Innovation Network
- Joshua Marks, Senior Solution Architect, Public Consulting Group
- Matthew Pinsky, Chief Executive Officer, Parchment
- Kelly Palmer, Chief Learning and Talent Officer, Degreed
- Dimitrios Pikios, Team Leader, DG Employment, Social Affairs and Inclusion at the European Commission
- Marty Reed, Chief Executive Officer, RANDA Solutions
- Robert Sheets, Consultant, U.S. Chambers of Commerce Foundation
- Val Thomas, Lead, Talent Mobility Strategy, Talent Cloud
- Rick Torres, Chief Executive Officer, National Student Clearinghouse
- Colin Tück, Director, European Quality Assurance Register
- Jason A. Tyszko, Vice President, Center for Education and Workforce at the U.S. Chamber of Commerce Foundation
- Vikas Wadhwani, Director Learning and Certifications, Meta

Concepts

A Primer on Credentials

Broadly speaking, a credential can be described as any document that makes one or more claims about a person. Employment-related credentials typically include identity credentials that can be used to prove who a person is, educational credentials which attest to what a person has studied, and experiential or job credentials which attest to what a person has done or can do. Many panelists also distinguish skill credentials that indicate the attainment of specific knowledge, skills or competence.

For the purposes of this study, digital credentials are defined as claims which are issued in a format that is both human and machine-readable. A key research question is whether these credentials bring enough value to employers over other legacy technologies including paper-based credentials, digital reproductions or digital documents that are not machine-readable.

Envelope and Content
Digital credentials usually are composed of two parts—an envelope and the content (also referred to as the letter or the payload). The envelope contains the information required to package and secure the content. The content contains the actual claims being made about the user. Typically, an envelope can be used to package different kinds of claims. Envelopes and their packaged content are exchanged between systems via communication protocols such as email, APIs or dedicated exchange systems.

Envelopes can be digitally signed by their issuers. This serves the dual purpose of identifying the issuer and protecting the content of the credential. This is equivalent to how a wax seal on a paper document identifies the issuer through the incorporation of a crest and ensures that the content has not been tampered with as long as the seal has not been broken.

Delivering a paper envelope from one party to another requires a postal system. Similarly, delivering a digital document from one party to another requires a mechanism to transport the envelope and its content between computer systems. This is the realm of a third set of standards for communication between systems and may include APIs, as well as other communication protocols such as those used for email.

Recently, significant efforts have been focused on developing a particular form of digital credential, known as Verifiable Credentials. These are digitally signed credential envelopes that are issued according to the W3C Verifiable Credentials Recommendation. While the terms Verifiable Credentials and digital credentials are increasingly used interchangeably, this report maintains the distinction.

In an educational and employment context, a typical credential lifecycle involves a set of six processes:

- A person **earns** a personal, educational, professional or administrative achievement
- A credential issuer then **issues** a credential to that person, describing the achievement
- The person **stores** the credential, in a safe physical location or a digital wallet
- The person **shares** the credential with a third party, such as a potential employer
- The third party **verifies** the authenticity and provenance of the credential
- The third party **assesses** the claims made in the credential

Credential Verification and Validation

Verification ensures authenticity and integrity of a credential and deals with the envelope of a credential. It allows a third party to confirm that the content of a credential has not been changed. Validation involves processing the claims inside a credential within the context of a particular use case. It allows a third party, such as an employer, to determine whether a credential is fit for the purpose for which it is being presented. It requires the use of shared standards and protocols so that the content of a credential can be received, read and validated. Specific aspects of the verification and validation process are listed below:

- Ability of a verifier to **receive** a digital document, according to a commonly agreed format with the issuer/sharer
- **Verification of the authenticity** of the envelope either by reference against a registry and/or by verifying a digital signature
- **Automated processing** of the content of the document according to the formats and schemas laid out by a data standard/model
- **Analysis and assessment** of the content of the document within the context of its intended use case—by humans and/or assisted by AI
- The resulting **determination** if an applicant might be suitable for a particular job or task

Understanding the Actors

Practically all panelists emphasize that dividing stakeholders into issuers, holders and validators or educational institutions, learners and employers does not adequately reflect the complexity of the ecosystem. Each of these groups is extremely diverse, and different sub-groups have different relationships with credentials—as a result they often will not face the same problems or require the same solutions.

Employers

Panelists indicate that at a high level, employers share the need to attract and retain talent, and to ensure that their workforce holds the right skills to handle the tasks assigned to them, or perform in the jobs they were hired for.

Medium and Large employers (consisting of enterprises employing 50-249 and more than 250 employees respectively[1]) encompass nearly two thirds of the U.S. workforce.[2] These employers tend to have specialized departments for HR, and sometimes are further divided into departments dealing with hiring/applicant tracking, performance and training. They also tend to have standardized internal procedures covering all HR processes and significant needs for internal tracking and documentation. They typically make extensive and sophisticated use of technology to support hiring and talent management processes.

Small and Micro employers (consisting of enterprises employing 10-49 employees or fewer than 10 employees respectively[1]) often are significantly less specialized, and more informal. Specific functions in training and hiring are often not assigned to a specialist but merged into other roles. They also do not have access to enterprise-class HR systems/software due to a lack of volume which would justify the cost and/or complexity of implementation.

Employers also vary in the type of people they retain and hire. Most jobs require a mixture of industry-specific skills and knowledge, as well as more general professional competencies and abilities. Employers' attitudes to credentialing are correlated with their expectation of these different types of abilities. For example, employers hiring for the approximately one quarter of U.S. jobs that require a license[3] tend to emphasize credentials and industry-specific skills. On the other hand, employers who prioritize general knowledge-processing, problem solving or communication skills tend to emphasize interviews, competitions and trials much more strongly than credentials.

Issuers

Traditional academic issuers have been issuing credentials at scale for years, and include universities, colleges, professional certification providers, etc. These issuers tend to have strong integration with research, employment and social environments and have established quality assurance, recognition and verification procedures that embed trust in their credentials. Traditional issuers emphasize that their credentials are designed to be portable and widely recognized in multiple usage contexts. As such, they tend to package broad arrays of competences into single credentials, such as degrees or diplomas, that represent broad swaths of achievement, rather than explicitly list more granular skills and competencies.

Alternative providers offer micro-credentials, often directly tied to specific skill acquisition and tightly tied to employer demand—these include Massively Online Open Course (MOOC) providers and corporate training portals. These programs tend to be designed to address specific industry demands. The issuing institutions tend to have more flexible business processes and eschew many of the formalized assessment, verification and quality processes and procedures used by traditional issuers. Quality and recognition of credentials is often described in terms of proving fitness for

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[1] Organization for Economic Cooperation and Development, "Enterprises by Business Size," *Entrepreneurship at a Glance*, 2017, https://doi.org/10.1787/31d5eeaf-en.

[2] Organization for Economic Cooperation and Development, "Employment by Enterprise Size," *Entrepreneurship at a Glance*, 2017, 42–49, https://doi.org/10.1787/entrepreneur_aag-2017-6-en.

[3] Goodwin, K., "The State of Occupational Licensing: Research, State Policies and Trends," *National Conference of State Legislatures*, 2017.

purpose for their assigned use case. It should be noted that a significant number of traditional colleges and universities are also active in this category.

The 'world of work' describes all use cases where persons may obtain skills while doing a job outside formal education. Issuers in the 'world of work' include enterprises, governments, non-profit and civil society organizations, contract-agencies and entrepreneurs. For these organizations, skill-development of their employees, volunteers or customers is not the main business focus. They therefore also rarely issue credentials for such achievements. Despite this, proof of achievement in this context is an important part of a job application, which is instead often sourced through a mixture of candidate interviews, referees and standardized testing.

Software Categories and Providers

Vendors of software that deal with skills information are critical actors in the digital ecosystem. Within the educational sector, Learning Management Systems (LMS) and Student Information Systems (SIS) store information about achievement and student identity. The market is a mixture of software licensed from vendors, implementations of open-source solutions and custom-software built by organizations to manage their processes. Credential management may be included as a function of such software packages.

An ecosystem of specialist digital credential providers including Credly (now part of Pearson), Concentric Sky (now part of Instructure), Accredible, Accredify, as well as government-led platforms such as Europass, and the Dutch and Norwegian diploma registries, interface with these systems to transform learning and employment data into credentials.

On the employer side, a suite of providers develops tools classified as HRMS—often including modules for Talent Management and Applicant Tracking Systems (ATS). According to PwC's 2020 HR Technology Survey, 58% of businesses use HR technology to find, attract and retain talent.[4]

In terms of market capitalization, HRMS providers dwarf specialized digital credential providers. In early 2022, Workaday, one of the market leaders in the sector, had a market capitalization of around $40 billion. On the other hand, Credly, a leader in digital credentials was acquired by Pearson for a comparatively small $200 million.

In their dominance of HR technology, vendors of HRMS software effectively act as gatekeepers for any technology which many employers use to analyze and track skill data. Their willingness to integrate or ignore digital credentials as part of their product to a large extent determines acceptance.

Credential-Holders

Credential-holders can include students, jobseekers and employees. They collect credentials over a lifetime, and may include them in a learning and employment portfolio. They need to be able to share credentials with a third party (e.g., an employer), to represent what they know and what they

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[4] PWC, "Is Technology the Answer to Your Biggest HR Challenges? Find out what top executives say," Oracle, n.d., https://www.oracle.com/a/ocom/docs/pwcs-hr-technology-survey.pdf.

can do. They also need to communicate their potential, i.e., what they are able to learn, as well as to receive guidance on how to realize their potential.

Furthermore, panelists emphasize that credential-holders differentiate themselves based on education, access and ability to use technology, which in turn are tied into wider issues of diversity and equity. Credential-holders tend to have concerns around ability to present information in a way that best reflects their own specific needs, as well as around safety and privacy of their information.[5] Socio-economic barriers can affect their ability to document their skills and effectively present them to employers. Basic prerequisites for effective use of credentials—such as how to search for quality employment, prepare a job application or resume, how to conduct oneself in an interview or create a career pathway—are not evenly or universally distributed among the population.

Despite being at the center of every exchange of credentials, credential-holders' requirements are not a main driver in the development of credentialing systems for employment. Typically, a jobseeker will try to adapt their processes to that of an employer—meaning that credential systems are driven primarily by employer requirements. Additionally, credential-holders, consumer groups and unions have very little knowledge about the advantages of digital credentials, which further weaken the voice of this stakeholder.

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[5] Cacicio, Sarah, Brian Tinsley, Antionette Miller, and Christina Luke Luna, "Inclusive Design Principles for Learning and Employment Records: Co-Designing for Equity," Digital Promise, 2022, https://doi.org/10.51388/20.500.12265/154.

Employer Use Cases for Digital Credentials

Over the last decade, there has been a growing need for new and flexible models of education, and a growing interest in recognizing knowledge, skills and competences regardless of where they were gained. Digital technologies, changing demographics and globalization continue to change the nature of the workplace and employment structures. With some jobs at risk of being obsolete, others being transformed and new ones being created, the notion of a 'job for life' is a thing of the past.

The effect of emerging technologies on the future of work and skills means that individuals will need to learn throughout their entire life, in new and flexible ways—both inside and outside of formal education. The International Labor Organization emphasizes that "the frontloading of skills through initial training for a single lifetime qualification is not sufficient or effective and education and training systems of the future need to be flexible and prepare individuals to learn continuously over their life."[6]

According to the World Economic Forum (WEF) Future of Jobs Report, 85 million jobs may be displaced by automation by 2025, while an additional 97 million new roles may be created globally. On average, companies estimate that around 40% of workers will require reskilling of six months or less and 94% of business leaders report that they expect employees to pick up new skills on the job.[7] Trends in employment point toward higher labor mobility—not only between companies, but between entirely different professions. More than half of the people who quit their jobs in the U.S. in 2021 changed their field of work or occupation.[8]

This need for reskilling is being catered for at scale by professional education providers and micro-credential platforms that offer a host of new education programs. Sometimes these are part of corporate learning programs offered to employees, and sometimes employees pursue additional education independently. The transition to online learning allows educational providers to scale globally, massively and in a shorter time than traditional education, giving learners a new array of options. WEF estimates that online learning has quadrupled in 2021. Surveys of MOOC platforms

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[6] International Labor Office and Organization for Economic Co-operation and Development, "Global Skills Trends, Training Needs and Lifelong Learning Strategies for the Future of Work," International Labor Organization, n.d., https://www.ilo.org/wcmsp5/groups/public/---dgreports/---inst/documents/publication/wcms_646038.pdf.

[7] World Economic Forum, "The Future of Jobs Report 2020," World Economic Forum, October 2020, https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf.

[8] Parker, Kim, and Juliana Menasce Horowitz, "Majority of Workers Who Quit a Job in 2021 Cite Low Pay, No Opportunities for Advancement, Feeling Disrespected," Pew Research Center, March 10, 2022, https://www.pewresearch.org/fact-tank/2022/03/09/majority-of-workers-who-quit-a-job-in-2021-cite-low-pay-no-opportunities-for-advancement-feeling-disrespected/.

show a significant growth in users, starting well before the COVID-19 pandemic, and only being accelerated by it. 2021 saw 220 million users take courses with the major online MOOC providers.[9]

Additionally, as economies recover from the COVID-19 pandemic, major structural shifts in the workforce triggered by changes to migration patterns, new attitudes to work-life balance and aging populations have exacerbated skill-shortages being reported by many employers for years. The Manpower Group Employment Outlook Survey finds that 3 of 4 employers report difficulty in finding talent—the highest proportion in over a decade.[10]

Most of the panelists stated the main potential value of digital credentials is helping companies address the challenges created by this shift in workforce recruitment and training. Our panelists elaborate a set of use cases, ranked in descending order of importance, where adoption of digital credentials could create value for enterprises.

Matching Skills to Jobs

Every member of our panel identifies skill-based hiring as the most important current trend in employment. With employers having favored degree holders for many positions for the decade before the COVID-19 pandemic,[11] recent data shows that a tightening of labor markets is leading employers to reduce degree-requirements for many mid-tier occupations, due to lack of qualified traditional candidates.[12]

This talent-gap translates into a need for employers to seek out other proxies of talent than those typically included in a resume. Industry shows a broad desire to complement the credentials typically presented by a job applicant (which generally consist of a list of academic credentials and employers, or positions held) with alternative credentials,[13] as well as detailed information on the skills they possess.

Depending on the employer, this is driven by a desire to identify whether a user has:

- Specific 'hard' skills (often linked to digital skills) that are in high-demand or rare
- Transversal soft skills such as interpersonal skills
- The ability to adapt to new situations and gain additional skills while in employment

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[9] Shah, Diwal, "A Decade of Moocs: A Review of MOOC STATS and Trends in 2021." Class Central, December 18, 2021, https://www.classcentral.com/report/moocs-stats-and-trends-2021/.

[10] ManpowerGroup, "ManpowerGroup Employment Outlook Survey Results," ManpowerGroup, September 13, 2022, https://go.manpowergroup.com/meos.

[11] Carnevale, Anthony P., Jayasundera, Tamara and Artem Gulish, "America's Divided Recovery. College Haves and Have Nots 2016," Georgetown University Center on Education and the Workforce, 2016, https://1gyhoq479ufd3yna29x7ubjn-wpengine.netdna-ssl.com/wp-content/uploads/Americas-Divided-Recovery-web.pdf.

[12] Sigelman, Matt, "The Emerging Degree Reset," The Burning Glass Institute, February 9, 2022, https://www.burningglassinstitute.org/research/the-emerging-degree-reset.

[13] Society for Human Resource Management, "Making Alternative Credentials Work: A New Strategy for HR Professionals," Society for Human Resource Management, n.d., https://shrm.org/foundation/about/Documents/Making%20Alternative%20Credentials%20Work%20A%20New%20Strategy%20for%20HR%20Professionals.pdf

Practically all panelists see this ability to better understand their current job applicants as the number-one use case for digital credentials. They identify a trend of employers wanting to move beyond summaries of data encapsulated in resumes to gain access to additional rich metadata about a person's experiences. Given the effort it would take to sift through this type of data manually, this implies providing the ability to match individuals to the jobs required.

Widening Access to Talent

Closely tied to the idea that employers need to better predict suitability of existing candidates for their jobs is the idea of using digital credentials to strengthen recruitment pipelines and identify new candidates. This includes candidates whose experience has been in a different industry, and who may not use the appropriate terminology when describing their own skills or even be aware that they would qualify for jobs in a separate industry even though they have all the skills required. Another use case are candidates who only lack a small specific set of skills that can easily be gained through additional training, but who might get filtered out by more automated review processes. The post-COVID-19 shift to more hybrid and remote work might also create an opportunity to review hiring practices and requirements and use this moment to address some existing inefficiencies.

Credentials that better reflect specific skills or competencies can be combined with data on occupational profiles, job applications and learning opportunities to:

- consider applicants who do not hold the previously required types of credentials, but may have all the necessary skills and
- expand the pool of candidates by suggesting learning pathways which could fill a specific skill gap a candidate might have.

Furthermore, aggregating this more fine-grained information about skills, competencies and abilities into searchable databases enables more proactive search for candidates who may not even think that they are eligible for a specific job. However, developing such databases relies on potential candidates to self-report their experience and skills in online profiles or resume-builders, as much of this information is only available if self-reported. In addition, issuers would need to include this information within digital credentials. The absence of this information excludes many qualified candidates who may not take the time to fully complete an online profile, may not have the knowledge and skills to do so or may not have access to these tools. It also raises very serious data privacy issues. When candidates agree to store and share detailed, granular credentials, it becomes possible to data-mine these credentials with very little future input needed from the users. This could increase uptake and widen access by identifying new possible matches between candidates and jobs, but it could also further entrench inequities as certain types of candidates may be screened out based on their particular set of credentials or experiences.

Verifying Credentials

A typical workflow for a job application involves an individual describing their educational credential, or possibly including a scan or copy of it in their resume. Employers will filter resumes based on selection criteria, and then further filter candidates based on interviews and other forms of assessment. For valid candidates, an employer will typically engage a background check company to verify the credentials attached to the resume. Several panelists stress that many academic credentials in the United States are already digitized for the explicit purpose of verification of authenticity. The National Student Clearinghouse holds a centralized register of enrollment and graduation documents for 19,900 high schools and 3,600 colleges and universities and serves 1 million requests per day for verification. Typically, a background check will involve checking the Clearinghouse in the first instance and, should the record not exist, making further enquiries with the issuing institution.

Verifiable Credentials can increase the efficiency and reduce the costs involved in this process, by allowing verification to take place instantly and without reference to fee-charging external services. This said, some of our panelists stress that the improvements digital credentials offer to employers, especially large employers, are not dramatic compared to the current system. As such, there is limited demand for new systems. On the other hand, given the difficulty of verification without the assistance of a specialist provider, smaller employers may not even choose to go through the trouble of verification, relying instead on interviews and trial-periods to determine a candidate's knowledge.

The following table summarizes different verification needs of different types of employers:

	Demand for verification	Role of credentials in continuing education	Focus of verification (envelope or content)
Large Employers	Mostly outsourced to credential verification and background check companies	Good opportunity for adding rich metadata in credentials awarded at work	At application stage, credential content is critical—verification of the credential only comes at pre-hiring stage
Small Medium Enterprises (SMEs)	Easier verification offers significant benefits as verification is usually done in-house or not at all	Hard to do—SMEs tend not to have a training infrastructure of their own, this is something that would come from outsourced partners	At application stage, credential content is critical—verification of the credential only comes at pre-hiring stage
Regulated professions	Verification is an absolute necessity for every application process	High interest in adding more reliable metadata	Authenticity of the credential is verified as a prerequisite to apply in certain cases

In addition to the presentation of academic credentials, a job application might require submission of an ID card, membership to a professional organization, driver's license, security clearance, license to practice and so on. While in many professions the academic requirements can be waived or adjusted depending on the other skills presented by a person, these types of credentials are considered prerequisites to employment without which a person would not even qualify for an interview. In this context, verification takes on higher importance, and the idea of a priori rather than post factum credential verification becomes more attractive. Panelists see significant potential for instant, multiple-verifications of these kinds of credentials, whereby an applicant might submit a set of credentials of different types and from different issuers (e.g., ID card, driver's license and board licensing) in a package and have them instantly verified.

Simplified View of the HRMS Space
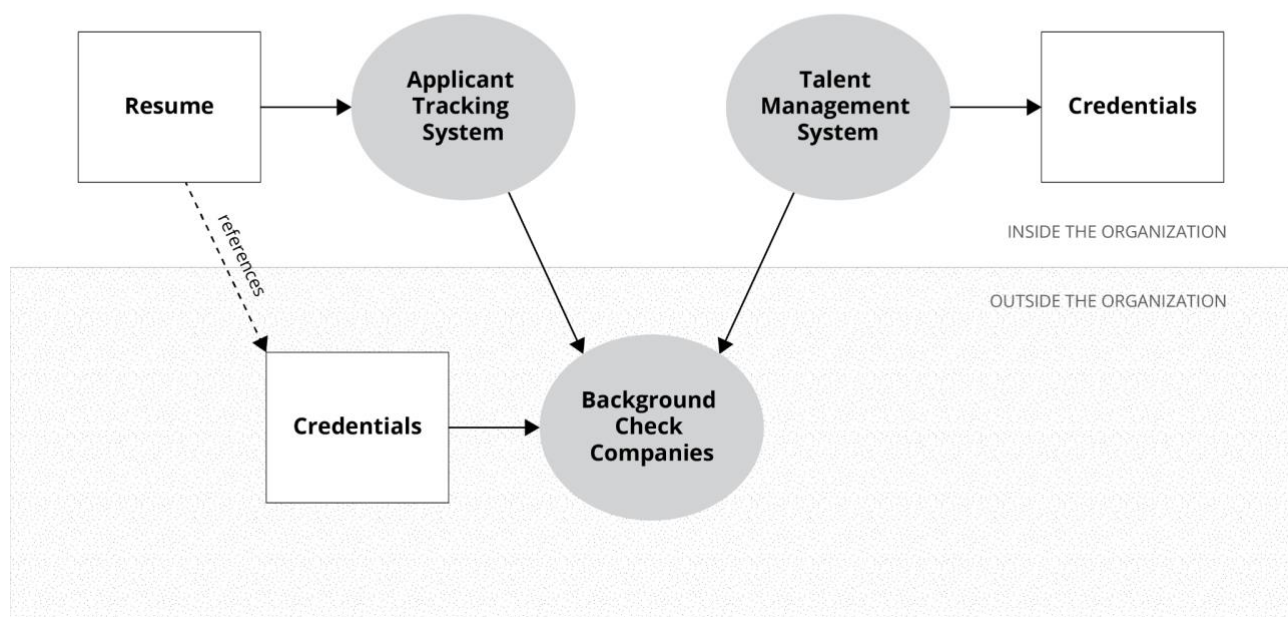
Talent Management

Panelists see a significant role for using digital credentials to document ongoing skill-development of employees. Talent management systems record the tasks or projects an employee has been involved in, internal training received, notes on competences (such as problem solving) made by managers, as well as ratings from clients (such as Uber or Lyft driver ratings). Making this data available to employees as digital credentials provides significant advantages. In this vein companies are increasingly viewing employee development as a 'co-investment', which implies documenting skill investments made by the company as part of an overall benefits package.

An emerging subset of companies, including ones in fast food and logistics, advertise themselves as a place to gain additional skills and competences which can be taken on to other employment.

Several companies finance their employees' college participation or upskilling via various forms of alternative credentials.

While talent management using credentials is very much an emerging field in most organizations,[14] they can be used for a variety of purposes including:

- planning workforce and schedules across stores, or even across entire regions to ensure adequate supply of qualified personnel for times of key demand,
- ensuring compliance with legislation around licenses required to operate machinery, or do other specialist tasks,
- creating competence databases to identify individuals with skills for specialist jobs in knowledge intensive service industries such as legal and consulting firms, and
- developing and tracking personal development plans for employees.

Issuing experiential credentials earned at a company as portable digital credentials is currently extremely rare. However, some of our panel indicate that they expect forward looking companies will increasingly see this as a differentiator that will allow them to attract talent. We discuss the incentives and barriers to this use case in the 'world of work' section further on.

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[14] Gallagher, Sean R., Mosley, Rashid and Tova Sanders, "The New Landscape for Workplace Learning: Employers and Workers Managing the Digital Transition," Northeastern College of Professional Studies, October 2021, https://cps.northeastern.edu/wp-content/uploads/2021/10/Workplace-Learning-Report-1.pdf.

Challenges & Barriers: What is Limiting the Adoption of Digital Credentials?

Any discussion of the role of digital credentials needs to be considered as part of a broader labor market shift. Digitization of credentials is not seen as a goal itself, but rather as an enabler of several paradigm shifts, which taken together can transform hiring processes and career development pathways.

- Skills-based hiring sees employers look for direct proof of skill acquisition, rather than rely on proxies for talent such as employment or educational history.
- Lifelong learning coupled with changing attitudes around jobs for life sees employees constantly seeking new skills and opportunities.

An unbundled education sector could meet these challenges by offering a global marketplace of diverse providers, including traditional academic institutions as well as new types of training providers and credential issuers.

Set against this background, our panel of experts have identified a set of challenges which are holding back digital credentials from achieving their full potential to employers. Our conversations indicate that there is no one obstacle whose removal would suddenly supercharge digital credential adoption. Rather limited adoption is a function of a complex set of economic, political, technical and cultural factors.

Employers and HRMS Vendors Lack Incentives

In a context of hiring, information on a person's achievement is practically always presented to an employer via an HRMS. Should these software systems start accepting digital credentials, then employers will be accepting them by default. Our panel indicates that the most direct route for this to happen is for employers to request the feature from their vendors.

However, to a large extent, merely digitizing academic/university credentials alone does not bring enough value to employers for them to show much active interest in them. The digitization of all administrative processes is considered to be inevitable and ongoing, and therefore employers do not take much interest in the mechanics of accelerating it. To a large extent, it is expected to happen, and when the technologies and standards are mature enough, they assume that continuous iterative updates in software systems and procedures will integrate it into their processes.

Furthermore, while much of the work of the credentials community is focused on automating verification through the use of cryptographic signatures and openly accessible trust registries, many

employers outsource this function to background check companies at reasonable cost and interviews have not identified this as a significant pain point for them.

Low acceptance by employers in turn implies no urgent need for credential-issuers to prioritize issuing Verifiable Credentials in lieu of their current formats. The lack of urgency translates into low support for digital credentialing in the SIS and LMS systems used by most educational institutions. For example, of the 60 LMS and SIS packages which are certified by 1EdTech for integrating one of 1EdTech's interoperability standards, only one has certified support for the Comprehensive Learner Record.[15]

This problem is exacerbated by practically all providers of digital credentials providing an option to export as PDF—thus continuing to reinforce the ubiquity of PDFs instead of promoting an alternative solution that offers enhanced features.

In fact, few organizations are issuing digital credentials at scale (and in a machine readable format). The most common container for a credential presented to employers is still a PDF. Our panel indicates that even successful digital credential implementation stories, such as Open Badges with over 50 million credentials issued in the United States,[16] only represent niche use cases. For the typical jobseeker today, digital credentials will document only a tiny fraction of their overall achievement.

Our panel indicates that for employers to become excited about digital credentials requires:

- evidence that they can be used for more than verification—namely skills matching and talent identification, or
- a reasonable belief that a plurality of job candidates will hold digital credentials in the near future.

To some extent, this represents a 'chicken and egg' problem. Neither issuers nor HRMS vendors/employers are prioritizing digital credentials while waiting for demand or movement from the other side. With the situation left unchanged, while digital credentials will continue to be adopted, this adoption will be slow, uneven and likely fail to have large impacts on either the educational or employment communities in the short-to-mid-term.

Issuers are Not Issuing the Types of Credentials Employers Need or Want

All our panelists highlight a gap in what current credentials on the market can say about their holders and the information employers are looking for to improve their hiring and career

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[15] 1EdTech, "Product Directory," Product Certifications | IMS Global, n.d., https://site.imsglobal.org/certifications?refinementList%5Bproduct_category%5D%5B0%5D=Student%20Information%20System%20%28SIS%29&refinementList%5Bproduct_category%5D%5B1%5D=Learning%20Management%20System%20%28LMS%29.

[16] IMS Global Learning Consortium and Credential Engine, "Badge Count 2020," 1EdTech, 2020, http://content.imsglobal.org/badge-count-2020/badge-count-2020/.

progression decisions. As discussed earlier, in the current employment environment characterized by high labor mobility and a constrained supply of (re)skilled personnel, many applicants for a position will not have direct experience of the work in their target profession. Nor will they have gained a title that is explicitly targeted toward that new position. To be able to assess these kinds of applicants, employers want insight into which specific skills and experiences of a presenter may be transferable to new contexts. This includes skills a candidate may have gained outside of formal education, for example through professional development programs, on-the-job training, volunteering experience or experiences in their other professions.

With respect to more general skills, most traditional credentials do not reflect one of the most important outcomes of a college education, the ability to learn new things in the future. Employers are not only looking for evidence that a candidate is able to fill a current role, but they would like to predict if that person is going to continue to learn and grow into future roles.

Educational Institutions

Many of our panelists, as well as numerous others, have been arguing that traditional academic credentials such as diplomas or transcripts lack the rich data on skills and competencies that would enable skills-based hiring and talent management practices. Some consider the traditional credentials as outdated and no longer fit for purpose. However, the criticism seems to be more about pushing for future innovation than about assessing the current role of academic credentials in the marketplace.

Demand from employers continues to increase and is now higher in the United States than at any other point in history.[17] This creates new challenges for candidates with less traditional backgrounds and excludes candidates who may have the necessary skills, but lack the required formal credentials. To date there are few examples where different approaches to recruiting based on skills have been deployed at scale, and they seem most common in technology fields, where employers struggle to fill available positions and candidates can demonstrate technical abilities in other ways. In addition, the traditional credentials that aggregate a wide range of experiences and achievements, continue to serve as a trusted proxy for some of the soft skills that many panelists argued were critically important.

> *"[W]hen it comes to hiring individuals, the government relies very heavily on using degrees as a proxy …. [E]very job poster that goes out, outward facing or internal facing, I would say 99% of the jobs will have a clause in there saying that a degree is required. Whether or not it is officially required for the job is a whole other thing that is part of the process …. The degree is not a proxy for talent, if anything, it just sets up barriers for those … facing systemic inequalities …. [M]y observation is that I think employers take that path because [it is] the path of least resistance, that they have always done it that way, and that is the way that they measure it."*
>
> *— Last Mile Report Panelist*

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[17] Fuller, Joseph B. and Manjari Raman, "Dismissed by Degrees: How Degree Inflation Is Undermining U.S. Competitiveness and Hurting America's Middle Class," Harvard Business School, October 2017, https://www.hbs.edu/faculty/Pages/download.aspx?name=dismissed-by-degrees.pdf.

Despite well-grounded criticisms, academic credentials continue to enjoy widespread acceptance from employers because they are well-known and trusted. The call from all stakeholders, employers and others, seems to be less a criticism of degree-based education than the suggestion that credentials could communicate much more than they do today, in particular by adding detailed skill information.

Typically, academic credentials will consist of a title document (e.g., awarding a degree in Biology), sometimes accompanied by a transcript of records. However, in the U.S., award of a document describing the achievements of a student at course level, together with rich learning outcome descriptors for each course is still the exception. Instructors will typically describe a course and its learning outcomes in significant detail as part of the course design process and perhaps documented in a syllabus, course catalog, accreditation documentation and learning-design systems. However, the details from this process are typically not linked or included as part of a degree or transcript, and would go a long way to meeting employer demands. Examples from other countries could offer a possible way forward.

The **Diploma Supplement**[18] is a standardized credential format designed by the Council of Europe, UNESCO and the European Commission, which is awarded automatically to all students who graduate Higher Education in the European Higher Education Area. It contains a detailed description of the program followed, including the learning outcomes, a summary of each module studied by the student together with grades, together with a brief description of the grading and educational systems. It is typically issued in at least two languages and was designed to improve recognition of academic credentials by employers, as well as other educational institutions. Countries, regions or even individual institutions, including in Australia, Asia and South America have adopted the European format or a derivative thereof in recent years to improve their academic credentials. Additionally, standardization groups have adapted the template to be shareable as linked open data.

Alternative issuers tend to offer shorter, targeted learning experiences, which are specifically designed to address skill gaps. This by default makes their credentials more granular than those issued by traditional academic institutions. That said, research shows that a large percentage of alternative credentials are designed with the same limitations as traditional ones—they contain only short descriptions of the title of a learning program, with little additional metadata or evidence of the learning achievement provided.[19]

Learning in the Workplace

The issue of insufficiently detailed credentials only becomes more acute when it comes to documenting learning acquired at the workplace, by receiving training on the job or through

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[18] European Commission, "Diploma Supplement," European Commission, n.d., https://education.ec.europa.eu/education-levels/higher-education/higher-education-initiatives/inclusive-and-connected-higher-education/diploma-supplement.

[19] Camilleri, A. F., Rampelt, F., Roman, G., Szalma, E., and D. Zarka, "Credentials in Open Education," OEPass Consortium, n.d., https://oepass.eu/wp-content/uploads/sites/22/2020/02/OEPass_O1_final_20022020.pdf.

independent activities. Few mechanisms exist that document these experiences or skills gained—the reference letter (or reference call) often mentioned as the default tool for proving competence achieved in previous employment.

Larger companies may have relatively sophisticated talent management systems in-house which may break each activity the company performs into discrete sets of skills, and which group employees by the activities they know how to perform and/or the skill sets they have. Within professions that require licensing, such information is typically standardized using skill frameworks, occupational profiles, model learning journeys, skill taxonomies and other similar tools. However, outside these systems, large employers tend to create their own in-house data structures and spend little effort on making the information relevant or interoperable outside the company. SMEs are less likely to build such skill and occupational profiles, because the cost would often be prohibitive given the small number of employees performing discrete tasks.

In all cases, irrespective of the sophistication of the information, the data usually remains warehoused within the company. Employees are rarely able to export it at all—let alone in the format of semantically rich interoperable documents. Of the nearly 1 million different credential types tracked by Credential Engine, less than 5% are directly tied to employment experiences (via credentials for apprenticeships, occupational licenses and certifications).[20]

In summary, somewhat ironically, employers are not currently issuing the type of data-rich credentials to their employees that they would ideally like to see job applicants present. While most of our panel acknowledges that certain employers may consider such data proprietary, most indicate this is not a major factor preventing the issue of more and better credentials in workplaces. The problem is rather rooted in business processes that are not necessarily designed to track personal development except as a factor of overall output.

Education and Employment Often Speak Different Languages

> *"When we ... look at how some of these early solutions are engineered, both from a data standard, and even the credential wallets themselves, they are complex, and they are built by people who really don't think about how to make this easy for consumers, and what employers really want."*
> — *Ian Davidson, iDatify*

Specifications that describe learning achievement, such as Comprehensive Learner Record (CLR) or the Credential Transparency Description Language (CTDL), support the documentation of skills obtained in any context—be it within an educational institution, or at the workplace. However, in practice these standards are written primarily by educational stakeholders, which is reflected in standard design, as well as in naming and marketing of the standards. It is telling that none of the major standards actually mention 'employment' in their naming, and it is hard to find marketing

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[20] Credential Engine, "Counting U.S. Postsecondary and Secondary Credentials," Credential Engine, February 2021. https://credentialengine.org/wp-content/uploads/2021/02/Counting-Credentials-2021.pdf.

materials aimed at employers and HRMS vendors, or examples of the standards aimed at workforce development.

Data from Gradintelligence[21] indicates that people in their network share credentials for purposes of accessing further studies nearly three times more often than they share the credentials for purposes of recognition for employment.

While employers generally do want more data to make informed hiring decisions, many academic credentials contain lots of information that is not necessarily relevant to employment use cases, such as information about student and course codes, assessment weighting information, credit transfer information and others, while sometimes omitting more useful data such as licensing information, links to occupational profiles, etc.

The concept of Learning and Employment Records (LERs), as promoted by the T3 Innovation Network, offers a good practice in bridging the two domains. The initiative is developed from the ground up to bring together any type of record in a single learner wallet and interchange it with any system. LERs support multiple semantic standards linked to academic achievement and job vacancies, and package them using a verifiable credential wrapper—standardizing transport and verification. The governance and branding of the initiative is careful to give equal importance to learning and employment without segmenting these into silos.

In short, many credential standards are designed primarily for the needs of credential-issuers, typically educational institutions. While 'officially supported', employment-related use cases are often somewhat of an afterthought—limiting acceptance and adoption by employers.

Digital Credentials Do Not Leverage Trust Models

> *"There are high stakes, medium and low stakes digital credentials. From a consumer standpoint, it's hard to differentiate between them …. that's perhaps one of the barriers in terms of employers adopting digital credentials more seriously, because it's harder for them to differentiate …"*
>
> — *Vikas Wadhwani, Meta*

Much of the work around Verifiable Credentials is centered around creating a direct, verifiable link between an issuer and a credential. Thus, if an employer knows and trusts the issuer, they can also trust the credentials issued and signed by that issuer. For issuers that have a close relationship with certain employers or top universities with universal brand recognition this kind of direct link is enough to give value to their credentials. However, for lesser-known issuers an employer will typically not just want to know whether the credential is authentic, but also whether the issuer can be trusted. Additionally, it is not uncommon for diploma-mills to use brands which are designed to

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[21] Bolland, John and Alex Johnson, "Gradintelligence Digital Credentials Services," The Association for International Credential Evaluation Professionals, n.d., https://www.taicep.org/taiceporgwp/wp-content/uploads/2021/03/Presentation-Materials-7.pdf.

be confused with those of established institutions—making it harder for students and employers to know which credentials to trust.

The perceived trustworthiness and value of a particular credential is a function of multiple factors including accreditation, internal quality assurance practices, external quality audits, published assessment procedures, independent review of content and other techniques. Sometimes issuers use quality labels to indicate adherence to a particular set of quality principles. Lower-value credentials will often be issued *en masse* for activities as granular as attending a workshop and be subject to no quality checks at all.

Distinguishing between the different credential values, especially when the credentials were issued using the same standards and live in the same wallet, is especially challenging. For this reason, many of the more successful examples (in terms of recognition) of digital credential stores exist as closed systems which only admit certain credentials from specific providers.

> The University of California Irvine runs an Alternative Digital Credential Program which issues Open Badges to students using competency-based assessments. The program is backed by a set of ten criteria a digital credential must fulfill before it is included in the program. This includes that certified skills must be immediately relevant to the workplace and that credentials cannot be issued for trivial or irrelevant learning. Furthermore, all credentials must be assessed according to established rubrics, assessors must meet specific criteria of competence, and credentials issued to students must indicate different levels of mastery.[22]

Employers use a combination of different sources of trust to verify claims made by applicants.

- To ensure that universities and colleges are themselves authentic, they refer to licensing or accreditation registries.
- They use rankings and other classifications of educational institutions, which can be used to assess the reputation of educational organizations.
- Various professional licensing organizations keep lists of examinations and programs required to obtain a license, and the institutions that offer these.

Additionally, employers and HRMS vendors are beginning to explore the role of 'social trust' in understanding the value of persons and credentials. These models of social trust vary from understanding what credentials other employers value, to looking at the networks, connections and recommendations of job applicants to determine their respect in the community.

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[22] Xu, Di and Ying Xu, "Alternative Digital Credentials: An Imperative for Higher Education," ERIC Institute of Education Sciences, March 2019, https://files.eric.ed.gov/fulltext/ED596296.pdf.

"… we know that 80% of people get a job based on who they know, based on networking … it just facilitates that human tendency, which is massively filled with bias and inefficiency."
— Jake Hirsch-Allen, LinkedIn

Currently, many of the sources of trust listed above are not yet included in most digital credentialing standards and protocols. Existing standards do not typically contain information on the provenance of the credential to allow for direct evaluation of the quality of an issuer or program. This would require supplementing credential metadata with links to everything from accreditation records to quality assurance systems, grading range tables and even information about under whose guidance/teaching/mentorship persons acquired skills.

While the idea of 'trusted issuer lists' for institutions which comply with a specific set of criteria is an oft-suggested solution, there are no well-accepted standards for publication of such lists yet, nor are there standards for linking digital credentials to those lists. For some, such lists are even considered antithetical to the principles of decentralization and openness espoused by members of the self-sovereign identity community. Licensing and accreditation organizations are also largely absent from standardization bodies dealing with credentialing and are rarely included in digital credential pilots.

Multiple initiatives have tried to make various kinds of social recommendations by issuing credentials. However, up to this point they have worked better in closed social networks rather than as open credentials due to the ability of social networks to tie a recommendation with the profile (and identity) of the recommender. There are also several nascent initiatives to create open linked data around which skills, credentials and issuers are valued by employers.

Open Skills Network has published a standard for Rich Skill Descriptors.[23] This allows any organization to publish an open machine-readable statement with a definition of a skill, together with a list of employers and/or educational organizations that accept/teach the skill. The vision of the network is that with enough of these descriptors published in the wild, it will be easier to understand which educational organizations best train students for specific professions, by crowdsourcing data on recognition.

In summary, respondents highlighted that better standardization, adoption and verification of existing trust relationships would be a key factor in enhancing the reputation of digital credentials generally and accelerating adoption.

Tools for Verification and Validation Are Nascent

"I've talked to employers at large companies who say that 50% of jobseekers who they've decided… to make an offer to fail a background check … because they got … a small detail wrong … or because they were lying very intentionally."
— Ian Davidson, iDatify

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[23] Open Skills Network, "Rich Skill Descriptors," Open Skills Network, n.d., https://www.openskillsnetwork.org/rsd.

Much of the work around using issued digital credentials is centered around two key processes:

- Verification, which involves checking the authenticity of a credential
- Validation, which involves processing the claims inside a credential within the context of a particular use case

The goal of universal verification is to ensure that an application can process and authenticate credentials from different issuers, irrespective of their origin. The Verifiable Credential data model[24] is indicated by most of our panel as the best effort yet at encouraging this in the field of education.

At the same time, members of our panel point out major concerns on whether the specification will be normative enough to serve as a real standard, or if it will result in a series of similar but incompatible systems. This concern is significantly heightened when it comes to standards for signing the credentials and transferring credentials between various wallets.

> *"… a lot of stakeholders are looking for credentials to solve things that really only can be solved at the program level … You can't have a digital credential with machine-readable data for a program that itself isn't evaluating and assessing things that people care about [referring to skills] … I think we don't pay enough attention to the content and the payload. We spend so much time talking about the envelope."*
>
> *— Matthew Pinsky, Parchment*

Panelists emphasize that from an employer perspective, achieving universal verification would be somewhat moot without it being paired with some degree of standardization in validation. Verifiable Credentials are often characterized as secure envelopes in which an issuer can choose to put any content. Employers need more, they need claims they can process and understand that are also packaged in secure envelopes. Given the multiplicity of semantic standards that have not reached a critical mass, software that can accurately validate the majority of (digital) credentials held by a job applicant remains elusive.

Validation also requires systems to have access to large volumes of contextual information, which allow for comparison of different skills, academic credentials and occupations. This typically takes the form of various frameworks for qualifications and skill taxonomies. Our panel notes that while much work has been done in this direction, high-quality data on skill requirements still does not exist for many occupations. Furthermore, a lack of open-source models and (semantic) validation libraries serve as a significant barrier to entry to creating tools which can perform general purpose validation.

In Singapore, the development of skills frameworks is an integral component of its industrial transformation policy. It is co-created by employers, industry associations, education institutions, unions and government for the Singapore workforce. It provides key information on sector, career pathways, occupations/job roles, as well as existing and emerging skills required for the

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[24] W3C, "Verifiable Credentials Data Model v1.1," W3C, March 3, 2022, https://www.w3.org/TR/vc-data-model/.

occupations/job roles. It also provides a list of training programs for skills upgrading and mastery. Using the overall skills framework as a guide, sectoral competence frameworks for 34 different professions have been outlined.

Rather than using hundreds or thousands of variations of skills in course descriptions, credentials or job advertisements, it creates a common skills language for individuals, employers and training providers exchanging credentials. This simplifies validation processes, by reducing fragmentation, facilitating skills recognition and supporting the design of training programs for skills and career development.[25]

Many HRMS providers point to AI approaches for processing unstructured data as the best currently available approach to dealing with validation. Currently these approaches suffer from insufficient accuracy. Improving them requires development of large and high-quality reference datasets to better train the models. Even so, whether it is even possible for them to reach the same (or better) levels of accuracy than a human validator is a matter of debate.

Sharing bundles of credentials with an employer provides the most complex instantiation of this problem. A typical use case would be for a user to present different kinds of credentials (say an ID card, driver's license, university diploma and letter of recommendation from an employer) as part of a single package. Each of these credentials would likely use different semantic standards, rely on different trust mechanisms, and be subject to different validation rules. Additionally, even if all the educational credentials were structured as Verifiable Credentials, other credentials may use different verification standards (for example ISO/IEC 18013-5[26] is gaining significant adoption in the area of driver's licenses.) Finally, using this information to match candidates to jobs would require some way of comparing different degrees from different universities, and evaluating the weight to give different letters of recommendation from employers.

When asked to define a 'credentialing utopia'—an ideal state mature use case for credentials—spanelists indicate that users should be able to have all their achievements documented as credentials, be able to store those credentials in a wallet of their choice, and be able to easily share them and have them verified and validated with any actor. Reaching that goal will require further development and tightening of existing standards, industry convergence around a subset of standards, and integration of applications that can work with these standards across the entire HRMS/SIS/LMS space.

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[25] Government of Singapore, "Skills Framework," SkillsFuture, n.d., https://www.skillsfuture.gov.sg/skills-framework.

[26] ISO, "ISO/IEC 18013-5:2021," ISO, September 2021, https://www.iso.org/standard/69084.html.

Resumes and Credentials Are Still Built for the Old World

"[W]e're relying mostly on traditional resume texts, LinkedIn, data that the candidate has provided to us via our career site and the application process ... then we're relying heavily on the interview results versus say, hiring someone who has a certain level of education or has gone through some certification process."

— Angeliki Dedopoulou, Meta

Many credential-issuers characterize the process of applying for a job as a matter of simply matching Verifiable Credentials to a job-advertisement. However, it is rare that an application process simply requires submission of credentials.

For this reason, many common resume-builders de-emphasize the role of credentials in the application process. They focus on enabling a user to create a summary of their knowledge and skills in a single format, while credentials are relegated to documents which can prove these statements, rather than acting as the primary source of the statement. Resumes also provide a standardized format for users to surface the most important parts of their experience.

Another reason for the centrality of resumes is their ability to include claims by third parties together with claims a person makes about themselves. Many panelists emphasize that often this part of the resume is as important, if not more, than the evidence section.

Similar approaches are possible with emerging standards for description of skills and experiences, which will allow the combination of Verifiable Credentials and claims made by an individual about themselves. By making it easier for individuals to describe their experience in the same language that an institution would use, it would simplify the interpretation of resume data, and it allows third parties to certify that an individual really has the skills they themselves report.

However, despite their centrality in the job application process, resumes are themselves not standardized, which poses challenges in creating automatic tools to summarize academic standards into resumes. This issue is currently being addressed by HR Open Standards in the United States and by the Europass initiative in Europe. Both are working on digital resume containers that can act as containers for Verifiable Credentials.

Several members of our panel suggest that the concept of the resume as a summary document representing one's skills is somewhat outdated. Others argue that Verifiable Credentials provide a useful extension of the current resume standard, by making it easier to verify the information contained within the resume. Increased flexibility in labor and education implies that the number of educational and employment experiences which need to be described on a resume are increasing dramatically. The number of times an employee may need to present credentials for evaluation throughout their career is also increasing. Taken together, this suggests we will need systems that can document, process, and interpret much larger amounts of skills and credential data in the future.

AI may allow employers to ingest and analyze far larger amounts of information while making hiring decisions than was previously possible. Given this, many of our panelists suggest that the future

belongs to a 'credentials first' approach, whereby a person submits digital credentials into an online wallet that aggregates their skills data. The credentials can contain detailed information about all the person's accomplishments and shared selectively with employers. A resume, if used at all, would serve more as an index and explanatory note for the information being presented, then as the prime source for that information. The drawback to this vision is that it assumes that all or most of a person's major accomplishments can be described as credentials.

Replacing resumes with Verifiable Credentials implies no less than the transformation of the foundational business process behind all of hiring. Even if proven as technologically robust, implementing such a transformation would require acceptance and a significant shift in thinking prevalent across most of the HR industry today.

There Is No Integrated Ecosystem of Organizations Working with Skills

"I would say that we as a community need to do more to build trust across the organizations that are involved in these processes and build on each other's work."

— Mark Leuba, 1EdTech

What might be referred to as the 'skills sector' comprises traditional educational institutions, specialized corporate training providers, HR departments of companies, specialist companies (mainly startups) that build skills analysis software and professional organizations which manage the skills requirements for specific industries.

Our interviews show that rather than an integrated sector, these groups are rather organized around a set of semi-permeable cells—each of which is more or less self-referring with limited (but not non-existent) communication with other cells. The cells are organized around:

- Educational organizations, student information system providers and credentialing companies selling to them and standards organizations serving them,

- The 'Verifiable Credential' community consisting mainly of technical persons who wish to use credentials to bring concepts around self-sovereign identity to fruition,

- The 'HR' space that involves HR departments of employers, HRMS/ATS providers, and standardization bodies that cater to their needs,

- The 'skill interoperability' space that, while less organized than the other three, contains a host of startups and organizations trying to link up skills data to create new applications, and

- The 'quality assurance' space including sectoral organizations responsible for licensing standards for various professions, as well as various regulators and accreditation bodies are largely missing from discussions around credentials, despite their pivotal functions in the ecosystem.

All our respondents agree that there is insufficient communication between these cells, and within each cell, insufficient understanding of the requirements of the other. Where one of these actors makes an effort toward improving part of the credentials lifecycle, this effort isn't necessarily recognized or reciprocated by the others, due to matters pertaining mainly to culture.

Respondents generally agree with the sentiment that differences in perspective do not derive from fundamental differences in how stakeholders view the world. Rather, they emerge from this lack of communication. **Should the right initiative bring them together, most respondents believe that it will be relatively straightforward to find consensus and map a joint vision and strategy forward.** However, none of the existing standardization bodies or stakeholder organizations representing the various sectors seems appropriately placed to bring these disparate groups together.

In the European Union, the European Commission is providing funding for the creation of a 'Skills Data Space' to connect currently fragmented and dispersed data from various ecosystems, from the private and public sectors.[27] It will offer an interoperable, trusted IT environment for data processing, and a set of rules of legislative, administrative and contractual nature that determine the rights of access to and processing of the data. The aim of the data space for skills is to create a secure and trusted environment where skills data for various purposes can be shared and accessed. These purposes range from analytical and statistical to policy development or re-use for innovative applications. The data space is intended to bring together schools, universities, learning organizations, businesses, students, HR organizations, and employment agencies and make daily use of data—from job and occupational profiles, vacancies and skills, to available training programs, degrees and graduate numbers.

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[27] European Commission, "Preparatory Actions for Data Spaces (DIGITAL-2021-PREPACTS-DS-01)," European Commission, November 2021, https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/digital-2021-prepacts-ds-01-skills.

Bridging the Last Mile: Recommendations to Realize the Potential of Digital Credentials

"... [credential recognition] is more of a change management problem than [a] technology problem. And until employers change processes and behaviors, they're not going to be asking for what they don't know ... we've done tests years back with certain data standards and competency frameworks ... if you just give this stuff to an employer who has no context for them, they're less likely to use them, or at least use them in an optimal way. But where employers have already been buying into a change management process, and then you give them these tools, the uptake is considerably higher."

— *Jason Tyszcko, US Chambers of Commerce*

This section suggests a number of recommendations which might increase the rate of adoption of digital credentials, by either increasing their utility or removing barriers to implementation. The recommendations are sourced from suggestions given by our panel, suggestions from literature and analysis of the identified problems.

Each recommendation has been cross-checked during the interviews, to ensure feasibility of adoption by relevant stakeholders. Recommendations are grouped by the groups that could implement them.

Recommendations for Colleges and Universities

R1: Accelerate the Issuing of Verifiable Credentials at Scale

To a large extent, the adoption of digital credentials is being held back by a hesitancy on the part of issuers—whether they be colleges, universities or others—to issue digital credentials at scale. Even those institutions considered leaders in the field tend to only issue credentials to a subset of their students, often as part of pilot programs.

While it is true that merely digitizing university credentials does not provide massive value to employers, it is also equally true that the absence of large-scale market adoption of credential-issuing software is holding back support by HR management software.

We therefore recommend that institutions develop a strategy for adoption that involves a technical feasibility analysis followed by large-scale issuance of portable, verifiable credentials to their entire student cohort.

These digital credentials can still be backed by links to central databases such as registrar databases at the issuing institution, the National Student Clearinghouse or attested via paper copies. Following the initial rollout, institutions can then focus on improving their credentialing

practices by working to give equivalent value to digital credentials as certified paper copies, and to increase metadata and other recognition information contained within credentials.

R2: Add More Data on Skills and Competencies to the Credentials

All panelists in this study highlight the value of detailed information about an individual's specific accomplishments and experiences in informing better decisions around hiring and career progression. To this end, credentials need to be enhanced with additional data about individual courses/modules a person has studied, together with the learning outcomes (skills/knowledge) obtained in each of those modules and other documentation of ability. Credentials should also be used to connect to evidence of achievement such as architectural portfolios or coding projects. Wherever possible, credentials should refer to occupational standards or sectoral competence frameworks to increase the ability to interpret them in a specific context.

In the longer term, institutions should consider unbundling more complex aggregate documents into separate more granular credentials. For example, issuing credentials for completion of individual courses within programs, to complement the final program credential allows for a simpler overall architecture, and allows students to begin using their credentials (e.g., to apply for apprenticeships) before even completing a program.

Issuing data-rich granular credentials also may obviate the need to issue many different types of credentials by including all the information in the same credential. It may reduce the need for separate Course Assessment Results, Diplomas, Transcripts of Records, Detailed Transcripts of Records and Diploma Supplements.

R3: Choose Credential Solutions that Provide Interoperability

Where issuers, such as colleges and universities, choose to make the transition to digital credentials, they need to prioritize the use of widely accepted standards and avoid credential silos. Currently, no credential technology or data model has emerged as a universally accepted standard.

While many in our panel argue that the market can support the coexistence of different credential standards (both in terms of envelope and content standards) and technologies, further fragmentation of the space remains a threat to adoption.

In choosing credential solutions, issuers should prioritize credentialing technology that addresses the following requirements:

- **Is based upon a set of open standards, managed transparently by an independent body or organization**
- **Allows learners or jobseekers to control and share their records**
- **Provides tools to automatically verify authenticity for long after the credential has been issued**
- **Can capture rich structured metadata, preferably as linked open data**
- **Is accepted by validators for employment use cases**

By adhering to these principles, issuers can ensure that their efforts would help increase recognition and acceptance not only of their own credentials, but of digital credentials generally.

Recommendations for Employers

R4: Pilot Employer-Based Credential-Issuing

> *"Performance measurement … is an opportunity to start looping in those transferable skills. When I think about credentials, I imagine the opportunity of having a record that is dynamic, this is … where you get that real-time kind of check-in … for those types of skills …"*
> — *Last Mile Report Participant*

At present, skills-based hiring presents somewhat of a paradox: while it is strongly in demand from industry, there is little evidence of employers prioritizing or issuing the detailed documentation of on-the-job experiences that such hiring requires, even for their own currently employed staff.

As discussed above, academic credentials are criticized for the lack of detailed information they contain. However, employers have come to accept that they can act as proxies for a set of knowledge and skills that the student attained. On the other hand, documentation of employees' experiences tends to be reduced to an employment history, letters of recommendations and reference checks—none of which typically contain much skill-related data.

While employee skill acquisition could theoretically be tracked and credentialed, even the most basic questions on how that tracking could take place efficiently and scale remain unanswered.

- Do employers recognize that skill-based hiring implies providing employees with much more detailed documentation of their careers?
- Is it feasible to assess competence and issue credentials for performance reviews?
- Should employers issue credentials that certify that employees were responsible for specific tasks?
- Should employers issue credentials that certify that employees have specific skills or competencies?
- Should employers issue credentials for employer-organized training?
- Are letters of recommendation the right format to continue to use to share some of this information?

While academic institutions have experience in breaking down courses into learning outcomes and assessing student acquisition of these outcomes—employers have far less experience in this area, with even job postings often not providing particularly detailed descriptions of skills and competence required.

Significant additional work needs to be done with employers to operationalize the concept. We need employer pilot studies to investigate skill-based credential-issuing in the workplace and process architectures to propose how to integrate ongoing skills assessment and credential-issuing into employee and talent tracking systems used within companies. Studies would need to focus on whether incentives for skill-based hiring align with the additional time and investment such approaches would take.

R5: Invest in Sectoral Competence Frameworks

Sectoral competence frameworks are indicated by our panel as a key tool to increase the interoperability of credentials between employers and educational organizations within specific professions. They enable the design of flexible learning pathways by educational organizations or by individuals, to meet employment needs.

A well-designed competence framework should outline:

- a set of occupations that is typical within a specific sector,
- occupational specialties within each of those occupations,
- skills which are typical for each of these occupations or specialties,
- skill attainment levels for each skill, and
- synonyms for all the concepts outlined above.

Studies indicate that employers strongly support the development of such competence frameworks.[28] This holds true across the EU, UK, Singapore, Australia and the U.S.

Competence frameworks are best developed by employers in close collaboration with academia, unions, government and other relevant stakeholders. When published using a prevalent semantic standard, such frameworks can facilitate validation and thus significantly enhance adoption in specific industry areas.

Recommendations for Governments

R6: Support Innovation in Credentialing

Stakeholders have significantly different opinions on the potential of government intervention to increase adoption of digital credentials. While some actors suggest legislative routes to accelerate adoption, others strongly advocate that the government keeps a hands-off approach and let the industry set standards. This said, there is some agreement between these camps on initiatives which could possibly incentivize adoption without tamping innovation.

At a legislative level, legislation to create equivalence between paper and digitally-signed credentials, and furthermore to allow for verification of authenticity based on cryptographic signatures, would cut through a patchwork of licensing and hiring policies, without necessitating individual changes to hundreds of different statutory and legislative instruments that make reference to older forms of credentialing and verification.

Legislation such as the California Consumer Privacy Act[29] or the General Data Protection Regulation (GDPR) in Europe creates new rights for employees to request the data their employers hold about them. Both conceptually, as well as practically, it is only a small evolutionary step in going from

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[28] 1EdTech, "Wellspring Initiative Digital Credentials & Competency Framework," 1EdTech, November 2021. https://www.imsglobal.org/sites/default/files/wellspring/Wellspring_II_Employer_Research.pdf.

[29] State of California, "California Consumer Privacy Act of 2018 [1798.100 - 1798.199.100]," California Legislative Information, n.d., http://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?division=3.&part=4.&lawCode=CIV&title=1.81.5.

complying with this legislation to offering credentials to the relevant employees attesting to that same information.

At an executive level, the government can continue to stimulate innovation by funding market-led research, piloting and testing. Several members of our panel specifically highlight the Department of Homeland Security's Silicon Valley Innovation Program[30] as the model for designing such interventions.

The government also has the power to set conditions for educational institutions receiving financial aid indirectly via student grants. Tying the eligibility for federal aid to the issuance of Verifiable Credentials would create strong incentives for institutions to issue digital credentials to their students.

Finally, at an administration level the U.S. government is the largest employer in the world and could adopt digital credentials in its employment practices. Accepting digital credentials in applications for government positions, or issuing credentials to employees, to describe workplace learning would instantly create the economies of scale necessary to accelerate growth of the entire industry, whether such policies were enacted at state or federal levels.

Recommendations for Trust Providers

R7: Publish Trust Information as Linked Open Data
Verification of the authenticity of a credential includes ensuring the identity of the provider and that a credential has not been tampered with. True verification implies that there is reasonable basis to believe that the claim made about the holder in a credential is indeed true. This requires the ability to connect a credential with its basis of trust—the set of documents, procedures and/or claims which give it value and authorize its issue.

Standardization of these concepts would allow for validators to sift through credential wallets and distinguish which credentials are most relevant in a specific use case. Critical to linking up such trust information is a more prominent role for dedicated trust providers in the credential ecosystem. These organizations include accreditation boards and regulators of professions, as well as others such as ranking boards and private quality assurance agencies who publish quality standards for educational organizations and maintain lists of which organizations match the criteria.

In the first instance, they need to work with the credentials standardization community to define ways to link a credential with supporting information linked to its integrity. Work is needed to develop common approaches to use this to describe concepts such as internal quality standards, external audits, or even accreditation credentials.

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[30] Department of Homeland Security, "Silicon Valley Innovation Program," Department of Homeland Security, n.d. https://www.dhs.gov/science-and-technology/svip.

These standards should be used by trust providers to develop trust lists—services that allow validators to automatically ascertain that a specific credential or issuer meets a set of requirements of the trust provider.

In Europe, the Database of **European Quality Assurance Agencies (DEQAR)** stores quality assurance and accreditation reports for most Higher Education Institutions on the continent. DEQAR is linked to the Bologna Process and its quality assurance standards for the European Higher Education Area, ESG. Within the DEQAR CONNECT project, it has been experimenting with various methods to use its registry as a trust anchor for other services. It has implemented APIs which can be accessed by services querying the accreditation status of organizations issuing credentials.[31] It has also experimented with releasing 'accreditation credentials' linked to institutions as Verifiable Credentials which are which can be linked to form institution-awarded Verifiable Credentials to offer proof of accreditation.[32]

R8: Develop Credential Quality Guidelines and Processes

Quality and accreditation standards govern the operations of many educational institutions, as well as corporations. Similar approaches and guidelines are lacking for digital credentials. And digital credentials are not mentioned in existing quality standards for hiring or career development processes. Adoption by employers in particular is limited by the absence of clear expectations around digital credentials in these standards.

Credential criteria that should be included in quality standards:

- Degree and granularity to which an organization documents student or employee learning outcomes
- Degree to which organizations provide users ownership of this data by issuing them as verifiable credentials
- Degree to which issued credentials use standards that can be verified and validated by employers and other actors

Depending on the trust provider, these principles can be expressed in multiple ways, including through development of new quality standards for digital credentials, revision of accreditation guidelines for educational organizations, revision of training standards for regulated professions, creation of 'best practice' guides for employers and issuers.

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[31] European Quality Assurance Register for Higher Education, "From Data to Policy - Linking Quality Assurance and Recognition," Presentations from DEQAR CONNECT, EQAR, December 2021, https://www.eqar.eu/about/projects/deqar-connect/conference/presentations/.

[32] European Quality Assurance Register for Higher Education, "European Blockchain Service Infrastructure (EBSI)," EQAR, n.d., https://www.eqar.eu/qa-results/synergies/european-blockchain-service-infrastructure-ebsi/.

Recommendations for Joint Action

R9: Create a Roadmap for an Integrated Skills Ecosystem

There is a gap between the value digital credentials provide today and the expectations placed upon them by stakeholders. In many of our conversations, we found that there is so much focus on potential future use cases that the already significant value digital credentials offer today is left somewhat ignored. Given this, employer hesitancy and confusion are not surprising—often the promises made by digital credentialing are unable to live up to the hype generated by its promoters and evangelists.

Most panelists agree that HRMS/ATS, employers, credential-issuers and users do not sufficiently collaborate with each other. Furthermore, no current grouping within any organization seems to be appropriate to nurture such cross-sectoral collaboration at the required level to bring about large-scale adoption in the short term.

To progress, the ecosystem requires initiative to bring together all stakeholders to make a case for Verifiable Credentials and create an 'ecosystem map'. The remit of such a group would not be to develop standards or to run pilots. Rather it would exist to identify structural challenges holding back adoption and make recommendations on how to address them. It would serve to elucidate which credentialing-use cases could have the most impact, and direct development resources and standardization work toward them.

Funders could use the ecosystem map to identify specific challenges. Technology companies could use it to decide which standards to integrate into their products (on both issuing and verification sides). The map could also describe the progressive rollout of new types of credentials and credential-linked services.

R10: Enhance the Evidence-Base around Employer Benefits

Respondents in our study highlight that despite some recognition of the advantages digital credentialing can bring to employers, there is little direct evidence of their effect on employer priorities. Studies/pilots which can prove that, e.g., hiring accuracy has improved thanks to data-rich credentials, hiring costs are decreased thanks to accepting such credentials or fraud and compliance costs are reduced are not available to back up arguments promoting digital credentialing. This makes it difficult for management to quantify cost-savings or potential return on investment from adopting or demanding these tools.

Since there aren't enough digital credentials in the market to simply ask employers to accept digital credentials and monitor the results, efforts need to be made to create 'end-to-end' pilots where credentials can be tracked from issuing until acceptance, and the results can be monitored. Licensed professions, in areas where there are a relatively small number of issuers, are ideal for the organization of such pilots.

" ... the place where things are more aligned than any other set of domains is in places where licensure is required to practice ... certain business community areas ... healthcare areas. That means a lot of trades. I think if there were some end-to-end pilots in those spaces, that would be hugely valuable. And we have not done anything about end-to-end pilots that I've seen. "
— Phil Long, T3 Innovation Network

Most panelists suggest that healthcare is an obvious place to implement such a pilot because of a number of unique characteristics. This said, a pilot in any industry sector that meets the following criteria would enhance the evidence of effectiveness of digital credentials:

- **clear and extensively documented requirements in terms of validation,**
- **a history of requiring verified credentials, and low tolerance for exceptions,**
- **a requirement for institutions to be certified to offer education that leads to licensing,**
- **mandatory reskilling requirements throughout life for many professions, and**
- **a strong stakeholder and industry associations who have the resources and knowledge to support pilots.**

R11: Support Development of Tools for Validation of Abilities and Achievements
Making it easier to interpret the content of a credential to be an accurate description of an individual's skills, competencies and abilities will require significant investment in tools and processes for verification and validation. This might include open-source software libraries linked to major semantic standards for display and verification of credentials, directories of such software and the creation of networks of validators who are able to validate different types of credentials.

Publishers of semantic standards should accompany their standards with open-source credential display and/or verification libraries, to facilitate integration of their standards into existing software tools. Alternatively, they should provide standardized APIs which allow the verification of the credentials (include any link to trust registries etc. which are required by the respective use case).

Another idea is incentivizing networks of validators, whereby a general-purpose wallet might call on services offered by specialized industry wallets to display and/or verify credentials. There is no one solution to address the need for validation capabilities, but a series of actions taken together, may sufficiently lower barriers to accelerate adoption in different industry sectors.

Glossary

Competence Framework: define the competencies needed to identify, evaluate, and recognize effective performance, typically in the workplace as attached to a job role or occupation. They are typically used as a guide for designing training and learning activities, evaluating individual and team performance, recognizing achievements and issuing records of achievement, as well as identifying individual, organization and sectoral needs, career planning and managing talent.[33]

Comprehensive Learning Record: is a technical specification designed to support traditional academic programs, co-curricular and competency-based education, as well as employer-based learning and development—in any domain where it's important to capture and communicate a learner's and worker's achievements in verifiable, digital form.[34]

Credential Transparency Description Language: is a vocabulary of terms that are useful in making assertions about a Credential and its relationships to other entities.[35]

Learning Outcomes: are statements of what an individual should know, understand and/or be able to do at the end of a learning process.[36]

Linked Open Data: refers to a set of best practices for publishing structured data on the Web. The idea behind these principles is, on the one hand, to use standards for the representation and the access to data on the Web. On the other hand, the principles propagate to set hyperlinks between data from different sources. These hyperlinks connect all Linked Data into a single global data graph, similar as the hyperlinks on the classic Web connect all HTML documents into a single global information space.[37]

Occupational (Skills) Profile: summarizes essential characteristics required for a given job: the level of education and training required (and hence the complexity of the occupation); the field of

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[33] Green, Dennis, and Carolyn Levy, "Uses for Competency Frameworks," eCampusOntario Open Competency Toolkit, March 29, 2021, https://ecampusontario.pressbooks.pub/competencytoolkit/chapter/uses-for-competency-frameworks/.

[34] 1EdTech. "Comprehensive Learner Record Standard™," 1EdTech, n.d., https://www.imsglobal.org/activity/comprehensive-learner-record.

[35] Credential Engine, "Credential Engine Schemas Handbook." Credential Engine, July 8, 2022, https://credreg.net/ctdl/handbook.

[36] European Union, "COUNCIL RECOMMENDATION of 22 May 2017 on the European Qualifications Framework for Lifelong Learning and Repealing the Recommendation of the European Parliament and of the Council of 23 April 2008 on the Establishment of the European Qualifications Framework for Lifelong Learning in Official Journal of the European Union," Publications Office of the European Union, May 22, 2017, https://op.europa.eu/en/publication-detail/-/publication/ceead970-518f-11e7-a5ca-01aa75ed71a1/language-en).

[37] Berners-Lee T., "Linked Data." June 18, 2009. from https://www.w3.org/DesignIssues/LinkedData.

education and training required; and other requirements in terms of knowledge, skills, competence, occupational interests and work values.[38]

Open Badges: is a digital credentials data standard that recognizes and verifies learning and achievements. Open Badges contain metadata that describe an achievement, the individual who achieved it, and the issuer of the credential.[39]

Reference Letter: is a letter in which the author assesses the qualities and skills of an applicant/candidate positively, deeming them as an ideal candidate for the job, scholarship, or the university they are applying.[40]

Trusted Issuer List: is a machine-readable registry of credential-issuers that meet a specific set of quality, accreditation or licensing criteria.

World of Work: The 'world of work' includes all enterprises, civil society organizations and the public sector.[41] As compared to 'employment' which implies 'work done for the employer', it is used to describe a holistic view of learning integrated with work, and the integration and relationship between work, society and personal life.

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[38] European Centre for the Development of Vocational Training, "Quantifying Skill Needs in Europe," 2013, https://www.cedefop.europa.eu/files/5530_en.pdf.

[39] Badge Wiki, "What Are Open Badges?" Badge Wiki, n.d., https://badge.wiki/wiki/What_Are_Open_Badges.

[40] Freshteam, "HR Glossary: Reference Letter Definition," Freshworks, n.d., https://www.freshworks.com/hrms/resources/hrglossary/reference-letter/.

[41] European Association of Institutions in Higher Education, "Professional Higher Education in Europe. Characteristics, Practice Examples and National Differences," n.d., https://www.eurashe.eu/wp-content/uploads/2022/01/phe-europe-oct-2014.pdf.

Abbreviations

AI   Artificial Intelligence

ATS   Applicant Tracking System

CLR   Comprehensive Learner Record

CTDL   Credential Transparency Description Language

GDPR   General Data Protection Regulation

HR   Human Resources

HRMS   Human Resource Management Systems

LER   Learning and Employment Records

LMS   Learning Management Systems

MOOC   Massive Open Online Course

SIS   Student Information Systems

SME   Small Medium Enterprises

WEF   World Economic Forum