Tampere University

PADMASHEELA KIISKILÄ

Managing Micro-Credentials in the Higher Education Context

From Digital Platforms to Data Governance in University Alliances

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ACADEMIC DISSERTATION
To be presented, with the permission of
the Faculty of Management and Business
of Tampere University,
for public discussion in the auditorium Pieni sali 1
of the Festia, Korkeakoulunkatu 8, Tampere,
on 21 November 2025, at 12 o'clock.

ACADEMIC DISSERTATION
Tampere University, Faculty of Management and Business
Finland

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The originality of this thesis has been checked using the Turnitin Originality service.

Cover design: Roihu Inc.

ISBN 978-952-03-4216-6 (print)
ISBN 978-952-03-4217-3 (pdf)
ISSN 2489-9860 (print)
ISSN 2490-0028 (pdf)
http://urn.fi/URN:ISBN:978-952-03-4217-3

PunaMusta Oy – Yliopistopaino
Joensuu 2025

Dedication

To my son Manu, whose inspiration kept me going, and to my husband Marko, for his steadfast support.

ACKNOWLEDGEMENTS

This PhD journey has been more than just an academic exercise for me. It was toward the end of the Covid era when I first approached Professor Henri Pirkkalainen after listening to his talk on micro-credentials and the work he was leading within ECIU. That conversation soon led me to join his team and marked the beginning of an incredibly exciting and fulfilling journey as a doctoral student. I am forever grateful for the wonderful opportunities he provided and for his invaluable mentorship throughout these past few years. His passion for academic excellence and commitment to rigorous research deeply influenced my own growth as a scholar. I not only gained an exceptional supervisor but also an inspiring team that became my academic family.

I would like to express my sincere gratitude to my second supervisor, Associate Professor Hongxiu Li, for her support and guidance throughout this journey. I am deeply thankful to Professor Virpi Tuunainen for kindly agreeing to serve as my opponent in the public defense. I also wish to extend my gratitude to Associate Professor Tuomas Korhonen for acting as the internal reviewer and for providing valuable feedback that helped strengthen this dissertation. Furthermore, I am grateful to Professor Patrick Mikalef and Senior Research Fellow Alexander Mikroyannidis for their insightful comments, which greatly helped me refine and finalize the dissertation.

I was fortunate to be able to combine project work with my doctoral research. Working within the ECIU provided invaluable opportunities to take my research to the next level and to explore its practical applications. While I am grateful to all members of the ECIU team, I would like to express special appreciation to several colleagues with whom I had the privilege to work closely over the past few years. My sincere thanks go to Mairéad Nic Giolla Mhichíl for our close collaboration in the ECIU work package including co-authoring white papers and our forthcoming book chapter on micro-credentials. I am also grateful to Elena Tsigki, Olga Wessels, Andrea Brose, Dorothea Ellinger, Johan Peterson, and Timothy James Marshall, whose insights have greatly contributed to shaping my research. I would further like to extend my deep appreciation to Ildiko Mazar, Kia Likitalo, and Anthony Camilleri for their exceptional support and collaboration in both project work and research.

I would like to extend my sincere thanks to my colleague and co-author, Henri Jalo, for his support and encouragement. I am also grateful to my current and former colleagues, Miiko Siivonen, Miikka Palvalin, Osku Torro, Bakhtawar Khan, and Givemore Muchenje, as well as others in the Insight team and the Unit of Information and Knowledge Management. Finally, I wish to express my heartfelt gratitude to my son, Manu, who has been a constant source of inspiration, and to my husband, Marko, who has always been there cheering me on. A very special mention goes to Kaarina and Kirsi, whose friendship and encouragement have meant so much to me.

ABSTRACT

Micro-credentials have emerged as a promising approach to support lifelong learning, reskilling, and the recognition of smaller units of learning. As higher education institutions adapt to changing learner needs and labor market dynamics, micro-credentials can serve as digitally verifiable recognition of specific skills, competencies, or learning achievements. Despite growing policy and institutional interest, managing and governing micro-credentials introduces new complexities, such as ensuring interoperability across systems, maintaining academic quality, and fostering stakeholder trust in diverse institutional and national contexts. These challenges are particularly pronounced in cross-institutional settings, where governance and infrastructure remain under-explored.

In alliance-based or cross-border contexts, such challenges are compounded by differences in digital maturity, regulatory frameworks, and data governance practices. Systemic uncertainties, particularly around the governance of credential issuance highlight the need for deeper empirical understanding of how micro-credentials can be effectively managed across institutions and jurisdictions.

This dissertation addresses these gaps by investigating how micro-credentials can be strategically managed and governed in higher education, with a focus on inter-institutional alliances. Grounded in Information Systems research, it draws on a case study of a European university alliance to examine how governance choices, micro-credentialing platforms, and stakeholder dynamics shape the management and governance of micro-credentials. The study is guided by the overarching question: How can micro-credentials be managed and governed in the higher education context? It adopts three interrelated perspectives, technological, stakeholder, and institutional to explore how these dimensions co-evolve in practice.

The research unfolds in three phases aligned with the sub-research questions. First, it identifies the technological and infrastructural features needed for issuing micro-credentials, including the role of European-wide digital standards and platforms such as the European Blockchain Services Infrastructure (EBSI). Second, it investigates how different stakeholders, learners, institutions, and employers perceive the value of micro-credentials and how these perceptions influence adoption and design. Third, it analyzes how micro-credentials can be managed

centrally in the alliances, particularly when individual institutions lack the capacity to issue credentials independently. In such cases, a centralized governance model can provide a viable solution, though it may also generate tensions between institutional autonomy and alliance-level coordination.

The findings suggest that successful management and governance of micro-credentials depend on the alignment of technological capabilities, stakeholder expectations, and institutional conditions. Interoperable and verifiable infrastructures are essential but must be supported by policy coherence and organizational readiness. Stakeholder trust, especially among learners is central to establishing the legitimacy of micro-credentials. In alliance settings where institutional capacity is uneven, centralized issuance supported by a legal entity can enable cross-border implementation while ensuring quality assurance and regulatory compliance.

This dissertation contributes to Information Systems research by empirically examining how digital credentialing infrastructures are adopted, managed, and governed in inter-organizational higher education contexts. It further draws on Scott's institutional theory to analyze how regulative, normative, and cultural-cognitive pressures influence platform-related decisions, thereby contributing to the information systems literature that applies institutional theory in multi-actor settings. It also advances micro-credential literature by offering a multi-level empirical account of how these credentials are implemented, valued, and governed across institutional and alliance contexts, with attention to learner and institutional perspectives. Finally, it contributes to alliance governance research, particularly in the area of data governance, by illustrating how centralized models can support coordinated micro-credential issuance across national and institutional boundaries. Practically, the findings provide actionable insights for policymakers, university leaders, and platform developers seeking to build scalable and trustworthy micro-credential ecosystems that balance innovation with institutional legitimacy and learner trust.

TIIVISTELMÄ

Pienet osaamiskokonaisuudet ovat nousseet lupaavaksi lähestymistavaksi tukea elinikäistä oppimista, uudelleenkouluttautumista ja lyhyiden oppimiskokonaisuuksien tunnistamista. Korkeakoulujen mukautuessa opiskelijoiden muuttuviin tarpeisiin ja työmarkkinoiden dynamiikkaan, pienet osaamiskokonaisuudet tarjoavat joustavan ja moduulipohjaisen vaihtoehdon perinteisille tutkinnoille. Digitaaliset osaamistodisteet ovat keskeinen osa pieniä osaamiskokonaisuuksia. Ne tarjoavat uudenlaisen ja tavan myöntää digitaalisesti varmennettavia todisteita, joita ei voi väärentää. Digitaalisten osaamistodisteiden hallinta ja ohjaus tuo kuitenkin mukanaan uusia monimutkaisuuksia, kuten järjestelmien yhteentoimivuuden varmistamisen, akateemisen laadun ylläpitämisen ja sidosryhmien luottamuksen rakentamisen erilaisissa yhteistyöverkostoissa. Nämä haasteet korostuvat erityisesti korkeakoulujen välisissä ympäristöissä.

Korkeakoulujen välisten pienien osaamiskokonaisuuksien hallinnan ongelmat kumpuavat laadun varmistamisen, tutkintojen viitekehysten yhteensopivuuksien ja eri sidosryhmien tarpeisiin vastaamisen haasteista. Liittoumapohjaisissa tai rajat ylittävissä yhteistöissä tällaisia haasteita monimutkaistaa erot digitaalisessa kypsyydessä, sääntely-ympäristöissä ja datanhallintakäytännöissä. Epävarmuudet, erityisesti digitaalisten osaamistodisteiden myöntämisen hallinnan ympärillä, korostavat tarvetta syvemmälle empiiriselle ymmärrykselle siitä, kuinka pieniä osaamiskokonaisuuksia voidaan tehokkaasti hallita korkeakoulujen ja maiden välillä.

Tämä väitöskirja vastaa näihin tutkimusaukkoihin tutkimalla sitä, kuinka pieniä osaamiskokonaisuuksia voidaan strategisesti hallita korkeakoulujen välisissä yhteistyöliittoumissa. Työ positioituu tietojärjestelmätieteen alaan eurooppalaisen yliopistoliittouman tapaustutkimuksella. Väitöskirjassa tarkastellakseen, kuinka hallintapäätökset, digitaalisten osaamistodisteiden tietojärjestelmät ja sidosryhmädynamiikka muovaavat pienten osaamiskokonaisuuksien hallintaa. Tutkimuksen päätutkimuskysymys on "kuinka pieniä osaamiskokonaisuuksia voidaan hallita korkeakoulutuksen kontekstissa?" Väitöskirja sisältää teknologisen, sidosryhmäperusteisen ja institutionaalisen näkökulman. Työssä tarkastellaan, kuinka nämä kolme näkökulmaa vaikuttavat toisiinsa.

Tutkimus sisältää kolme vaihetta, joista jokainen sisältää oman osatutkimuskysymyksen. Ensiksi tunnistetaan digitaalisten osaamistodisteiden myöntämiseen tarvittavat teknologiset ja järjestelmätason ominaisuudet. Työssä tarkastellaan eurooppalaisten digitaalisten standardien ja alustojen, kuten European Blockchain Services Infrastructure (EBSI) roolia. Toiseksi tutkitaan, kuinka korkeakoulujen hallintohenkilöstö ja opiskelijat kokevat digitaalisten osaamistodisteiden arvon. Lisäksi toisessa vaiheessa tutkitaan kuinka nämä käsitykset vaikuttavat osaamistodisteiden käyttöönottoon ja suunnitteluun. Kolmanneksi analysoidaan keskitettyä digitaalisten osaamistodisteiden myöntämisen ja hallinnan mallia eurooppalaisessa yliopistoliittoumassa. Erityisesti sellaisissa tilanteissa, kun yksittäisillä korkeakouluilla ei ole itse kykyä myöntää osaamistodisteita. Tällaisissa tapauksissa keskitetty hallintamalli voi tarjota hyödyllisen ratkaisun, vaikka se saattaa myös aiheuttaa jännitteitä korkeakoulujen autonomian ja liittoumatasoisen koordinoinnin välillä.

Väitöskirjan tulokset osoittavat, että pienten osaamiskokonaisuuksien onnistunut hallinta riippuu teknologisten valmiuksien, sidosryhmien odotusten ja institutionaalisten ehtojen yhteensovittamisesta. Digitaalisten osaamistodisteiden myöntämiseen tarkoitettavat infrastruktuurit ovat olennaisia, mutta niiden tueksi tarvitaan johdonmukaisia käytänteitä ja organisatorista käyttöönoton valmiutta. Sidosryhmien ja erityisesti opiskelijoiden luottamus on keskeistä pienten osaamiskokonaisuuksien onnistuneessa hyödyntämisessä. Yliopistoliittoumissa, joissa yliopistojen valmiudet ovat eri tasoilla, digitaalisten osaamistodisteiden keskitetty myöntäminen voi mahdollistaa maiden rajojen ylittävät yhteiskäytänteet siten, ettei korkeakoulujen tarvitse luopua laadunvarmistuksen ja lainsäädäntöön liittyvistä periaatteista.

Tämä väitöskirja edistää tietojärjestelmätieteen tutkimusta tarkastelemalla empiirisesti, kuinka pieniä osaamiskokonaisuuksia otetaan käyttöön, hallinnoidaan ja johdetaan organisaatiorajat ylittävissä korkeakoulutuksen kontekstissa. Tutkimus hyödyntää institutionaalista teoriaa analysoidakseen, kuinka säätelyyn, normatiivisuuteen ja kulttuuri-kognitiivisiin paineisiin liittyvät tekijät vaikuttavat alustoihin liittyviin päätöksiin. Tämä kontribuutio täydentää erityisesti tietojärjestelmätieteen kirjallisuutta, joka soveltaa institutionaalista teoriaa monitoimijaympäristöissä. Väitöskirja syventää myös pieniin osaamiskokonaisuuksia koskevaa kirjallisuutta tarjoamalla monitasoista empiiristä tietoa siitä, miten digitaalisia osaamistodisteita otetaan käyttöön, arvotetaan ja hallitaan eri instituutioiden ja allianssien konteksteissa, huomioiden sekä oppijoiden että organisaatioiden näkökulmat. Tutkimuksella luodaan myös uutta tietoa allianssien hallinnasta, erityisesti datanhallinnan alueella. Työssä osoitetaan, kuinka keskitetyt hallintamallit voivat tukea digitaalisten osaamistodisteiden myöntämistä kansallisten ja institutionaalisten rajojen yli. Käytännön tasolla tutkimuksen tulokset tarjoavat konkreettista informaatiota päättäjille, korkeakoulujen johdolle ja alustakehittäjille. Tulokset voivat auttaa heitä kehittämään skaalautuvia ja luotettavia malleja pienten osaamiskokonaisuuksien ympärille pyrkimyksissään tasapainoilla uusien toimintatapojen ja teknologioiden, lainsäädännön ja ohjeistusten sekä opiskelijoiden tarpeiden välillä.

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ABBREVIATIONS

EBSI – European Blockchain Services Infrastructure
ECIU – European Consortium of Innovative Universities
HEI – Higher Education Institutions

ORIGINAL PUBLICATIONS

Publication I	Kiiskilä, P., Hanafy, A. and Pirkkalainen, H. (2022). Features of micro-credential platforms in higher education, 14th International Conference on Computer Supported Education. Vol. 1, pp. 81-91.
Publication II	Kiiskilä, P., Kukkonen, A., & Pirkkalainen, H. (2023). Are micro-credentials valuable for students? Perspective on verifiable digital credentials. SN Computer Science, 4(4), 366.
Publication III	Kiiskilä, P., Hylli, O., & Pirkkalainen, H. (2023). How can European blockchain services infrastructure be used for managing educational digital credentials? In The proceedings of the 14th Scandinavian Conference on Information Systems (SCIS). Association for Information Systems.
Publication IV	Kiiskilä, P., & Pirkkalainen, H. (2024). Exploring Centralized, Decentralized, and Hybrid Approaches to Micro-Credential Issuance in HEI Alliances. 16th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management.
Publication V	Kiiskilä, P., Jalo, H., & Pirkkalainen, H. Balancing Centralized Control with Organizational Autonomy for Micro-Credential Governance in HEI Alliances. (under review).

AUTHOR'S CONTRIBUTION TO CO-AUTHORED PUBLICATIONS

Publication I: The research idea was developed in collaboration with my supervisor (third author). The second author led data collection. I conducted the qualitative analysis of the interview data and acted as the primary author of the manuscript. My supervisor provided ongoing guidance and substantive feedback throughout the writing process. I also served as the corresponding author, submitted the manuscript to the International Conference on Computer Supported Education (CSEDU) in 2021, and revised it in response to reviewer comments. The paper was accepted and presented by me at CSEDU 2022.

Publication II: The study was jointly conceived with my supervisor (third author). I designed the interview protocol, conducted interviews with one participant group, and led the overall qualitative analysis. The second author conducted interviews with the other group and analyzed those data. I integrated the findings from both groups and conducted the cross-case analysis for the main research question. I served as the primary and corresponding author and revised the manuscript based on feedback from my supervisor. The manuscript was submitted to Springer Nature Computer Science in 2022, accepted after revisions, and published in 2023.

Publication III: The paper was developed jointly with my supervisor (third author). The second author was responsible for developing the credentialing prototype. I contributed domain-specific input to the design process, created the interview protocols, conducted interviews, and led the qualitative analysis. I wrote the initial manuscript as the primary author. The second author contributed technical insights, and my supervisor provided detailed feedback on the full draft. I revised the manuscript and submitted it as the corresponding author to the 2023 Scandinavian Conference on Information Systems (SCIS), where I also presented the accepted paper.

Publication IV: The study was planned collaboratively with my supervisor (second author). I designed the interview protocol, conducted all interviews, and carried out the qualitative analysis. I drafted the initial results and discussion sections, which were reviewed and refined together with my supervisor. I submitted the manuscript to the Knowledge Management and Information Systems (KMIS) conference in 2024 as the corresponding author, revised it following peer review, and presented the final version at the conference.

Publication V: The research idea was developed collaboratively with the co-authors. I designed the interview protocol and conducted all interviews. The theoretical framework was proposed by the second author and selected after joint deliberation. I led the qualitative analysis, which was reviewed and refined in collaboration with the second author. I drafted the initial version of the manuscript, and both co-authors provided comments and revisions. I submitted the paper to a journal as the corresponding author, and it is currently under review.

1 INTRODUCTION

Micro-credentials have emerged as a promising innovation in higher education, offering flexible, modular learning opportunities that support lifelong learning and address evolving skill needs. This doctoral compilation dissertation contributes to the growing body of research by exploring how micro-credentials can be effectively managed and governed within the higher education context. Drawing on five peer-reviewed publications, this article-based dissertation examines three interrelated themes. These include the technological characteristics of micro-credential platforms, the perceived value of micro-credentials among learners and institutions, and governance models for micro-credential issuance particularly within higher education institution (HEI) alliances. The study employs a combination of qualitative case studies, interviews, and a design science research methodology to investigate these aspects of micro-credential implementation and governance.

1.1 Background and motivation

In recent years, the landscape of higher education has been reshaped by rapid digitalization, shifting workforce demands, and an increasing emphasis on flexible lifelong learning. Traditional degree programs are increasingly viewed as insufficient for addressing the evolving skill requirements of both learners and employers (Alangari, 2024; Oliver, 2019; Resei et al., 2019). In this context, micro-credentials initially emerged as short-format digital certificates designed to recognize discrete sets of skills or learning outcomes. Early development was closely tied to Massive Open Online Courses (MOOCs), with major platforms such as Coursera, edX, and Udacity partnering with universities to offer modular learning units that could be completed online and often stacked toward larger qualifications (Alhazzani, 2020; Baturay, 2015). These early offerings were primarily industry-driven, aimed at quickly upskilling learners in emerging technology areas (Waks, 2018).

Micro-credentials have been defined in various ways in the literature. In some cases, the term refers to the credential awarded to the learner as proof of completed learning; in others, it denotes the short, targeted learning experience itself (Pickard et al., 2018; Rossiter & Tynan, 2019). In its recommendation on a European approach to micro-credentials, the European Commission (2022) defines them as certifications of assessed learning outcomes gained through short learning experiences. These credentials aim to demonstrate the attainment of specific knowledge, skills, or competences aligned with societal, personal, cultural, or labor market needs. This framing has increasingly shaped policy and practice across European higher education by supporting consistency in recognition, the development of digital infrastructure, and the promotion of lifelong learning. The influence of this approach is evident in initiatives such as the European Consortium of Innovative Universities (ECIU) and the European Digital Credentials Infrastructure (ECIU, 2024; Daukšienė et al., 2024; Hudak & Camilleri, 2021).

Technological advances have enabled the large-scale delivery of such credentials (Johan et al., 2025), allowing individuals to construct personalized learning pathways that align with evolving labor market needs (Datta et al., 2024; Flintberg, 2022). As a result, micro-credentials are gaining recognition as a valuable tool for learners seeking ongoing development and for industries facing persistent skills gaps (Kayyali, 2025; Olcott, 2022). HEIs are playing an increasingly central role in implementing and legitimizing micro-credentials within their educational offerings. Rather than replacing traditional degrees, these credentials are positioned as complementary, enabling universities to promote lifelong learning, enhance employability, and support broader societal goals (Desmarcheller & Cary, 2022; Noelle et al., 2024). HEIs are also recognizing that engagement with micro-credentials is integral to their evolving role in a rapidly transforming educational landscape, helping them remain responsive to diverse stakeholder expectations (Rami et al., 2025; Tamoliune et al., 2023).

Alongside this institutional momentum, both individual universities and higher education alliances have begun piloting digital credentialing platforms, such as Open Badges, Gataca, and blockchain-based infrastructures like the European Blockchain Services Infrastructure (EBSI) to support the issuance, verification, and portability of educational credentials (Felton et al., 2023; Saad et al., 2024; Alsobhi et al., 2023; Hoyos & Kloos, 2023). These platforms enable the delivery of a range of digital credentials, including formal degree certificates, participation badges, and increasingly, micro-credentials, often with built-in metadata and verification features. From an Information Systems perspective, these platforms represent evolving digital infrastructures that require alignment across institutional, technical, and policy layers. However, despite the rise of these technical solutions, there is relatively limited empirical understanding, of which platform features are considered essential by higher education institutions when it comes to issuing and managing micro-credentials. This lack of evidence is particularly problematic in inter-institutional contexts, where platform functionalities must support not only institutional workflows but also cross-border interoperability and policy alignment.

While platform infrastructure plays a foundational role, the perceived value of micro-credentials among stakeholders significantly shapes their adoption and impact. Learners increasingly view micro-credentials as tools to support employability, career advancement, and skills visibility, especially when they are transparent and verifiable (Ahmed & Jassim, 2021; Kässi & Lehdonvirta, 2024). From the institutional perspective, micro-credentials are framed as a strategic response to demands for flexible, modular learning that aligns with labor market needs (Olcott, 2022; Rami et al., 2025). However, there remains a lack of empirical research on how different stakeholder groups, learners, institutional leaders, and employers perceive the value of micro-credentials and how these perceptions influence institutional decision-making and strategic positioning.

Some alliances have begun experimenting with decentralized models, where each institution issues its own micro-credentials (ENHANCE, 2024). Others adopted hybrid models, in which one or more institutions issue credentials on behalf of all partners (Una Europa, 2024). However, there remains a lack of academic research on how such models are governed in practice. Moreover, there is little scholarly or practical guidance on governance approaches when neither hybrid nor decentralized models are viable, particularly in alliances where legal constraints, uneven readiness, or lack of institutional mandate prevent partners from acting on each other's behalf. In these settings, cross-institutional governance becomes especially complex, as decisions must balance institutional autonomy with shared responsibilities for credential design, quality assurance, and data infrastructure (Brown et al., 2023; Pouliou, 2024).

Prior research has shown that multi-institutional collaboration in higher education often encounters structural and cultural barriers that hinder standardization (Beerkens, 2004; Kehm & Teichler, 2007). These governance challenges are further shaped by institutional pressures, including regulatory compliance, sector norms, and internal organizational logics, which can conflict with alliance-wide goals and require ongoing negotiation (Dacin et al., 2002; Scott, 1995). From an Information Systems perspective, this creates a layered problem of data governance across institutional boundaries, where decisions about issuing and verifying credentials intersect with platform control, metadata standards, and regulatory compliance. A deeper understanding of how such pressures influence data governance is needed to develop scalable, context-sensitive models for managing micro-credentials across borders.

Given the growing strategic importance of micro-credentials in higher education, it is essential to investigate which platform features are critical for HEIs to issue and manage them effectively, how stakeholder perceptions, particularly those of learners and institutions shape their value and adoption, and how alliances can govern micro-credentials when neither hybrid nor decentralized approaches are feasible. These questions are not only practically relevant but also represent an underexplored area within Information Systems research, particularly concerning how digital infrastructures for credentialing are adopted, managed, and governed across institutional boundaries. By addressing these challenges through an IS lens, this dissertation contributes to both the IS field and the emerging micro-credentialing literature, offering a systems-level understanding of how technological, organizational, and governance dimensions interact in the evolving digital credentialing landscape.

1.2 Research questions

Micro-credentials are an emerging field in higher education, yet significant research gaps remain, particularly concerning their issuance and management. This dissertation addresses these gaps by examining how HEI alliances can effectively issue, manage and govern micro-credentials. Initially guided by a predetermined overarching research question, the study evolved as additional sub-questions emerged. For instance, after identifying the technological characteristics necessary for micro-credential management, it became essential to explore the perceived value of micro-credentials for both learners and institutions. Although this dissertation broadly examines the management and governance of micro-credentials in higher education, it places particular emphasis on HEI alliances, especially in governance-related studies. In these contexts, the research explores how governance structures are shaped in multi-institutional settings, highlighting the unique challenges and dynamics that arise within alliances.

The central research aim of this dissertation is: *How can micro-credentials be managed and governed in the higher education context?* To answer this broad main research aim, the dissertation addressed three research questions across five publications. The research questions, publications and gaps they address are illustrated in Figure 1.

RQ1: What technological characteristics are essential for the management and issuance of micro-credentials?

This question emerged from the observation that micro-credentials depend on robust digital platforms to issue, store, and verify credentials. Although these technologies are central to micro-credential initiatives, relatively little was known about which specific platform features are critical for HEIs to issue micro-credentials. To address this gap, Publications I and III explore technological characteristics in different but complementary ways. Publication I draws on extensive interviews and group discussions with micro-credential experts and platform providers to identify core platform functionalities, highlighting how higher education institutions can effectively utilize them. Publication III then evaluates a specific artifact developed for micro-credential issuance and management, illustrating how issues such as data privacy, usability, and interoperability can affect practical implementation in real-world contexts.

RQ2: How do institutional, technological, and learner perspectives influence the perceived value and strategic role of micro-credentials in higher education?

While advanced digital solutions provide the technical foundation for micro-credentials, their success depends equally on how key stakeholders perceive both their immediate value and long-term strategic relevance. This research question explores how the perceived value and the envisioned role of micro-credentials are shaped through the interplay of technological features, learner expectations, and institutional conditions. Publications I, II, and III contribute to this inquiry. Publication I highlights platform-level capabilities, such as transparency, portability, and metadata that influence how institutional representatives envision the role of micro-credentials in enhancing educational flexibility and learner engagement. Publication II deepens the analysis by drawing on Expected Value Theory (EVT) to examine both learner and institutional perspectives. Through interviews with students and discussions with administrators, it identifies the drivers and barriers, such as clarity of purpose, workload, institutional incentives, and perceived career value that shape engagement with micro-credentials.

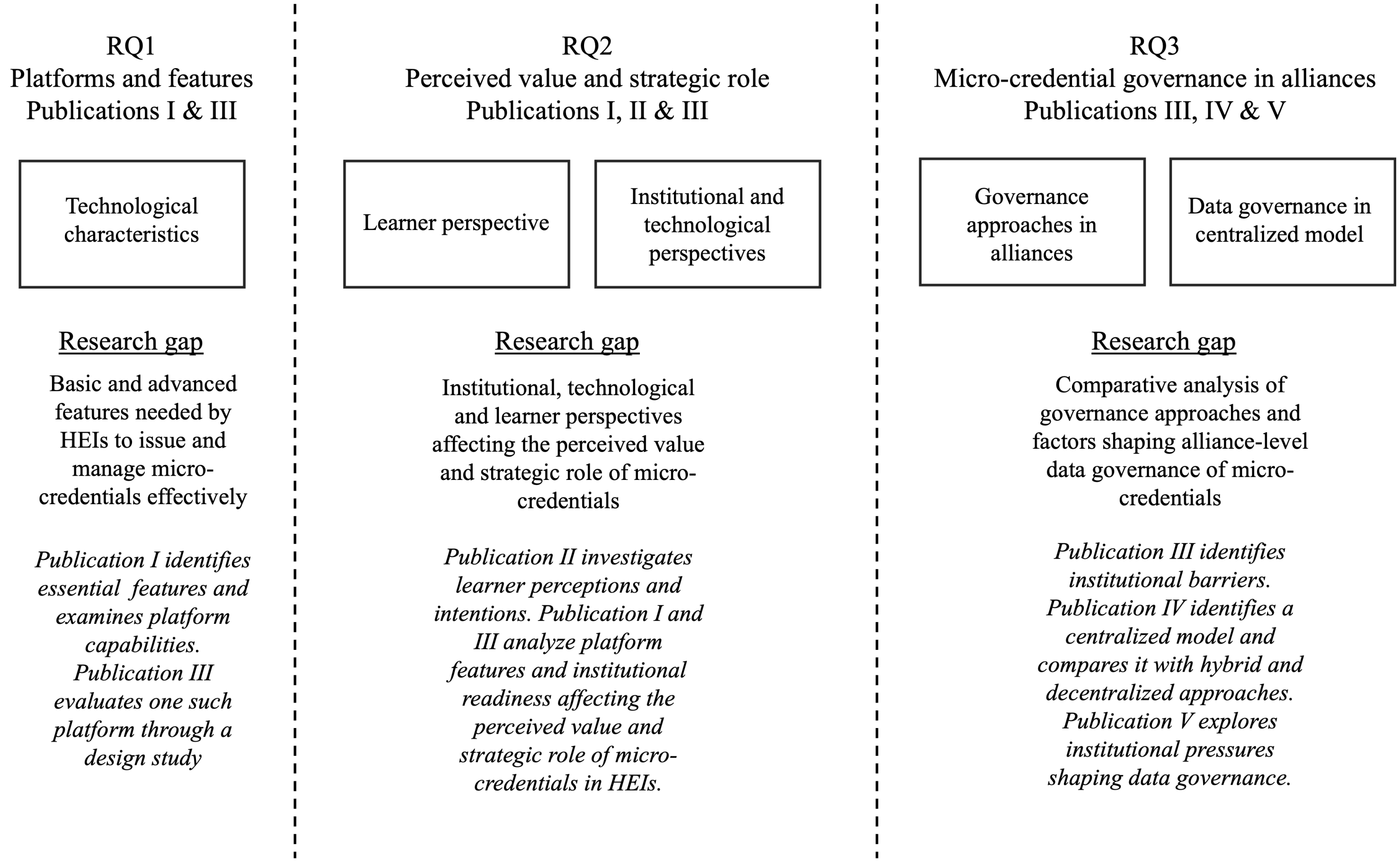

Figure 1: Research questions, gaps and publications addressing the gap

Publication III extends this by examining the institutional readiness and policy-level conditions necessary for micro-credentials to be strategically adopted, such as alignment with national strategies, platform interoperability, and the unbundling of traditional credentials. Together, these studies provide a clear picture of how technological features, learner needs, and institutional conditions shape not only how micro-credentials are valued but also how they are positioned within higher education strategies.

RQ3: How do organizational structures and policies impact the governance of micro-credentials?

In contexts where multiple institutions collaborate, such as university alliances, differing administrative processes, data management practices, and regulatory frameworks can complicate the shared issuance and long-term governance of micro-credentials. Publication III highlights how cross-border issuance and verification introduce additional governance challenges, particularly the role of national strategies, interoperability requirements, and evolving European frameworks such as EBSI. Publications IV and V build on this by examining how governance structures, whether centralized, decentralized, or hybrid shape decision-making, compliance, and legitimacy in multi-institutional settings. Publication IV analyzes governance models within a European university alliance, identifying the trade-offs between institutional autonomy and the benefits of centralized coordination. Building on this, Publication V focuses on a centralized issuance structure and uses institutional theory to uncover how regulative, normative, and cultural-cognitive pressures influence governance choices and generate tensions around control, alignment, and accountability. Together, these studies emphasize that robust governance depends not only on organizational structures and formal policies, but also on institutional logics, external infrastructures, and stakeholder expectations that shape what is perceived as legitimate and sustainable. Clear governance structures encompassing defined roles, data policies, and collaborative decision-making are essential for ensuring that micro-credentials evolve beyond isolated experiments into scalable, trusted, and interoperable practices across institutional and national boundaries.

Taken together, the three research questions provide a comprehensive understanding of micro-credential issuance and governance from technological, stakeholder, and organizational perspectives. The dissertation first investigates the digital infrastructure and technical capabilities required for secure, verifiable, and scalable issuance. This reflects a systems design view of technology, focusing on the features and standards that platforms must support. It then analyzes how technological, institutional, and learner perspectives influence the perceived value and strategic role of micro-credentials. Here, the technological dimension is viewed through a stakeholder lens, highlighting how platform attributes such as verifiability or portability shape perceptions and strategic adoption. Finally, it examines how organizational structures and institutional pressures shape governance decisions, particularly in collaborative, cross-border contexts. By addressing these dimensions, the dissertation offers a holistic view of how micro-credentials can be effectively managed and governed within higher education.

This dissertation comprises five peer-reviewed academic publications, with Publication V currently under review. Each publication has its own specific research questions, which collectively contribute to the overarching inquiry of this dissertation.

1.3 Research setting, method and contributions

The empirical research for this dissertation was conducted within the European Consortium of Innovative Universities (ECIU), a transnational alliance of higher education institutions formally established as a legal entity in the Netherlands. During the time of the research, ECIU was facilitating collaborative educational initiatives among its member universities, including micro-modules (short, flexible courses) and challenges, which were project-based learning experiences co-developed with external partners. These offerings were available to students across member institutions but were not formally labeled as micro-credentials at the outset. The alliance had not yet established a unified model for credential issuance; instead, credentialing practices varied across institutions. This context provided a valuable empirical setting to study the early-stage management and governance challenges associated with issuing and coordinating short-format credentials in a multi-institutional environment. Some of the governance structures analyzed in this dissertation, such as centralized issuance emerged from and were influenced by the alliance's evolving practices over the course of the research.

This dissertation adopts a qualitative research approach, with all five studies employing semi-structured interviews as the primary data collection method (Ghauri & Grønhaug, 2020; Yin, 2009). The dissertation consists of five peer-reviewed publications (the fifth currently under review). Publication I is a qualitative study based on expert interviews and focus group discussions, aiming to identify key platform features relevant to micro-credential issuance in higher education. Publication II examines the perceived value of verifiable digital credentials through interviews with university administrators and students who had recently received a micro-credential. Publication III follows a design science research approach (Baskerville et al., 2018; Peffers et al., 2007), using a prototype implementation of a blockchain-based infrastructure to explore institutional factors affecting digital credential adoption. Publication IV presents a single case study of the ECIU alliance, introducing a centralized governance model for micro-credential issuance and comparing it with alternative approaches. Publication V draws on qualitative interview data to analyze how centralized data governance interacts with institutional autonomy, applying institutional theory to explore cross-border governance tensions in an alliance setting.

While each of the five publications employs a distinct methodological lens and focal point, they are thematically interlinked and build upon one another to form a coherent research trajectory. The research began with a broad identification of relevant platform features (Publication I), which laid the foundation for examining how these features translate into perceived value for learners and institutions (Publication II). Insights from the first two studies informed the design and implementation of a prototype infrastructure, allowing for an exploration of adoption challenges in Publication III. Building on these empirical and design-based insights, Publication IV focused on the governance models emerging within the alliance, particularly the shift toward centralized issuance. Finally, Publication V extends this governance focus by examining data governance tensions through an institutional theory lens, thereby deepening the understanding of cross-border coordination challenges. Together, these studies provide a cumulative and layered examination of how micro-credentials are managed and governed in a multi-institutional higher education context.

Focusing on how digital technologies are managed and governed in organizational and inter-organizational contexts, this dissertation contributes to information systems research by examining how digital credentialing infrastructures interact with governance processes in multi-actor settings. It offers empirical insights into how credentialing platforms are integrated with institutional systems, policies, and stakeholder needs, and applies institutional theory to analyze how regulative, normative, and cultural-cognitive pressures shape governance decisions.

The dissertation also contributes to the micro-credential literature in higher education by offering a multi-level understanding of how these credentials are implemented, valued, and governed. It provides empirical validation of the EBSI pilot and explores platform features, governance models, and stakeholder perceptions relevant to the design and adoption of credentialing systems. By identifying technological enablers, organizational conditions, and institutional strategies, the dissertation offers both conceptual and practical insights for institutions seeking to implement scalable and trustworthy micro-credentialing practices.

Finally, the study contributes to alliance governance research, particularly in the area of data governance, by analyzing how centralized models for issuing and managing digital credentials operate across institutional and national boundaries. The findings highlight how centralized approaches can address implementation challenges such as legal constraints, uneven digital readiness, and the need for interoperability, offering new perspectives for managing innovation in inter-institutional collaborations.

1.4 Structure of the dissertation

Section 1 introduces the research, including the research background, motivation, research questions and a brief description of the included publications. This dissertation comprises three conference proceeding publications and two journal publications, one of which is currently under review.

Section 2 presents the theoretical background underpinning the research. The dissertation draws on Expectation Value Theory (Eccles, 2005) and Institutional Theory (DiMaggio & Powell, 1983), which inform the analyses conducted in the included publications.

Section 3 details the methodology and research settings used to address the research questions across the individual publications. This section also outlines the overarching qualitative data collection and analysis methods employed throughout the dissertation.

Section 4 presents the findings from the individual publications and their contributions to the overall dissertation. This section also discusses the theoretical and practical contributions of each publication and outlines potential directions for future research.

Section 5 includes discussion of the findings that address the individual research questions and how they answer the overarching main research question.

Finally, section 6 details the theoretical and practical contributions of the dissertation. Limitations of this research and possible future research directions are included at the end.

2 THEORETICAL BACKGROUND

This section provides the theoretical and conceptual foundation for understanding micro-credentials in the higher education context. It begins by outlining the current state of research on micro-credentials in higher education, including their definition, design, and implementation challenges. In addition, it introduces key contextual elements such as platform infrastructure and data governance, which are examined both in relation to micro-credentialing practices and within the broader context of inter-institutional alliances. Following this, the chapter introduces the two main theoretical lenses that guide the dissertation's analytical approach. First is the Expectancy-Value Theory, used to examine learner motivation and value perception followed by Institutional Theory, which is used to explore how organizational behavior is shaped by external pressures in alliance contexts. Together, these frameworks provide a multi-level lens for analyzing the management and governance of micro-credentials across technical, organizational, and institutional dimensions.

2.1 Micro-Credentials in Higher Education

2.1.1 Evolution of micro-credentials

The evolution of micro-credentials is closely linked to advances in digital technologies, which have enabled the development, delivery, and verification of credentials at scale (West & Lockley, 2016; Jovanovic & Devedzic, 2015). These technologies have transformed credentials from static records into dynamic, metadata-rich digital assets that can be securely issued, stored, and shared across platforms (Grech & Camilleri, 2017; European Commission, 2022). As such, micro-credentials are increasingly embedded within digital infrastructures that support scalable, portable, and verifiable recognition of learning across institutional and national contexts (Grant, 2016; McGreal & Olcott, 2022).

The emergence of digital badges and alternative credentialing systems in the early 2010s sought to recognize discrete skills and learning achievements outside traditional degree programs, particularly in informal and non-formal learning contexts (Ghasia et al., 2019; Misko, 2008). Platforms such as Mozilla's Open Badges initiative provided a way to document and share learning accomplishments digitally, enhancing the visibility of skills often overlooked in conventional academic transcripts (Araújo et al., 2017; Open Badges Standard, 2012). The digital nature of badges enabled them to be shared across social media platforms such as LinkedIn (Andone et al., 2021; Perkins & Pryor, 2021). Badges in higher education initially served as gamification tools to encourage student participation and engagement (Hartnett, 2021; Sousa-Vieira et al., 2021), but as they evolved into digital formats, they gained the ability to include metadata, such as the issuing institution and verifiable evidence of achievement (Grant, 2016).

Parallel to the development of digital badges, the rise of massive open online courses (MOOCs) brought renewed attention to the need for more flexible and modular forms of credentialing. Programs such as edX's MicroMasters and Coursera's Specializations began offering bundled courses that could be stacked toward formal degrees, blurring the line between informal upskilling and accredited education (Pickard et al., 2018). These early models demonstrated that alternative credentials could serve both lifelong learning and academic progression goals, although the lack of common standards often limited their portability and recognition across institutions and employers (Oliver, 2019; Ifenthaler et al., 2016).

Significant research has been conducted on how MOOCs and similar online courses can support upskilling and reskilling (Duke-Benfield et al., 2019; Fong et al., 2016; Kato et al., 2020) and on their role within higher education (Cheng et al., 2018; Ma et al., 2016; Gallagher, 2022). However, the primary focus of these studies has been the content and structure of the learning offerings rather than the credentialing mechanisms themselves. The growing global interest in short, focused learning certifications led to a proliferation of related terms and formats, including badges, micro-credentials, nanodegrees, short learning programs, and alternative credentials, often used interchangeably (Tamoliūnė et al., 2023; Varadarajan et al., 2023). Most of the research on these credentials, particularly on digital badges and micro-credentials has often focused on how they can be integrated into existing qualifications frameworks (Ward et al., 2023). However, terminology, scope, and recognition practices remain inconsistent across contexts (Fedock et al., 2016).

Although these innovations expanded opportunities for learners, the lack of consensus on definitions, quality assurance standards, and recognition mechanisms created barriers to widespread adoption of micro-credentials (Knight, 2018; Steel et al., 2022). Research has highlighted that without clearer standardization and alignment with national qualifications frameworks, micro-credentials remain fragmented and poorly understood across education and employment ecosystems (Brugera et al., 2022; Oliver, 2019). Despite increasing efforts toward formalization, persistent challenges related to interoperability, platform integration, and institutional acceptance remain critical areas for further investigation, particularly from an information systems perspective.

2.1.2 Definitions, standards and contexts of micro-credential usage

As higher education institutions, industry partners, and policymakers increasingly recognized the potential of micro-credentials to bridge skills gaps and promote lifelong learning, efforts to formalize the concept gained momentum. Governments in countries such as New Zealand, Australia, and Canada were among the first to introduce national frameworks that integrated micro-credentials into formal qualifications systems, aiming to standardize definitions, ensure quality assurance, and improve interoperability (New Zealand Qualifications Authority, 2018; Selvaratnam & Sankey, 2021; McGreal & Olcott, 2021).

In Europe, the Council of the European Union (2022) defined micro-credentials as certifications of learning outcomes acquired through short learning experiences, assessed against transparent standards and subject to quality assurance. This definition also emphasizes standard metadata elements, including learning outcomes, workload, assessment methods, and qualifications framework levels, to promote consistency and transferability across national systems. New Zealand, one of the early adopters, formally integrated micro-credentials into its qualifications framework, defining them as coherent learning packages between 5 and 40 credits (New Zealand Qualifications Authority, 2018). Australia introduced a national framework that similarly stresses consistency in terminology and transparency (Selvaratnam & Sankey, 2021). In the United States, decentralized initiatives such as Credential Engine have sought to map the complex ecosystem of non-degree credentials, but standardization efforts remain fragmented (Credential Engine, 2021). Although definitions increasingly converge around transparency, verifiability, and modularity, they differ in important ways. European and New Zealand frameworks tend to emphasize integration with formal qualifications systems, whereas many U.S. initiatives are industry-driven, prioritizing workforce skills without necessarily embedding credentials into higher education structures. These variations create persistent difficulties for international recognition, learner mobility, and cross-institutional collaboration (McGreal & Olcott, 2021; Reed, 2023).

Micro-credentials are now utilized across formal, non-formal, and informal education settings. In formal education, micro-credentials can carry academic credit, align with national qualifications frameworks, and support the modularization of degrees (Ahsan et al., 2023). In non-formal learning contexts, such as professional upskilling programs, they are often developed in partnership with employers to signal specific workforce competencies (Adams Becker et al., 2017; Davis, 2023). In informal settings, micro-credentials may certify skills acquired outside traditional educational institutions, such as through volunteer work or personal projects (Tamoliūnė et al., 2023). Each context raises distinct challenges around credibility, quality assurance, and integration with lifelong learning pathways (Boeren, 2024).

Despite these developments, the literature continues to highlight several research gaps. First, there remains limited understanding of how variations in definitions and standards affect the interoperability and portability of micro-credentials across borders (Raffaghelli & Stewart, 2020). Second, while frameworks emphasize quality assurance, empirical studies investigating how quality standards are operationalized across different issuing contexts are scarce (Patterson & Hepburn, 2025). Third, much of the existing research focuses primarily on course design, content delivery, or learner experiences, rather than on the credential itself as a distinct digital artifact (Ahsan et al., 2023; Keoy et al., 2024; Reed et al., 2024). Furthermore, although significant attention has been paid to defining micro-credentials, research on the development and structuring of metadata within these credentials remains limited (Trepule et al., 2024). Finally, although an increasing number of platforms now support the issuance of micro-credentials, very little research has examined the organizational, technological, and governance factors critical for building scalable and interoperable micro-credential ecosystems.

In this dissertation, the focus is placed on the issuance, management, and governance of micro-credentials rather than on course design, pedagogy, or curriculum development. By foregrounding technological and organizational perspectives, the study addresses underexplored dimensions critical for the sustainable integration of micro-credentials into higher education systems.

2.1.3 Technological infrastructure

The shift toward digital micro-credentials has brought questions of technological infrastructure to the forefront. Issuing, verifying, managing, and sharing micro-credentials require robust digital systems that ensure authenticity, security, interoperability, and learner ownership (Grech et al., 2021; Pretorius et al., 2021). Early implementations often relied on basic digital badges, popularized through platforms like Mozilla's Open Badges. While badges introduced the concept of portable digital recognition, they lacked many of the formal quality assurance and integration capabilities now expected in micro-credentials aligned with higher education systems (Clements et al., 2020; West & Lockley, 2016).

Emerging infrastructures have increasingly adopted standards such as the W3C Verifiable Credentials model, which enables micro-credentials to be cryptographically secured, issued by trusted authorities, and verified independently of the issuing institution (W3C, 2019). Regional initiatives, such as the European Digital Credentials Infrastructure (EDCI) and the EBSI, aim to promote cross-border recognition by supporting standardized metadata, trusted issuers, and decentralized verification mechanisms (European Commission, 2022; Grech et al., 2021). However, practical implementation remains complex. Many institutions operate fragmented IT ecosystems, and integration between learning management systems, student information systems, and credentialing platforms is rarely seamless (Tan et al., 2023).

Micro-credential issuance systems must accommodate both mandatory data (e.g., learning outcomes, assessment methods, workload) and optional metadata (e.g., skills frameworks, quality assurance references) (European Commission, 2022). Additionally, technological infrastructures must align with data protection regulations, particularly the General Data Protection Regulation (GDPR) in Europe (Voigt & Von dem Bussche, 2017), adding governance and compliance requirements that further complicate platform design and implementation. While research has extensively explored the potential of technologies like blockchain for educational credentialing (Turkanović et al., 2018; Sharples & Domingue, 2016), relatively few empirical studies examine the actual adoption barriers in higher education settings, especially in relation to system integration, national policy alignment, institutional readiness, and the operational complexity of issuing verifiable credentials at scale (Silaghi & Popescu, 2025)).

When institutions collaborate within alliances, new governance complexities emerge. For example, alliances such as Una Europa, Invest and ENHANCe have experimented with hybrid credentialing models, where some member universities issue credentials individually while others coordinate issuance through a centralized platform (ENHANCE, 2024; Invest, 2024; Una Europa, 2024). These approaches reflect pragmatic responses to variations in institutional autonomy, national regulation, and technological readiness. However, most existing literature remains focused either on technical implementations or on conceptual discussions of interoperability. Limited empirical research has addressed the organizational and governance challenges that arise when institutions collectively manage micro-credential issuance and verification across national and institutional boundaries. This dissertation addresses this gap by investigating how technological features, stakeholder expectations, and governance mechanisms jointly influence the management and governance of micro-credentials in higher education alliances.

2.2 Data governance in the Micro-Credential Context

Building on the technological and governance challenges outlined in the context of micro-credential issuance, this section introduces data governance as a critical analytical lens. To structure the discussion, the section is divided into three parts thus giving an overview of the concept of data governance, its specific relevance to micro-credentials, and the challenges of implementing data governance in multi-institutional alliances.

2.2.1 Data governance

Data governance refers to the frameworks, processes, and responsibilities that ensure the quality, integrity, availability, and security of data across its lifecycle (Khatri & Brown, 2010; Otto, 2011). It encompasses both the technical and organizational dimensions required to manage data as a strategic asset and to align data practices with institutional policies, regulatory requirements, and stakeholder expectations (Al-Badi, et al., 2018; Sharairi et al., 2024). Originally emerging from disciplines such as information systems, the concept of data governance has gained traction across sectors facing increasing demands for data transparency, trust, and accountability (Abraham et al., 2019; Weber et al., 2009).

From a disciplinary perspective, data governance is inherently interdisciplinary. It draws from information systems in its focus on aligning data and IT infrastructure with strategic objectives (Cheong & Chang, 2007; Naguib et al., 2024; Weber et al., 2009), organizational theory in its treatment of decision-making structures and accountability (Chukwurah et al., 2024; Khatri & Brown, 2010; Korhonen et al., 2014), and increasingly, public administration and policy studies, particularly when addressing governance across organizational boundaries (Janssen et al., 2020; Yukhno, 2024). It is also deeply entangled with data protection and law, especially in the European context where GDPR compliance forms a key governance requirement (Voigt & Von dem Bussche, 2017). More recently, data governance became important in implementation of AI to ensure data is managed securely, ethically and responsibly and avoid data misuse (Arigbabu, 2024; Pahune et al., 2025) as well as using AI for data governance (Sugureddy, 2024; Yandrapalli, 2024).

2.2.2 Data governance in micro-credential context

Micro-credentials, as outlined in the Council Recommendation (European Commission, 2022), require the management of multiple types of data including learner data (e.g., names, identifiers, achievements), institutional data (e.g., issuing institution, accreditation), credential metadata (e.g., learning outcomes, workload, assessment criteria), and digital verification components such as electronic signatures or eSeals. Compared to traditional diplomas or certificates, micro-credentials are often intended to be more portable, transparent, and learner-controlled (Resei et al., 2019; Zdunek et al., 2024).

This increased emphasis on portability and ownership of micro-credentials has led to the adoption of international standards such as the W3C Verifiable Credentials data model and technical infrastructures like the EBSI (Grech et al., 2021; Pretorius et al., 2021). These aim to ensure that micro-credentials can be issued, stored, and verified in a decentralized and interoperable manner, enabling lifelong learners to collect and share their credentials across institutions, borders, and digital ecosystems.

Although a wide range of actors (from universities to private training providers) now issue micro-credentials, this dissertation focuses specifically on micro-credentials offered and managed by higher education institutions. Within these institutions, data governance becomes critical not only for technical integration but also for ensuring that credential issuance complies with legal frameworks such as the GDPR, respects institutional policies, and maintains trust among stakeholders (Charles et al., 2025; Hill, 2025).

Existing research on micro-credential adoption has mostly highlighted technical challenges and broader institutional readiness (Gottlieb & Bacharach, 2022; Silaghi & Popescu, 2025). A few studies acknowledge the need to manage data (Tan et al., 2023), but they often do so in passing, without systematically addressing how data governance practices influence the feasibility, scalability, and legitimacy of micro-credentials. Moreover, as HEIs increasingly rely on third-party platforms or engage in collaborative credentialing initiatives, issues of data sharing, access control, ownership, and accountability become even more pressing. Despite these concerns, the data governance dimension remains largely underexplored in the literature on micro-credentials (Lokey-Vega et al., 2024). This represents a significant research gap as understanding how institutions assign roles, define data responsibilities, and ensure compliance is essential for the sustainable management of micro-credentials. This dissertation addresses this gap by analyzing micro-credential issuance through a data governance lens, focusing on HEIs operating both independently and in collaborative contexts.

2.2.3 Data governance in micro-credential alliances

As micro-credentials are increasingly issued in digital formats, questions of data governance have become central to their credibility, scalability, and interoperability, particularly in the European higher education context, where many pilot initiatives are being carried out through transnational alliances (ECIU, 2024; INVEST, 2024; MicroCredX, 2024). In these alliances, institutions from different countries collaborate to design, deliver, and issue joint micro-credentials. While this model offers new opportunities for innovation and learner mobility, it also introduces significant data governance challenges. Credential data such as learning outcomes, workload, assessment methods, and institutional identifiers must be standardized, verifiable, and trustworthy across borders.

Given the centrality of data in the micro-credentialing ecosystem, including learner records, credential metadata, and verification infrastructure, data governance provides a valuable analytical lens for studying the management and issuance of micro-credentials (Davidson & Winter, 2025; Koltay, 2016). It helps uncover how institutions assign roles, define access, ensure data accuracy, and coordinate compliance in digital environments where accountability may be distributed across departments or even between institutions (Nokkola et al., 2019; Verhulst & Marcucci, 2025). Moreover, in multi-institutional settings, data governance frameworks are often required to navigate the complexities of interoperability, data sovereignty, and standardization, making it particularly relevant for higher education alliances engaged in joint micro-credential initiatives (Amer et al., 2022; Ho, 2025).

Alliances formed by homogeneous partners with similar technological and institutional factors tend to be legitimacy-oriented and often adopt governance mechanisms rooted in equity partnerships (Lin & Darnall, 2015). While such alliances often share common strategic interests, they may still encounter added complexity due to cross-border regulatory requirements, diverse cultural expectations, and differing institutional policies (Cardoni et al., 2020; Krammer, 2025; Parkhe, 2003). These dynamics are particularly pronounced in alliances that rely on centralized platforms for operations such as issuing and managing micro-credentials, as data governance becomes a focal point. Existing research on data governance in alliances predominantly focuses on areas such as data security and risk management (Li et al., 2022), the development of new frameworks and governance models (Benfeldt et al., 2024; Melancon et al., 2024; Paskaleva et al., 2017), and organizational design considerations (Javadi et al., 2023). Additionally, studies address cross-border and transnational data governance, particularly in relation to regulatory compliance (Arner, 2022; Coche et al., 2024; Voss, 2019).

Initiatives such as the EDCI and experiments with blockchain-based systems like the EBSI aim to address some of these governance challenges by providing common standards and trusted mechanisms for credential verification. However, implementing these infrastructures within multi-institutional alliances still requires institutional coordination, platform integration, and careful alignment with both national policies and alliance-level agreements. This dissertation approaches data governance not simply as a technical issue, but as a strategic and organizational challenge especially in contexts where multiple institutions must work together to issue, manage, and validate micro-credentials.

While much of the current experimentation with joint issuance is taking place in Europe, similar data governance challenges are likely to arise in any setting where credentialing involves collaboration across institutional or national boundaries. These alliances require not only interoperability and regulatory compliance but also the negotiation of institutional roles, values, and expectations. However, existing research focuses on technical or structural dimensions of data governance, with limited attention to how institutional pressures, including regulative, normative, and cultural-cognitive forces shape decision-making and legitimacy in shared governance models (Gregory et al., 2022; Rachmad, 2023). This presents a gap in understanding how data governance is constructed and justified in alliance contexts, where diverse institutional logics must be reconciled. Addressing this gap is critical for designing data governance models that are both scalable and contextually adaptable within the evolving micro-credential landscape.

In this dissertation, data governance is also approached through the lens of contingency-based models developed specifically for organizational data management. The contingency model proposed by Weber et al. (2009), and further developed by Otto (2011), emphasizes that effective data governance structures depend on contextual factors such as organizational size, IT infrastructure, regulatory demands, and strategic priorities. Rather than prescribing a single best model, this approach allows institutions to select governance configurations that fit their specific environment. In the context of higher education alliances, where micro-credential issuance involves coordination across diverse institutions and systems, contingency-based thinking offers a practical way to evaluate when centralized, decentralized, or hybrid governance models may be most appropriate. These insights are used in this dissertation to guide the comparison of governance models in multi-institutional micro-credential ecosystems.

2.3 Theoretical Lenses

This dissertation draws on two distinct but complementary theoretical frameworks, namely Expectancy-Value Theory (EVT), and Institutional Theory, to examine different aspects of micro-credential management and governance. Each framework supports a different dimension of the research including learner motivation, governance model selection, and institutional behavior in cross-organizational settings. Together, these lenses provide a multi-level understanding of how micro-credentials are managed, and governed within higher education institutions and alliances.

2.3.1 Expectancy-Value Theory

Expectancy-Value Theory (EVT) has been widely applied across diverse research domains to examine how individuals make decisions based on motivation, perceived competence, and task value. Originally developed in educational psychology (Eccles et al., 1983), EVT posits that people are more likely to pursue an activity when they are confident, they can succeed (high expectancy) and when they perceive the activity as important, interesting, or useful (high value). It has been used extensively to study academic choices and achievement, particularly in areas such as education and gender disparities in math and science engagement (Bergann et al., 2025; Guo et al., 2017; Song et al., 2017; Wang & Xue, 2022). More recent studies include using EVT to understand broader phenomenon such as what drives early childhood education providers to increase quality (Hur et al., 2025; Shang et al., 2023).

Outside education, EVT is also used in understanding level of motivation in health care workers (De Simone, 2015), career decision-making, including career persistence and employee motivation, where it helps explain how value beliefs and success expectations shape job choices, entrepreneurial behavior, and ongoing professional development (Battle & Wigfield, 2003; Miles et al., 2024). In the information systems field, EVT has been used to understand user engagement with digital technologies, especially in education and training contexts (Jones and Hite, 2020). EVT's ability to account for both cognitive and affective components of decision-making make it particularly valuable in explaining user motivation in complex or unfamiliar digital environments.

In this dissertation, EVT is applied to examine how learners perceive and evaluate verifiable digital credentials in higher education (Publication II). The theory provided a structured lens to analyze the factors influencing learners' willingness to adopt micro-credentials, including their expectations of success in using digital systems, the perceived usefulness of the credentials, and the anticipated costs such as uncertainty about recognition or relevance. By applying EVT in this context, the study moves beyond anecdotal user perceptions and offers an understanding of how motivational factors shape the adoption of micro-credentials in formal higher education settings.

2.3.2 Institutional Theory

Institutional theory provides a powerful framework for analyzing how organizations respond to external pressures, norms, and shared belief systems in their pursuit of legitimacy (DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Scott, 1995). Moving beyond purely economic or functionalist views of organizational behavior, the theory emphasizes how sociopolitical and cultural contexts shape organizational structures, practices, and decision-making. In cross-border higher education alliances, institutional theory is particularly relevant, as member institutions must navigate diverse regulatory environments, stakeholder expectations, and cultural assumptions, challenges that are especially salient in the governance of micro-credentials (Brown et al., 2021; Wheelahan & Moodie, 2024).

Scott's (1995) three-pillar model, comprising regulative, normative, and cultural-cognitive pressures offers a structured lens for understanding how alliances manage complexity and pursue legitimacy. Regulative pressures include formal regulations and compliance frameworks such as accreditation requirements, data protection laws like the GDPR, and credentialing standards set at national or supranational levels (European Commission, 2022). Centralized platforms may support compliance, but cross-border legal fragmentation can heighten tensions between standardization and institutional autonomy (Grewal & Dharwadkar, 2002; Svendsen & Haugland, 2011). Normative pressures arise from shared values and expectations around academic quality, transparency, and fairness in credentialing (Durand et al., 2019; Ertug et al., 2024). These pressures often require negotiation, as institutions may vary in their pedagogical practices, quality assurance mechanisms, or engagement with labor market needs. Cultural-cognitive pressures reflect deeply embedded institutional norms and taken-for-granted assumptions that influence how governance structures are interpreted and enacted. In cross-border alliances, these pressures manifest in diverse organizational cultures and institutional legacies, often leading to resistance when governance approaches conflict with ingrained practices or beliefs (Ulijn et al., 2010; Galvin et al., 2021; Parkhe, 2003). Figure 2 provides a visual overview of the three institutional pressures, regulative, normative, and cultural-cognitive as they relate to governance decisions in the context of cross-border higher education alliances.

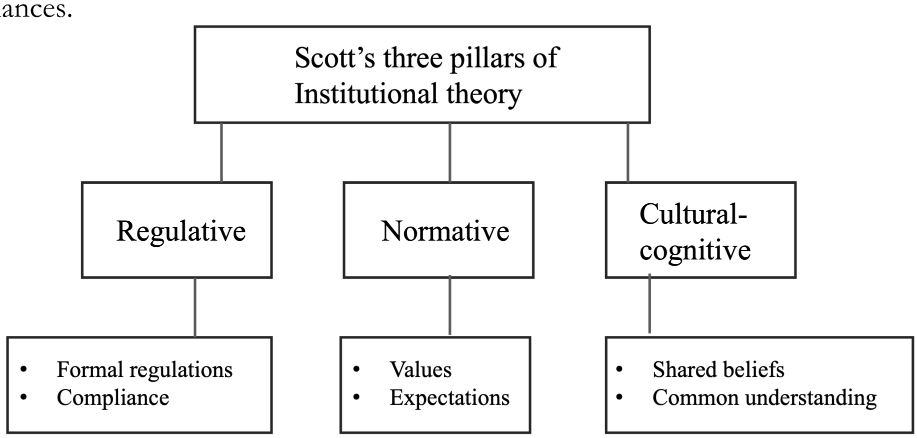

Figure 2: Institutional Pressures Shaping Micro-Credential Governance in Higher Education Alliances (adapted from Scott, 1995)

Institutional theory has also been applied in alliance research across various industries and transnational collaborations. In supply chain contexts, it has been used to understand buyer-supplier quality outcomes (Mellat-Parast, 2015), sustainable supply chain practices among SMEs (Shibin et al., 2020), and localization processes in global supply chains (Wu & Jia, 2018). These studies often examine how digital systems and data infrastructures mediate institutional responses, making them relevant to information systems contexts as well. In more explicitly collaborative alliance settings, institutional theory has informed research on airline industry partnerships (Kleymann, 2005), humanitarian collaborations during the refugee crisis (Yang et al., 2020), and alliance management capabilities in dynamic institutional environments (Vurro et al., 2024).

In information systems and related organizational research, institutional theory has been used to examine how organizations adopt and assimilate enterprise systems in response to external pressures (Liang et al., 2007), how public-sector IT programs evolve under legitimacy concerns (Currie, 2011), and how information systems can embody institutional logics (Gosain, 2004). Recent studies have further explored how institutional pressures shape digital transformation strategies (Lee et al., 2024), governance models in international projects (Lin et al., 2021), and green supply chain practices moderated by institutional environments (Nazir et al., 2024). In the public sector and multi-actor collaborations, researchers have shown how institutional logics influence responses such as coordination, accountability, and strategic alignment (Sedgwick & Lemaire, 2024; Lægreid & Rykkja, 2022; Vogel et al., 2022). These studies reinforce the relevance of institutional theory for analyzing how digital infrastructures and collaborative governance evolve under pressure to align with varying expectations, rules, and shared norms.

In this dissertation, institutional theory is not used as a grand explanatory framework for all organizational behavior, but as a structured lens to analyze how external legitimacy pressures shape decision-making about data governance in alliance-based settings. The three pillars, regulative, normative, and cultural-cognitive, serve as analytical categories to identify patterns in how stakeholder expectations, compliance concerns, and shared assumptions influence data governance decisions. By treating data governance not only as a coordination issue but also as a legitimacy-seeking process, institutional theory adds explanatory depth to the challenges faced by HEIs operating across institutional and national boundaries.

In this dissertation, Institutional Theory is used to examine how centralized governance structures for micro-credential issuance are influenced by external institutional pressures in a cross-border higher education alliance (Publication V). The framework guided the identification and analysis of regulative, normative, and cultural-cognitive factors that shape alliance-level data governance. These pressures were used as analytical categories to interpret stakeholder perspectives on compliance, coordination, and institutional autonomy. By applying Institutional Theory in this way, the dissertation highlights how governance structures are shaped not only by functional requirements but also by legitimacy concerns and the need to align with diverse institutional environments. The theory thus provided a valuable lens for understanding the complexity of governance in multi-institutional, cross-border collaborations.

3 METHODOLOGY

This chapter presents the methodologies used in this dissertation. It outlines the chosen research strategy, the methods employed and details the data collection and analysis procedures applied at different stages of the study.

3.1 Qualitative research strategy

Research in the field of information systems can be approached through a range of methodological traditions. The three most common approaches are: (1) qualitative research, such as interviews and focus groups (Ghauri & Gronhaug, 2005; Yin, 2009); (2) quantitative research, including surveys and statistical analyses; and (3) mixed methods research, which combines elements of both. The choice among these depends on the research question, the maturity of the phenomenon, and the desired depth of understanding.

Given that micro-credential governance and implementation remain relatively underexplored areas, especially in cross-institutional alliance settings, a qualitative approach was most appropriate for this dissertation. Qualitative research is particularly effective for studying emerging phenomena, as it allows researchers to explore perspectives, processes, and contexts in depth (Aspers & Corte, 2019; Ghauri & Grønhaug, 2020; Rosaline, 2008). It also helps uncover mechanisms that link micro- and macro-level organizational dynamics (Garcia & Gluesing, 2013) and facilitates sensemaking through interpretive engagement with the data (Flick, 2018).

In information systems research, qualitative methods have been widely applied to understand the interaction between technology, people, and organizational settings (Bertolotti & Tagliaventi, 2007) and have been used to explore phenomena such as intrinsic motivation in e-learning (Shroff et al., 2007). Qualitative research encompasses a wide range of methods, including interviews, case studies, design research (Avenier & Thomas, Hammarberg et al., 2016; Rosaline, 2008). For this dissertation, semi-structured interviews, case study research, and design science were chosen as the primary methodological tools. Semi-structured interviews allowed for the collection of rich, flexible insights from participants across institutional and organizational contexts. Case study research enabled in-depth analysis of governance structures, institutional processes, and alliance dynamics. One study employed a design science research approach to develop and evaluate a prototype infrastructure for credential issuance. These methods provided the flexibility and depth needed to explore a complex, evolving topic and to analyze both organizational and inter-organizational phenomena related to micro-credential governance. The rationale behind selecting each method in the five publications is described in the following sections.

3.1.1 Case study method

Case study research is a well-established method in qualitative inquiry, particularly suited for investigating complex, real-world phenomena in depth and within their natural context. According to Yin (2009), a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident. Stake (1995) highlights the value of case studies for providing rich, holistic insights into specific instances, while Eisenhardt (1989) emphasizes their utility in theory-building, particularly when existing theoretical frameworks are insufficient or exploratory understanding is needed.

Case studies can be classified into different types depending on their purpose. Exploratory case studies are used to gain initial insight into poorly understood phenomena (Benbasat et al., 1987). Descriptive case studies offer detailed accounts of specific instances (Kim et al., 2017), and explanatory case studies aim to uncover causal links or mechanisms (Yin, 2009). Another distinction is between single-case and multiple-case designs. Single-case studies are particularly valuable when the case is representative, revelatory, or critical to theoretical development (Yin, 2018). In information systems and higher education research, single-case designs are commonly used to study governance structures, digital transformation initiatives, or institutional strategy, especially when access to comparable cases is limited or the organizational setting is unique (Benbasat et al., 1987; Myers, 2019).

This dissertation adopts a single-case study design, with the ECIU alliance serving as the case. ECIU was selected due to its status as a legally established transnational alliance actively engaged in experimenting with short-form learning formats, including micro-modules and challenge-based learning. All five publications in this dissertation draw from this case. Primary data sources were semi-structured interviews with platform providers and experts (Publication I), interviews with university administrators and students who received micro-credentials (Publication II), and qualitative data collected during a design science study exploring credential infrastructure (Publication III). In addition, supplementary sources such as focus group discussions, institutional documents such as white papers, governance frameworks, technical documentation (e.g., from the EBSI initiative), and project reports were used to triangulate findings and enhance case richness across studies.

The use of a single-case design allowed for a deep investigation of micro-credential implementation and governance within a multi-institutional context, capturing both organizational and alliance-level dynamics. The longitudinal and multi-perspective nature of the case enhanced its relevance for studying cross-border collaboration, data governance, and the emergence of centralized models of credential issuance.

3.1.2 Interviews

Interviews are one of the most widely used methods in qualitative research and serve as a key tool for exploring participants' experiences, perceptions, and interpretations of a phenomenon (Alshenqueeti, 2014). A research interview is typically defined as a purposeful conversation, guided by the researcher, aimed at generating data relevant to a specific research question (Kvale & Brinkmann, 2009). In contrast to surveys or questionnaires, interviews allow for depth and nuance, enabling the researcher to probe for clarification, explore emerging themes, and adapt the conversation in real-time based on the participant's responses.

Interviews are particularly appropriate in exploratory studies and in research contexts where limited prior knowledge exists about a phenomenon (Myers & Newman, 2007). They are especially valuable for investigating complex social, organizational, or technological issues that cannot be easily captured through quantitative means (Jean Lee, 1992). In the context of this dissertation, interviews were used to access the views of diverse stakeholders, including institutional administrators, platform providers, and students on micro-credential adoption, value perception, and governance. The interview setting provides a unique opportunity for both interviewer and interviewee to engage in reflective sense-making, allowing researchers to access not only stated facts but also underlying motivations, institutional norms, and contextual constraints (Wengraf, 2001).

Interview interactions are shaped by both the researcher and the participant. The researcher plays an active role in guiding the conversation while remaining open to unexpected insights. Effective interviewing requires preparation, active listening, and the ability to adapt follow-up questions based on the flow of conversation (Rubin & Rubin, 2012). While interviews are often guided by a thematic outline or question set, they remain inherently interactive and co-constructed. This dynamic is especially important in research that explores institutional practices or governance processes, where responses may be influenced by organizational culture, role expectations, or evolving policy contexts (Myers, 1997; Rosaline, 2008).

There are several types of research interviews. While structured interviews follow a fixed set of questions, unstructured interviews are open and exploratory with no pre-defined guide. Semi-structured interviews offer a flexible middle ground, combining a set of pre-defined questions with the opportunity to explore emerging topic (Bryman, 2016; Eriksson & Kovalainen, 2008). This dissertation employs semi-structured interviews as the primary data collection method across all five studies. Semi-structured interviews allow researchers to follow a general guide while adapting to the flow of conversation and probing more deeply into themes that emerge during the discussion. This method is particularly effective when engaging with multiple stakeholder groups, as it balances comparability across interviews with openness to context-specific insights (Flick, 2018). Semi-structured interviews are also well-suited for cross-institutional research, where the organizational setting, language, and roles of respondents may vary. Moreover, the flexibility of semi-structured interviews helps build rapport with interviewees, which can be crucial when discussing governance decisions, institutional challenges, or policy tensions (Kvale & Brinkmann, 2009; Rubin & Rubin, 2012).

3.2 Design science research method

Design Science Research (DSR) is a methodological approach within information systems that focuses on the creation and evaluation of artifacts intended to solve identified problems or improve existing practices (Hevner et al., 2004). DSR follows a structured, iterative process that includes problem identification, artifact design, demonstration, evaluation, and reflection (Peffers et al., 2007). This approach is especially valuable in fields such as digital credentialing, where both technological innovation and contextual factors play key roles.

DSR has gained increasing recognition in information systems research for its ability to bridge theory and practice. In the context of this dissertation, DSR was employed in Publication III to explore the feasibility of using the EBSI for issuing micro-credentials. The artifact, a credential issuance prototype built on EBSI standards was developed to better understand the technical, organizational, and policy-level considerations involved in adopting such an infrastructure. While the artifact itself served as a boundary object to support discussions with institutional stakeholders, the evaluation focused on feasibility, integration potential, and regulatory compliance. This application of DSR aligns with the research emphasizing DSR's usefulness in uncovering interdependent technical and organizational conditions that influence digital infrastructure adoption in education and public-sector contexts (Gregor & Hevner, 2013; Purao, 2002).

While the primary methodological foundation of this dissertation is qualitative, the integration of DSR in one study provided a valuable complement to the interpretive insights generated through interviews and case study analysis. The combination of methods reflects the complexity of the research problem understanding micro-credential governance requires not only the exploration of institutional perspectives but also the examination of practical design and implementation issues. The DSR approach enriched the overall research by grounding theoretical insights in a concrete artifact and creating a touchpoint for empirical engagement around feasibility and adoption. Taken together, the case study, interview, and design science methods provided a holistic and practice-informed foundation for analyzing the governance of micro-credentials in higher education alliances

3.3 Data collection

The empirical data for this dissertation were collected through a series of qualitative case studies conducted within the context of a European higher education alliance. Data collection primarily involved semi-structured interviews, complemented by secondary sources such as focus group discussions, project documentation, white papers, and technical specifications related to digital credentialing systems. These diverse data sources enabled a rich and multi-perspective understanding of institutional dynamics, stakeholder experiences, and alliance-level governance practices.

A total of 61 semi-structured interviews were conducted between 2020 and 2024. The initial phase of data collection included 13 interviews with platform providers and micro-credential experts, for a focused understanding of platform functionalities and technologies to issue micro-credentials (Publication I). The second phase comprised 19 interviews with students who had received their first verifiable digital credentials, and 19 interviews with university administrators responsible for micro-credential development and implementation to understand value perception of micro-credentials from both learner and institutional view (Publication II). These administrator interviews were also used in subsequent studies, Publication III, which examined institutional readiness for credentialing infrastructure, and Publication IV, which analyzed governance models for credential issuance in higher education alliances. In the final phase, 10 additional interviews were conducted with individuals in central alliance-level roles, focusing on data governance coordination and the balance between centralized control and institutional autonomy (Publication V).

Participants were selected through purposeful and snowball sampling, ensuring representation across stakeholder groups and institutional contexts. Purposeful sampling refers to the deliberate selection of participants who are especially knowledgeable about or experienced with a phenomenon of interest, enabling the researcher to gain deep understanding of the issue under study (Patton, 2014). Snowball sampling, in which existing participants recommend other potential informants, was particularly appropriate given the emerging nature of the micro-credentialing field (Naderifar et al., 2017; Parker et al., 2019). As many relevant experts are not easily identifiable through formal directories or organizational charts, these approaches helped surface knowledgeable individuals actively involved in early-stage implementation and strategic development efforts. All interviews were conducted using a semi-structured format, allowing for consistent thematic coverage while also enabling flexibility to follow emerging issues. The interviews explored topics such as platform design, credential value perception, institutional strategy, and alliance-wide governance processes. Interview protocols were adapted for each study phase to reflect the evolving research focus and incorporate prior findings.

In addition to interview data, a range of secondary materials was used to support analysis and triangulate findings. These included three focus group discussions in the initial data collection phase, internal white papers and project documentation from the ECIU, as well as technical materials related to the EBSI. The analysis also drew on public documentation from other European university alliances, such as Una Europa and ENHANCE, which have shared practical examples of micro-credential issuance and governance through project websites and publicly available strategy papers. While the academic literature on alliance-level governance of micro-credentials remains limited, these examples provided valuable comparative insights and real-world reference points that informed the analysis of governance models in Publication IV.

Together, these data sources formed the empirical foundation for the five studies comprising this dissertation, enabling the exploration of micro-credential management and governance across institutional, technological, and alliance-level dimensions. Table 1 summarizes the data collection approach. The 19 semi-structured administrator interviews conducted as part of the Early Adopter Program were utilized across Publications II, III, IV, and V, each of which drew on the data from a different analytical angle.

Table 1. Summary of the publications' research designs and data collection approaches

	Research design and approach	Respondent details	Amount of data collected
Publication I	Single case study (inductive and qualitative)	Snow balling technique for identifying micro-credential experts and platform providers.	13 interviews and 3 supplementary focus group discussions.
Publication II	Single case study (inductive and qualitative)	Purposeful sampling for first stage with learners. Administrators from partner universities for second stage.	19 semi-structured learner interviews and 7 indicative questions (range 1-7). 19 semi-structured administrator interviews
Publication III	Single case study (Design science research method for artefact development Interpretive and qualitative)	Administrators from partner universities	19 semi-structured administrator interviews
Publication IV	Single case study (Interpretive and qualitative)	Administrators from partner universities Project documents, white papers and external documents	19 semi-structured administrator interviews
Publication V	Single case study (Interpretive and qualitative)	Administrators from partner universities for first stage Administrators in Central capacity role for second stage	19 semi-structured administrator interviews 10 semi-structured interviews from 8 individuals

3.4 Data analysis

The analysis of qualitative data in this dissertation followed established approaches for interpretive inquiry in information systems research (Sarkar et al., 2018; Elliott & Timulak, 2005; Kuckartz, 2014). Across the five studies, data were primarily analyzed using thematic analysis (Myers, 2019), supported by coding techniques that facilitated the identification of patterns, relationships, and emerging concepts from the interview transcripts and secondary data sources. Thematic analysis was conducted iteratively, beginning with initial readings to familiarize with the data, followed by open coding, category development, and axial coding to refine key themes (Strauss & Corbin, 2015). Coding was supported using qualitative data analysis software (e.g., NVivo) for publications IV and V, allowing for systematic organization and comparison of themes across stakeholder groups and research phases.

For the earlier studies (Publications I–III), the analysis focused on identifying recurring patterns in participant perspectives related to platform features, perceived value, and institutional decision-making processes. These analyses were primarily inductive in nature, allowing categories and concepts to emerge from the data rather than being imposed a priori. Codes were grouped into higher-order categories to reflect themes such as platform design priorities, learner expectations, and institutional constraints. The analysis was informed by prior literature but remained grounded in participant responses and organizational context.

In Publication V, the Gioia method was applied to support a more structured inductive analysis of institutional pressures and governance tensions in the centralized issuance of micro-credentials. The Gioia method provides a rigorous framework for qualitative coding that enables the construction of data structures moving from first-order concepts to second-order themes and aggregate dimensions (Gioia et al., 2013). This approach was particularly suited to the study's aim of identifying and categorizing the sources of tension across different types of institutional pressures, regulative, normative, and cultural-cognitive within the context of cross-border governance. The resulting data structure enabled the articulation of "tension creators" that shaped centralized data governance practices and informed the theoretical contribution of the study.

4 SUMMARIES AND MAJOR CONTRIBUTIONS OF THE INDIVIDUAL PUBLICATIONS

In this section, each individual publication included in the dissertation is summarized and their contributions to the overall dissertation are described. The author's role and contributions to each co-authored publication are detailed at the beginning of the dissertation after the listing of the original publications.

4.1 Publication I: Features of micro-credential platforms in higher education

4.1.1 Background and objectives of Publication I

Publication I investigates the essential features of micro-credential platforms that support the issuance and management of digital credentials. It focuses on how these platforms can benefit higher education institutions and learners by enabling both the secure, consistent delivery of credentials and the incorporation of any mandatory information required for successful issuance.

Micro-credentials are defined as short learning experiences that result in a credential upon successful completion. The platforms supporting these credentials must include specific features to facilitate their issuance and ensure that the required mandatory information is incorporated. As digitalization accelerates and the need for tamper-proof, easily shareable credentials grows, the European Commission is co-developing infrastructures to enable the secure issuance of digital credentials. Accordingly, HEIs must carefully evaluate available platforms to make informed adoption decisions.

Despite the growing number of micro-credential platforms, research on their operational models and functionalities remains limited. These platforms play a pivotal role in issuing, managing, and storing digital credentials, as well as facilitating data transfer among key stakeholders in the micro-credential ecosystem. Thus, HEIs require a comprehensive understanding of these platforms to assess their suitability.

This research aimed to provide a comprehensive overview of features that are essential for micro-credential platforms and to identify features offered by the existing platforms at the time of the study. The study employed semi-structured interviews and focus group discussions with micro-credential experts and platform providers. The data was analyzed iteratively, leading to the identification of key platform features and their relevance to both HEIs and learners.

4.1.2 Contribution of Publication I

For HEIs to effectively issue and manage micro-credentials, it is essential to understand the technological capabilities and limitations of existing platforms. This research identified twelve categories and thirty-eight specific features offered by micro-credential platforms, addressing the needs of three key stakeholder groups. The groups addressed here are issuing organizations, learners who receive and use the credentials, and recognizers such as employers or other institutions verifying credentials.

Findings indicate that most platforms are designed primarily for issuers, with user interfaces catering more to the issuing organizations than to learners or recognizers. The features identified include basic functionalities such as user interface, types of digital credentials, and portfolio management, while some platforms also offer advanced features, including learning pathways, credential verification, and validation of digital credentials. Among the critical features for HEIs, credential verification for authenticity and validation of micro-credential content and evidence are particularly important. Verification mechanisms such as eSeals ensure credentials remain tamper-proof, reducing the burden of manual verification on institutions.

Based on the empirical findings, micro-credential platforms provide significant benefits for both HEIs and learners. Institutions can issue and verify micro-credentials for a variety of learning offerings, including formal, credit-bearing programs as well as non-formal learning opportunities. These platforms enable institutions to efficiently manage their credentialing processes while ensuring compliance with authentication and security standards.

For learners, micro-credential platforms allow them to collect, store, and share credentials, enhancing ownership and portability. Learner interfaces typically display basic credential information, such as issuing organization and achievement details, alongside metadata like grades and additional learning evidence. The digital format and built-in verification mechanisms strengthen the credibility of these credentials, making them more widely recognized and transferable.

By providing secure, verifiable, and easily transferable digital credentials, these platforms support HEIs in managing their credentialing processes while empowering learners to retain control over their achievements.

4.2 Publication II: Are micro-credentials valuable for students? Perspective on verifiable digital credentials

4.2.1 Background and objectives of Publication II

The second publication aimed to explore the value of verifiable digital credentials for learners. Discussions involving multiple stakeholders, including higher education institutions and policymakers, contributed to refining the definition of micro-credentials. They are increasingly recognized as a mechanism for individuals to upskill or reskill, equipping them with competencies that are in high demand in emerging labor markets. Micro-credentials are defined as a combination of a short learning experience and the credential issued upon successful completion. The discussion surrounding micro-credentials primarily focuses on the evidence of achievement provided in a digital format at the conclusion of an academic endeavor. Understanding the value of these digital credentials for learners represents the next logical step toward examining their issuance, management, and broader adoption.

As the field of micro-credentials is still relatively new, a qualitative research methodology was chosen to gain deeper insights from both learners and HEI administrators involved in issuing digital credentials. Interviews with learners included a set of guiding questions designed to capture their perspectives on the perceived value of digital credentials. Following the initial analysis of learner responses, administrators from HEIs were interviewed to obtain a broader institutional perspective and to validate the insights gathered from learners.

Using Expectancy-Value Theory (Eccles, 2005), this study identified key factors that influence the adoption of digital credentials by learners. By integrating perspectives from both learners and HEI administrators, the study provides a comprehensive understanding of the perceived value of micro-credentials and the conditions that facilitate their adoption.

4.2.2 Contribution of Publication II

The analysis from this study provided valuable insights into learners' perceptions of the value of digital credentials and the factors that enhance their perceived utility. The findings indicate that learners recognize the future benefits of digital credentials, particularly in job searching, competency visualization, and sharing their qualifications as needed. Learners expressed confidence in their ability to navigate digital platforms for storing, viewing, and sharing credentials, suggesting that technological barriers do not hinder adoption. Additionally, the study found that learners are interested in acquiring more digital credentials to help them track their skills over time.

The metadata embedded in digital credentials, such as learning outcomes and skill-related data, was seen as particularly useful, especially for international job markets, where detailed competency-based information can provide a competitive advantage. Learners also found intrinsic value in digital credentials, viewing them as tools that could help them map out their learning pathways and achieve their long-term goals. As micro-credential adoption continues to grow, learners expect the long-term value of these credentials to increase.

The study's expectancy-value model demonstrated that higher expected success in using digital credentials, combined with strong value perception and low perceived cost, leads to greater adoption. This key insight is particularly relevant for HEIs in designing their micro-credential strategies. Administrators perceived the utility value of digital credentials to be high, believing that they could provide learners with a competitive edge by showcasing their skills and achievements. They also suggested that digital credentials could facilitate clearer learning pathways, enabling learners to be more proactive in skill acquisition. Furthermore, administrators saw potential benefits for credit transfers and admission processes, anticipating that if HEIs widely adopted digital credentials, these processes could become more streamlined in the future.

However, the study also highlighted institutional challenges in the adoption of digital credentials. Administrators noted that the cost of issuing digital credentials remains high, primarily due to the time and effort required to integrate credentialing platforms with local learning management systems. Despite this challenge, all administrators recognized the importance of issuing digital credentials for micro-credentials and saw their potential value. Digital credentials were also identified as a means to facilitate the unbundling of educational offerings, allowing HEIs to offer smaller, stackable micro-credentials. Additionally, they could strengthen credential verification processes by incorporating metadata such as assessment criteria, accreditation details, and secure verification mechanisms like electronic seals.

4.3 Publication III: How can European blockchain services infrastructure be used for managing educational digital credentials?

4.3.1 Background and objectives of Publication III

The third publication aimed to evaluate the feasibility of implementing a system for the issuance and verification of digital credentials. A key aspect of such a system is enabling learners to store digital credentials in a digital wallet, granting them full control over when and with whom to share their credentials. The increasing emphasis on micro-credentials and their growing adoption by learners of all ages, including traditional students and lifelong learners seeking upskilling and reskilling opportunities, emphasize the need for HEIs to establish a system for cross-border verification and validation of digital credentials.

To address this challenge, the study employed a Design Science Research (DSR) methodology to design and develop an artifact for managing cross-border digital credential exchange. This artifact utilized the EBSI as its underlying technology, leveraging blockchain-based trust mechanisms to facilitate secure and verifiable credential issuance.

The proposed solution was demonstrated through a case study involving two universities in different countries, simulating a cross-border verification scenario. The feasibility of implementing such a system for higher education institutions was then evaluated using a qualitative approach, drawing on interviews with HEI administrators, development logs, and an analysis of EBSI literature. The qualitative analysis followed an interpretive approach, aiming to assess the practicality of integrating blockchain-based credentialing systems into production environments

4.3.2 Contribution of Publication III

The analysis identified 14 key considerations, both technical and organizational, that influence the feasibility of implementing a blockchain-based system for digital credential issuance and verification. Each consideration was assigned a severity level based on administrators' perspectives. Overall, the findings suggest that while the technology is technically viable, it still requires further maturation to address critical issues such as compliance with the GDPR. On the organizational side, integrating such a system into an institution's daily operations appears unlikely in the short term, given the complexities involved.

Different digital credentialing systems use varied technologies for verification and validation. The artifact developed in this study relies on EBSI, which requires learners to actively request credentials before HEIs can issue them. While this requirement does not necessarily impact institutional decisions to adopt the system, it may pose a long-term usability challenge for learners, especially as HEIs begin issuing micro-credentials at scale. The need to manually request each credential could become cumbersome, potentially affecting adoption rates.

Even if systems adhere to recognized standards such as the W3C Verifiable Credentials (VC) data model, implementation could introduce additional complexity in countries that have not yet adopted these standards. As digital credentials gain traction, learners may accumulate multiple credentials across different platforms, potentially leading to challenges in managing them. Depending on the credentialing system adopted by each organization, learners may be required to maintain multiple digital wallets, raising interoperability concerns in the long term. If wallets lack interoperability, managing credentials across different platforms could become an additional burden for users.

From an organizational perspective, the study found that the strategic decision to implement digital credentials at an institutional level is the most critical factor influencing adoption. Administrators noted that many institutional-level considerations for large-scale implementation depend on this broader strategic choice. One of the key challenges is the integration of digital credentials with local student management systems, which requires direct access to institutional data.

The findings also highlight that national-level discussions on micro-credential strategies are currently shaping institutional decisions. Some institutions may delay adoption until national policies and frameworks become more defined, preferring to align their implementation strategies with broader national initiatives. In several countries, nationwide student and learning management systems already exist, while others are currently developing centralized national strategies for digital credentialing. This suggests that short-term implementation at the institutional level may not be feasible, as adoption will largely depend on the national strategy and its timeline for deployment.

The study also points out that micro-credential adoption maturity varies by country. If implemented today, some institutions may still need to issue paper-based certificates alongside digital credentials, leading to duplicated administrative efforts. Additionally, current institutional priorities and resource constraints may prevent HEIs from investing in student management system integration at this stage, as higher-priority projects may take precedence.

4.4 Publication IV: Exploring Centralized, Decentralized, and Hybrid Approaches to Micro-Credential Issuance in HEI Alliances

4.4.1 Background and objectives of Publication IV

The fourth publication investigates the issuance and governance of micro-credentials (micro-credentials) within higher education institution alliances, focusing on the different governance models that alliances can adopt. As micro-credential initiatives gain momentum, HEIs are increasingly collaborating through alliances to develop shared credentialing strategies. However, the governance of micro-credential issuance within alliances presents unique challenges, including data management across institutions, platform interoperability, and regulatory compliance. Unlike individual HEIs, alliances must coordinate issuance processes across multiple partners while balancing autonomy, administrative efficiency, and strategic alignment.

Although various alliances are piloting micro-credential issuance, there is limited research on how different governance models compare in practice. Existing examples suggest two main approaches. In the hybrid issuance model, one or more HEIs issue micro-credentials on behalf of all alliance partners, whereas in decentralized issuance, each institution issues its own credentials independently. While these approaches are being used in practice, their feasibility, scalability, and governance implications have not been systematically studied.

This research addresses this gap by identifying, introducing, and comparing three governance models, hybrid, decentralized, and a newly identified centralized approach. Through a qualitative case study involving an HEI alliance with 12 partner institutions across different countries, the study examines the feasibility of centralized issuance, where the alliance itself acts as the issuing entity.

Building on Weber et al.'s (2009) contingency approach for data governance, the study identifies key governance factors relevant to micro-credential issuance in alliances. These factors are compared across all three models, integrating organizational and platform considerations to determine the advantages and limitations of each approach. The findings provide a comprehensive framework to help HEI alliances select the most suitable governance model based on their strategic and operational needs.

4.4.2 Contribution of Publication IV

The qualitative analysis of the case study revealed that none of the institutions within the alliance were willing or able to take on the responsibility of issuing micro-credentials on behalf of other institutions. Most administrators cited multiple reasons for this, including institutional strategy, national policies, and the complexities involved in integrating digital credentialing systems. As a result, neither of the two practice-based approaches, hybrid or decentralized, proved viable for the alliance, necessitating the exploration of an alternative governance model.

Through empirical analysis, the study identified a third approach: a centralized model, in which the alliance itself procures an eSeal and acts as the issuing entity for micro-credentials on behalf of all partners. This centralized approach enables the alliance to establish a central platform that functions as the management and governance entity for all issued micro-credentials, ensuring that all necessary credentialing information is captured. The platform also provides a mechanism for partner institutions to indicate when students have completed the requirements for micro-credential issuance and supports re-issuance if needed. Since the alliance is a legally registered entity, procuring an eSeal and acting as the issuer is a feasible solution.

To systematically evaluate and compare governance models, the study applied the contingency model, incorporating both organizational and platform-related factors. Some factors, such as the degree of market regulation, remained constant across all approaches, as all models must comply with data regulation policies.

However, key differences emerged. The centralized approach provided an open strategy, as the platform was specifically designed for issuing micro-credentials, making it easier to scale and customize for new institutions or markets. While portfolio expansion is more straightforward in a centralized system, both hybrid and centralized approaches ensure higher portfolio quality, given their structured oversight mechanisms.

Within the case study, administrators overwhelmingly favored the centralized approach, citing administrative ease, control over credential issuance, and consistency as key advantages. They also noted that branding benefits could be achieved through centralized issuance, reinforcing the alliance's identity and quality assurance standards. Since none of the partner institutions were strategically or technically prepared to issue micro-credentials independently, centralizing issuance reduced the burden on individual institutions, allowing them to focus on designing high-quality micro-credentials under the alliance's framework.

Despite its advantages, the centralized approach also presents challenges. The lack of IT pipeline integration with partner institutions means that all relevant information, including course content and admission requirements, must be manually entered into the central system. This process is time-intensive and requires dedicated resources at each institution. Additionally, due to the sensitive nature of learner data, particularly grades, a decision was made not to include grades within micro-credentials. This, however, introduced additional administrative burden for institutions, as they must continue to issue transcripts of records separately alongside micro-credentials.

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4.5 Publication V: Institutional Pressures and Tensions Shaping Cross-Border Data Governance: Lessons from a Centralized Micro-Credential Consortium

4.5.1 Background and objectives of Publication V

The fifth publication explores the factors that create tension between centralized governance and institutional autonomy in the issuance and management of micro-credentials within HEI alliances. As alliances take on a greater role in coordinating micro-credential issuance, governance structures must balance centralized control to ensure consistency and efficiency with institutional autonomy to preserve flexibility and decision-making power. In alliances where micro-credentials are issued centrally, institutions must navigate governance structures in which key decisions, such as data management, compliance requirements, and standardization, are coordinated at the alliance level, potentially limiting individual institutions' autonomy over credentialing processes.

While centralized issuance streamlines administrative processes, enhances standardization, and strengthens the alliance's brand, it also presents governance challenges, particularly in managing cross-border data flows, aligning with diverse regulatory frameworks, and accommodating institutional autonomy. Unlike individual institutions that maintain full control over their credentialing processes, alliances operating under a centralized model must ensure that governance structures accommodate multiple national policies, institutional priorities, and stakeholder expectations. Although previous research has examined various micro-credential governance models, including centralized, decentralized, and hybrid approaches, there is limited empirical research on how centralized governance affects institutional autonomy and factors that might create tensions between them.

A qualitative case study approach was employed to investigate governance dynamics within an HEI alliance that employs a centralized platform for issuing and managing micro-credentials. The study is based on two sets of interviews. The first includes institutional-level interviews, which captured universities' goals, constraints, and regulatory and cultural-cognitive considerations regarding micro-credentials. The second set consists of central-level interviews, which focused on understanding governance challenges from a central perspective. Although positioned centrally, these stakeholders also reflected on the implications of centralized governance from their institutional vantage points, providing a dual perspective that bridged alliance-wide strategy with the practical considerations of implementation at the institution level. The key governance tensions identified in this study, referred to as 'tension creators' correspond to the four aggregate dimensions derived from our data analysis. These dimensions emerged through the structured coding process using the Gioia method and reflect the primary institutional pressures shaping governance decisions in the alliance. Each tension creator is associated with one of the three institutional pressures (regulative, normative, or cultural-cognitive), and together, they capture the challenges arising from centralized micro-credential issuance. Three propositions were derived from the findings that explain the role of institutional pressures in shaping inter-organizational data governance.

The study contributes to the institutional theory literature by examining how governance structures form in inter-organizational settings under multiple, overlapping institutional pressures and to data governance research by contextualizing these challenges within cross-border educational alliances.

4.5.2 Contribution of Publication V

This study uses institutional theory as a lens to interpret how regulative, normative, and cultural-cognitive pressures shape data governance in cross-border HEI alliances. While institutional theory has been applied in inter-organizational contexts in other fields, its use to explore institutional complexity in data governance within cross-border HEI alliances remains limited in information systems research. Specifically, it identifies tensions that emerge when centralized governance models, such as issuing credentials through a shared alliance-level entity encounter institutional constraints. Regulative tensions that may arise from navigating diverse national and institutional regulatory frameworks, can limit an individual institution's ability to fully participate in centralized initiatives. Cultural-cognitive tensions surface when there are inconsistent local practices, definitions, and system maturity, often requiring additional coordination and duplicative work. Normative tensions might emerge when data is collected centrally on behalf of all partners, raising data security and trust concerns in the absence of a clear, jointly agreed data governance plan.

By applying the theory to a centralized governance model for micro-credentials, the study illustrates how alliances respond to overlapping institutional demands through negotiated governance structures, role definitions, and compliance strategies. In doing so, it demonstrates the usefulness of institutional theory for understanding tensions between centralized coordination and local autonomy in digital governance settings. The study also contributes to the data governance literature by shedding light on alliance-level dynamics, an under-explored area where shared policies must account for varied regulatory and cultural contexts, highlighting the importance of joint decision-making in multi-stakeholder data environments.

This study highlights the importance of establishing shared data policies and joint decision-making bodies early in an alliance's formation to manage micro-credentials. By defining roles, responsibilities, and baseline compliance aligned with the strictest regulatory regimes, alliances can reduce inconsistency and strengthen trust. Our findings also show that alliances should anticipate regulative, normative, and cultural-cognitive pressures by conducting institutional audits and adopting layered governance models that balance standardization with local adaptation. Finally, the study emphasizes embedding data governance controls, such as role-based access and audit logs directly into technology platforms and supporting transparency through onboarding processes and helpdesk solutions. These measures help alliances accumulate standardized yet adaptable data practices that support long-term collaboration and interoperability.

5 DISCUSSION

This section describes how the findings of the publications address the research questions of the dissertation and how they converge to answer the main research question of the dissertation.

5.1 Technical features needed in a platform to issue and manage micro-credentials

The purpose of the first research question (*What technological characteristics are essential for the management and issuance of micro-credentials?*) was to understand the features needed in a platform to issue and manage micro-credentials. This question was addressed in Publications I and III. Publication I explored the essential technical features required to manage and issue micro-credentials effectively, identifying twelve categories and thirty-eight platform features relevant to three core stakeholder groups: issuers, learners, and verifiers. Publication III further advanced this understanding through a design science study that built and evaluated a prototype based on the EBSI, highlighting how technical implementation is influenced by policy-level and organizational constraints in real-world adoption.

To enable higher education institutions (HEIs) to issue and manage micro-credentials effectively, platforms must support both foundational and advanced functionalities (Kiiskilä et al., 2022). While early initiatives such as Mozilla's Open Badges laid the groundwork for digital skills recognition (Araújo et al., 2017; Grant, 2016), they lacked features such as portability, standardized metadata, and formal quality assurance, now considered essential in higher education (Clements et al., 2020; West & Lockley, 2016). Third-party platforms vary significantly in their offerings (Mallon, 2019; McGreal & Olcott, 2022), making it crucial for institutions to align platform selection with strategic objectives and existing capabilities (Kiiskilä et al., 2022).

Publication I confirms that credential creation, storage, and browsing are foundational platform functionalities (Rottmann & Duggan, 2021; Devedžić & Jovanović, 2015), as is enabling learners to own, manage, and share their credentials

(Daukšienė et al., 2024). However, advanced features, such as credential validation and metadata inclusion are equally critical for usability and trust (Kiiskilä et al., 2022, 2023). This is reinforced by the European Commission's (2022) guidelines, which mandate metadata fields such as learning outcomes, workload, and assessment details, and require that credentials be tamper-proof. Although most platforms allow learners to share micro-credentials on social media (Shariman & Damian, 2022), limited portability often forces them to manage multiple wallets for credentials from different issuers (Kiiskilä et al., 2022, 2023). The technological characteristics identified in this study are reflected in the platform features categorized in Tables 2 and 3, which present the basic and advanced functionalities respectively.

Global frameworks such as W3C Verifiable Credentials (W3C, 2019) offer new ways to enhance security, trust, and interoperability. When combined with regional standards such as the EDCL, they enable HEIs to issue micro-credentials that are metadata-rich and tamper-proof and are considered important features (Kiiskilä et al., 2023). However, practical implementation remains complex. Integrating institutional IT systems, such as student information and learning management systems, with third-party platforms remains complex and resource-intensive (Kiiskilä et al., 2023), and existing empirical research offers limited insights into these challenges (Silaghi & Popescu, 2025; Tan et al., 2023). GDPR compliance further complicates technical deployment, requiring that learner data be processed and stored securely without undermining transparency or usability (Kiiskilä et al., 2023).

Emerging infrastructures like EBSI are closely tied to the evolving notion of learner ownership, often referred to as self-sovereignty (Lacity & Carmel, 2022; Grech et al., 2021). Publication III illustrates how the implementation of self-sovereign principles within EBSI introduced practical challenges for higher education institutions, particularly regarding credential issuance workflows and integration with institutional systems (Kiiskilä et al., 2023). For instance, EBSI requiring learners to request each credential individually adds procedural complexity and necessitates substantial adjustments to institutional systems (Kiiskilä et al., 2023).

Broader empirical research in this area remains limited and often confined to pilot studies (Záklasník et al., 2023). In Publication III, blockchain-based verification was evaluated as one of two existing verification methods, illustrating how technical decisions are often intertwined with broader factors such as national strategies (Kiiskilä et al., 2023).

While features such as stackability and support for flexible learning pathways are seen as essential for the future, they remain technically infeasible with current infrastructures (Kiiskilä et al., 2022). Overall, the platform features identified in this research support all three core stakeholder groups, issuers, learners, and verifiers and are critical for institutional adoption (Kiiskilä et al., 2022, 2023). As emphasized by Varadarajan et al. (2023), the success of micro-credential ecosystems depends on stakeholder acceptance.

Table 2: Basic features essential in micro-credentialing platforms

Category	Features	Description
User interface	User interface for issuers	Interface for administrators and teachers
	User interface for learners	Interface for learners such as students
	User interface for verifiers	Interface for recognizers such as institutions
Types of credentials	Badges	Awarded for the completion of task
	E-certificates	Certificate of completion including diplomas
	Proofs with browsable data	Credential is text based with metadata
	Custom credentials	Customize the content and look
	Peer awarded credentials	Awarded by Peers as part of the learning
View and search	Search function for learners	Search credentials based on issuers
	View metadata	View all the metadata associated with a credential
	Custom display	Customizing display of credentials
Issuing credentials	Manually via web interface	Create and/or issue for a single learner
	Semi-automatic issue	Use tools such as Excel to create list of users to issue digital credentials
Bulk issuing	Automated awarding of credentials	Award credentials automatically when requested
	Via API integrations	Issue credentials in bulk
Portfolio management	Collecting credentials	Portfolio of all earned credentials
	Importing credentials	Importing from other sources
	Organizing credentials	Organize by category (such as badges)
	Stackability	Ability to display collection of credentials for particular skills/field
	Social media platforms	Share credentials on various social media platforms such as LinkedIn

Share credentials	With industry/institutions	Share credentials with potential employers and others

Table 3: Advanced features necessary in micro-credentialing platforms

Category	Features	Description
Pathways of credentials	Visualizing and documenting pathways for credentials	Collection of learning offerings that need to be completed to earn a larger degree or skill
Types of proofs attached with credentials	Issuer-related data	Allowing users to browse proof related to issuers
	Skill-related data	Use standard frameworks as taxonomy for skills
	Educational standards	(e.g. EQF, NQF in Europe)
	Awards and achievements	Meta data specific to achievements and awards
	Learning outcomes	Commonly associated with formal learning, includes skills learners will acquire
	Formal learning related data	Commonly associated with formal learning, includes data such as ECTS and learning hours
	Grading scheme related data	Commonly associated with formal learning, includes data on scale applied to grades
	Supplementary evidence of learning	Attaching appendices and supplementary evidence to the credential
	Support of learning assessment	Different versions of credentials for different levels of mastery
Link with learning offerings	Registration for learning offering	Search for learning offerings and register
Verification of authenticity	Blockchain	Use blockchain technology for authenticity of data
	Electronic seal	An authenticator signature to ensure data origin and integrity
Validation features	Reviewing metadata	Review metadata digital credential submitted by the learner
	Validating the credentials	Validate the evidence of achieving the credential

	With industry/institutions	Share credentials with potential employers and others

5.2 Perceived value and strategic role of micro-credentials in higher education institutions

The aim of the second research question (*How do institutional, technological, and learner perspectives influence the perceived value and strategic role of micro-credentials in higher education?*) is to examine how these interrelated perspectives collectively shape both the perceived value of micro-credentials and their strategic positioning within institutional agendas. Rather than treating these perspectives in isolation, this discussion considers their interactions and overlaps. Publications I, II, and III contribute complementary insights across platform capabilities, learner perceptions, and organizational integration efforts.

From a technological perspective, the value of micro-credentials is tightly linked to platform features that ensure usability, verifiability, and portability as well (Kiiskilä et al., 2022). Earlier research has emphasized the importance of built-in verification mechanisms, interoperable metadata, and learner-controlled credential sharing (Grech et al., 2021; Pretorius et al., 2021). These features contribute to institutional trust and allow micro-credentials to serve as dynamic digital assets rather than static records (Kiiskilä et al., 2023). The emergence of verifiable digital credentials, aligned with standards such as W3C Verifiable Credentials and the EU's European Digital Credentials Infrastructure, confirms the growing need for secure, standardized, and learner-centered systems (European Commission, 2022). For higher education institutions, maintaining the same level of quality and transparency for micro-credentials as for degree programs is critical to ensure credibility (Kiiskilä et al., 2022, 2023.

Learners engage with specific learning opportunities to gain content knowledge, yet findings suggest that receiving a micro-credential, particularly one with rich, transparent metadata, in itself perceived as valuable (Kiiskilä et al., 2023). Micro-credentials are increasingly framed not only as learner-centered tools but also as strategic instruments within higher education institutions (Olcott, 2022). Their value proposition extends beyond certification; they enable personalized learning pathways, institutional innovation, and greater responsiveness to labor market demands (Kiiskilä et al., 2023, 2023). This is further supported in the literature (Kässi & Lehdonvirta, 2024; Perea, 2020).

The inclusion of information-rich metadata differentiates micro-credentials from simpler digital badges and may increase their perceived legitimacy among employers (Kiiskilä et al., 2023). From the learner perspective, micro-credentials offer value by supporting career advancement, personal development, and educational progression (Kiiskilä et al., 2023) reinforcing the need for rich metadata in credential design. These findings align with earlier research on learners' generally positive attitudes toward micro-credentials (Ahmed & Jassim, 2021; Ghasia et al., 2019; Kato et al., 2020). Administrators also recognize the potential of micro-credentials to support credit transfers, especially by making learning outcomes and course details as transparent elements that learners would otherwise have to retrieve and submit manually (Kiiskilä et al., 2023). Furthermore, institutions also see them as tools that can foster a culture of lifelong learning (Scholl et al., 2025).

Drawing on Expectancy-Value Theory, Publication II identifies the enabling factors that shape learners' perceptions and intentions to use digital credentials (see Figure 3). Learners appreciated credentials that clearly presented learning outcomes, workload, and assessment information, features that support both external recognition by employers and internal recognition by universities. However, the decision to adopt micro-credentials was also shaped by cost-benefit considerations. As shown in earlier studies and echoed in the findings, uncertainty about recognition, lack of visibility, and unclear institutional endorsement were reported as key concerns (Narayanaswamy et al., 2024; Oliver, 2021; Reed, 2023). This highlights that technical affordances alone are insufficient, trust, recognition, and broader ecosystem integration are equally critical for learner engagement.

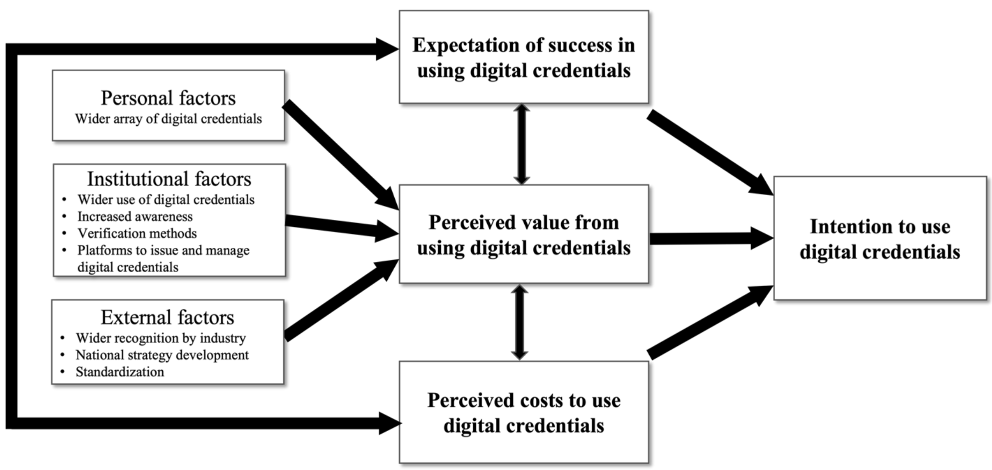

Figure 3. Summary of findings on factors influencing digital credential value and learner use intentions (modified from Hulleman et al., 2016).

Findings from Publications I and III show that institutions prioritize platforms that support verified issuance, digital signatures, and the inclusion of structured metadata such as learning outcomes, workload, and assessment criteria (Kiiskilä et al., 2022; 2023). Learner ownership and the ability to share credentials, whether through wallets or social platforms, were considered important for increasing visibility and trust. However, limitations persist in integrating these platforms with existing IT systems. Publication III identified fragmented infrastructures and the need to link multiple institutional data sources as high-severity challenges that impede readiness (Kiiskilä et al., 2023). Hence, the technological value of micro-credentials hinges not only on what is issued but on how seamlessly systems interconnect within the digital ecosystems of both institutions and learners.

As illustrated in Publication III, many institutions see micro-credentials as tools for extending access, promoting workforce alignment, and responding to national and EU-level policies (Kiiskilä et al., 2023). At the institutional level, micro-credentials are increasingly positioned as strategic responses to system-wide objectives such as modularizing degree programs, increasing the visibility of non-degree learning, and enhancing institutional outreach (Gallagher, 2022; McGreal & Olcott, 2021). However, strategic ambitions are often challenged by operational constraints. Organizational barriers found in this research, such as insufficient internal coordination, resource constraints, and administrative complexity mirror findings from other studies on institutional readiness (Clements et al., 2020; Turkanović et al., 2018; Rami et al., 2023). In Publication III, institutional leaders categorized both technical and organizational implementation challenges as high severity, suggesting that the strategic potential of micro-credentials cannot be realized without systemic alignment and sufficient resourcing.

Taken together, the findings demonstrate that the perceived value and strategic role of micro-credentials are not determined by a single actor or perspective but are instead co-constructed through the interplay of learner expectations, institutional objectives, and technological capabilities. While platforms must deliver essential functionalities such as verification, transparency, and interoperability, their successful adoption depends equally on institutional readiness and learner trust. For micro-credentials to move beyond pilot initiatives and become embedded in formal higher education systems, their design and implementation must address the needs of all key stakeholders. This includes ensuring that credentials are not only technically verifiable and portable, but also educationally meaningful, institutionally credible, and practically usable within the broader digital learning ecosystem.

5.3 Organizational structures and policies impacting the governance of micro-credentials

The third research question (*How do organizational structures and policies impact the governance of micro-credentials?*) investigates how governance arrangements, institutional roles, and cross-institutional coordination shape the implementation of micro-credential issuance, particularly in HEI alliance contexts. This question is addressed through Publications III, IV, and V, which together provide complementary insights into institutional readiness, cross-institutional collaboration, and the institutional pressures shaping data governance. Publication III examines internal administrative and strategic conditions influencing institutional adoption. Publication IV evaluates a centralized governance model adopted within an HEI alliance, comparing it with hybrid and decentralized arrangements to highlight trade-offs between standardization and institutional autonomy. Publication V extends this analysis by applying institutional theory to explore how regulative, normative, and cultural-cognitive pressures shape alliance-level data governance models. Collectively, these contributions offer a multi-layered understanding of how governance models evolve in cross-border educational settings.

At the institutional level, the adoption of micro-credentials is shaped by administrative structures, IT system maturity, and strategic alignment (Kiiskilä et al., 2023). Despite expressed strategic interest, many institutions emphasized pedagogical design over credential issuance strategies. This finding reflects earlier literature noting that institutional focus often prioritizes curriculum development rather than credentialing infrastructure (Ahmat et al., 2021; Vasilev, 2024). In addition, the legitimacy of micro-credentials is perceived unevenly across national and regional contexts, with prior research highlighting variability in recognition and policy support (Brown et al., 2023; Olcott, 2022). However, translating strategic intent into operational practice, particularly in the issuance of micro-credentials requires navigating specific administrative and technological constraints at both institutional and alliance levels (Kiiskilä et al., 2023, Kiiskilä & Pirkkalainen, 2024).

Publication III and IV both point to the difficulties institutions face in aligning micro-credentials with established standards, especially when metadata like learning outcomes and assessments are inconsistently captured or scattered across systems.

This corroborates findings by Pirkkalainen et al. (2023) and Varadarajan et al. (2023), which highlight that while metadata is essential for ensuring transparency and learner agency, it remains administratively burdensome to implement. Although learning outcomes are widely acknowledged as central to micro-credentialing (Oliver, 2022), they are typically defined at the program or institutional level, not at the granularity needed for micro-credentials (Birtwisle et al., 2016; Chaudhry et al., 2023). Consequently, efforts to align micro-credentials with national frameworks or European standards often require intensive coordination and resource investment (Kiiskilä et al., 2023).

Institutional adoption of infrastructures such as EBSI was limited by national-level readiness and uncertainty around long-term sustainability (Kiiskilä et al., 2023). While EBSI is designed to support secure, interoperable credentials enriched with metadata (European Commission, 2022; Grech et al., 2021), institutional participation was hesitant due to reliance on national governments to maintain blockchain nodes in case of EBSI (Lepore et al., 2024). As a result, institutions were often reluctant to invest in integration efforts or modify internal systems without corresponding national strategies or long-term guarantees of support (Kiiskilä et al., 2023). These findings reinforce earlier claims that institutional readiness is not an isolated factor but deeply interconnected with the policy landscape and infrastructural dependencies beyond the institution's control.

Publication IV contributes novel insights by empirically analyzing the implementation of a centralized governance model in an HEI alliance. Empirical research on governance structures in such alliances remains limited, with a few examples in practice using hybrid or decentralized approaches (ENHANCE, 2024; Una Europa, 2024). In this study, centralized issuance emerged as a pragmatic response to fragmented institutional readiness, where no single member could act on behalf of others. By procuring a shared eSeal and designating the alliance as the issuing authority, the model achieved consistency and alignment with evolving EU policies. However, it also introduced operational challenges in defining roles, managing data across institutions, and reconciling local practices with centralized requirements (Kiiskilä & Pirkkalainen, 2024). Publication V studied these challenges through the lens of institutional theory revealing how alliance-wide governance arrangements are influenced by layered institutional pressures that manifest across national and organizational contexts (Felder-Stindt, 2025; Lin & Darnall, 2015; Parkhe, 2003). These pressures, namely regulative, normative and cultural-cognitive help explain tensions between centralized governance objectives and local institutional logics (Dacin et al., 2007; DiMaggio & Powell, 1983; Meyer & Rowan, 1977; Scott, 1995). Table 4 illustrates the tension creators, their underlying institutional pressures and associated outcomes.

Table 4: Tension creators, institutional pressures and outcomes

Tension Creators	Institutional Pressure	Outcomes
Data collection and ownership	Normative	• Data hoarding • Insufficient data collection
Governance structure and policy gaps	Normative	• Adhoc governance • Exclusion of key data
Local norms and practices	Cultural-Cognitive	• Extra data generation • Centralized obligation from uneven local practices
Compliances across local, regional and global regulatory frameworks	Regulative	• Adapting to fragmented regulatory landscapes • Fragmented alliance legitimacy

Regulatory tensions arise when national mandates diverge from alliance-wide standards, particularly in areas like GDPR compliance or accreditation requirements (Publication V). While centralized models aim to ensure standardization and compliance with the strictest requirements, to establish legitimacy (Tankebe, 2019; Voss, 2019), as publication V shows, member institutions must also comply with country-specific mandates that may conflict with shared goals. Institutions tend to prioritize national obligations to avoid penalties, which may limit their ability to fully participate in alliance initiatives (Becker, 1968; Tallberg, 2002). As observed in Publication V, such tensions manifest in eligibility criteria, data handling protocols, and language requirements, resulting in partial implementation, local workarounds, or withdrawal from shared processes. These findings reinforce and add empirical specificity to the broader theoretical argument that regulative conformity is context-dependent and often negotiated in practice (Meyer & Rowan, 1977).

While data governance is often framed in technical or legal terms, publication V highlights how normative and cultural-cognitive pressures also significantly shape how centralized data governance is interpreted and enacted in alliances. Existing research has shown that organizations maintain legitimacy not only by complying with formal rules but also by adhering to sector-specific norms and internalized institutional logics (Beerkens, 2004; Dacin et al., 2002; Oliver, 1991). In the alliance studied, even when centralized data governance policies were formally adopted, institutions diverged in how they operationalized roles, responsibilities, and data management practices. These findings align with earlier research on organizational legitimacy (Beerkens, 2004; Dacin et al., 2002; Oliver, 1991) and reinforce the notion that governance structures cannot succeed without addressing underlying cultural and normative expectations (Durand et al., 2019; Kezar & Lester, 2009).

Taken together, these findings show that governance of data related to micro-credentials in alliances is a balancing act between formal centralization and contextual responsiveness. At the institutional level, successful adoption requires systems and governance practices to align with alliance-wide norms and internal mandates. At the alliance level, centralized governance offers benefits in terms of visibility, quality assurance, and policy alignment, but it also introduces new complexities. These include defining shared responsibilities, ensuring data security, and accommodating institutional variation. As demonstrated across Publications III, IV, and V, governance models in this context evolve not only through formal decisions but also through adaptive, negotiated practices shaped by regulative, normative, and cultural-cognitive pressures.

5.4 Micro-credential management and governance

Taken together, the three sub-research questions provide a comprehensive answer to the main research question (*How can micro-credentials be managed and governed in the higher education context?*) Drawing from five peer-reviewed publications, the discussion integrates insights from three thematic angles. First, it examines the technological characteristics essential for issuing and managing micro-credentials (Publications I and III). Second, it explores the perceived value and strategic role of micro-credentials from institutional, technological, and learner perspectives (Publications I, II, and III). Third, it analyzes the organizational structures and institutional pressures that shape governance choices, particularly in alliance settings (Publications III, IV, and V). Together, these studies offer a comprehensive, empirically grounded view of how higher education institutions and alliances can implement scalable, trusted, and strategically aligned micro-credential system.

Table 5: Research questions, publications and findings from each publication.

Research question	Publications	Key findings
RQ1: What technological characteristics are essential for the management and issuance of micro-credentials	Publications I, III	Publication I identified twelve categories and thirty-eight specific platform features necessary to support the issuance and management of micro-credentials, addressing the needs of issuers, learners, and verifiers. Publication III extended this work through a design science study using EBSI to develop and evaluate a credentialing prototype, revealing how technical capabilities, system integration, and policy constraints influence institutional adoption.
RQ2: How do institutional, technological, and learner perspectives influence the perceived value and strategic role of micro-credentials in higher education?	Publications I, II and III	Publication II applied Expectancy-Value Theory to examine factors shaping learner perceptions and intentions, including trust, metadata clarity, and institutional support. Publications I and III investigated how platform features (e.g., verifiability, portability) and institutional readiness influence both the perceived value of micro-credentials and their strategic role at the organizational level
RQ3: How do organizational structures and policies impact the governance of micro-credentials?	Publications III, IV and V	Publication III highlighted administrative and infrastructural barriers to implementation at the institutional level. Publication IV identified a centralized issuance model adopted by a higher education alliance, identifying challenges in role coordination, data sharing, and platform control. Publication V applied institutional theory to show how regulative, normative, and cultural-cognitive pressures shape alliance-level data governance of micro-credentials.

The findings from these five publications show that managing and governing micro-credentials in higher education requires simultaneous attention to technological infrastructure, stakeholder perspectives, and institutional conditions as summarized in Table 5. Technological readiness alone is insufficient unless it is accompanied by stakeholder trust, clear metadata, and interoperability across systems. Similarly, learner engagement depends not only on technical features but also on institutional endorsement and long-term recognition strategies. These insights suggest that micro-credentials are not merely digital artifacts, but an institutional endeavor embedded in broader educational strategies and system-level priorities.

The governance of micro-credentials, particularly in cross-institutional alliances, introduces an additional layer of complexity. This research demonstrates that alliances must navigate trade-offs between centralized coordination and institutional autonomy, often under conditions of regulatory fragmentation and infrastructural inconsistency. Centralized issuance models can provide legitimacy, quality assurance, and scalability, but they must be adapted to accommodate local practices, regulatory obligations, and cultural norms. As such, successful implementation requires hybrid strategies that balance standardization with flexibility, enabling institutions to participate meaningfully while aligning with alliance-wide goals. The contributions across the three research questions jointly illustrate that governance in this space evolves not only through formal structures but also through negotiation, adaptation, and shared commitment to educational innovation.

5.5 Policy-Making Implications

This section presents key insights derived from the study's findings, with the aim of informing policymaking on micro-credential governance in higher education alliances. As governments and institutions explore frameworks for lifelong learning and digital credentialing, it becomes essential to understand how governance choices, infrastructure design, and institutional collaboration affect the scalability and legitimacy of micro-credentials. Drawing from the empirical evidence and thematic analyses discussed in the five publications, this section outlines implications relevant to national and international policy actors, standard-setting bodies, and cross-border alliances.

First, the findings highlight the need for policy frameworks that support centralized trust mechanisms while respecting institutional autonomy. As demonstrated in Publications IV and V, no single institution within the alliance studied was capable of independently issuing micro-credentials in a way that ensured interoperability, trust, and cross-border recognition. Centralized issuance emerged as a practical solution to enhance trust and credibility, but such arrangements must be carefully designed to align with governance needs, and autonomy of participating institutions. Policymakers should therefore consider enabling structures that allow for mandated issuing authorities or shared governance models that reflect the distributed nature of alliances without compromising on trust and verification.

Second, the effective promotion of micro-credentials requires policies that explicitly address the technological foundations for verifiability and interoperability. As publication III highlighted, the European Blockchain Services Infrastructure (EBSI) and European Digital Credentials for Learning (EDC) formats provide promising architectures, yet their adoption depends on alignment between technical standards, regulatory conditions, and institutional readiness. Policy actors should therefore support not only open technical standards but also offer targeted guidance, incentives, and resources to facilitate implementation across heterogeneous contexts.

Third, governance choices were found to be shaped not solely by regulative mandates but also by normative and cultural-cognitive elements, such as institutional histories, values, and autonomy expectations (Publications IV and V). This suggests that top-down policy interventions may face resistance unless they are accompanied by instruments that support local adaptation. Flexible templates, regulatory sandboxes, and modular compliance frameworks can enable institutions and alliances to co-develop governance models that are both locally legitimate and policy aligned.

Finally, data governance emerged as a critical yet underdeveloped dimension across all studies. As seen in Publications III and V, key decisions related to learner identity, metadata, and portability often unfolded without clear data governance frameworks. Although centralized issuance helped resolve certain immediate challenges, it also revealed the need for federated data governance models that ensure privacy, accountability, and trusted data exchange across institutional and national boundaries. Policymakers should prioritize the development of secure, transparent, and equitable frameworks for the management and sharing of learner data.

In summary, the findings suggest that effective policymaking for micro-credentials requires a coordinated, multi-level approach, one that bridges technological infrastructure, institutional governance, and regulatory alignment. Only by addressing these interconnected domains can policymakers facilitate the development of sustainable and scalable credential ecosystems. Such ecosystems must be capable of evolving alongside the shifting needs of learners, higher education institutions, and labor markets.

6 CONCLUSIONS

In this section, the theoretical contributions and practical implications of the dissertation are described first, followed by limitations of the study and some possible future research directions.

6.1 Theoretical contributions

This dissertation contributes to three primary areas of research: information systems, micro-credentials, and alliance governance.

First, it advances information systems research by examining how digital credentialing infrastructures interact with governance processes in multi-actor higher education settings. The existing literature focused largely on definitions, typologies, and the role of micro-credentials in promoting flexible learning opportunities (Hall-Ellis, 2016; Oliver, 2019; Bradley et al., 2018; Crow, 2016; Hope, 2018). However, limited attention had been paid to the design and functionality of digital platforms that support micro-credential issuance in formal higher education. Through qualitative analysis of platform providers and domain experts, this dissertation offers a structured categorization of 38 features across 12 functional categories, providing the first empirically grounded overview of platform capabilities relevant to HEIs (Publication I). It further contributes by identifying several features that are underdeveloped yet considered critical by institutions, such as stackability, metadata transparency, and integration with learning management systems.

In addition, it contributes to the literature on blockchain-enabled credentialing systems by empirically validating the feasibility of using the EBSI for managing educational credentials (Publication III). While prior studies often highlighted blockchain's conceptual potential (Turkanović et al., 2018; Sharples & Domingue, 2016), this dissertation brings empirical depth to how real-world organizational and regulatory considerations influence institutional engagement with blockchain infrastructure.

The study also extends understanding of the institutional and national readiness factors affecting implementation (Publication III). While early studies on digital credentialing often emphasized the technical capabilities of platforms or infrastructures (Awaji et al., 2020; Kamišalić et al., 2019), fewer have examined how strategic, organizational, and policy-level factors influence actual adoption decisions (Mohammad & Vargas, 2022). This dissertation shows that implementation choices are shaped not only by internal institutional capacity, but also by broader national developments, such as regulatory alignment, government-led infrastructure initiatives, and centralized platform mandates. Drawing on qualitative data from university administrators engaged in cross-border credentialing initiatives, the research identifies key barriers related to platform integration, data access, and resource prioritization (Publication III). These findings are further supported by alliance-level evidence where institutional actors expressed reluctance or inability to lead micro-credential issuance on behalf of partners, citing institutional strategy, regulatory burden, and lack of technical capacity as key constraints (Publication IV). These insights contribute to both information systems and micro-credential literature by framing implementation as a complex coordination challenge requiring strategic readiness and policy coherence.

By applying contingency factors to assess governance models and by offering a comparative view of centralized, decentralized, and hybrid approaches to micro-credential issuance, this dissertation contributes to data governance literature. Moreover, by applying Scott's institutional theory, this dissertation adds to the institutional theory literature within information systems by showing how regulative, normative, and cultural-cognitive pressures influence the adoption and governance of credentialing infrastructures. These institutional forces are shown to interact with alliance-level governance models and decision-making processes, offering theoretical insight into how legitimacy concerns, shared norms, and compliance requirements shape digital transformation in higher education alliances (Publications IV and V).

Second, this dissertation contributes to the growing literature on micro-credentials in higher education. It offers a multi-level theoretical account of how micro-credentials are issued, valued, and governed across institutional and alliance contexts. By identifying and categorizing key technical features, this dissertation advances understanding of how digital infrastructures support formal micro-credential issuance. While limited exploratory research was available emphasizing their potential to support flexible learning and workforce alignment (Ghasia et al., 2019), and earlier studies explored student attitudes toward digital badges (Delello et al., 2018; Dyjur & Lindstrom, 2017), relatively few studies had examined how micro-credentials are experienced and evaluated by users in higher education settings

(Ahmed et al., 2022). Drawing on Expectancy-Value Theory, this dissertation develops a framework that explains how expected success, perceived utility, and low-cost influence learners' willingness to adopt and continue using digital credentials (Publication II). The study also reveals that learners value credentials that are verifiable, portable, and embedded with rich metadata, particularly when they can be used to showcase skills to employers or transfer credits across institutions. Institutional stakeholders, meanwhile, recognize the potential of digital credentials to support modular learning paths, track competencies, and enhance student engagement, but also highlight implementation challenges that affect institutional uptake.

This contribution advances conceptual clarity by distinguishing verifiable digital credentials issued by HEIs from simpler digital badges, showing how institutional trust, metadata depth, and verification influence perceived legitimacy. The findings align with and extend recent studies (Alenezi et al., 2024; LaPlante, 2024), offering practical implications for credential design and theoretical grounding for future research. In addition, this dissertation contributes to the governance of micro-credentials by analyzing how issuing responsibilities, data practices, and quality assurance mechanisms are coordinated across institutional and alliance levels. By uncovering the institutional and technical conditions required for collaborative issuance, it highlights governance as a dynamic and context-dependent process in micro-credential ecosystems.

Third, this dissertation contributes to alliance governance research, by advancing theoretical understanding regarding governance models for issuing micro-credentials in multi-institutional higher education alliances. While much of the existing literature has focused on potential hurdles in implementing micro-credentials from an HEI perspective (Raj et al., 2024; Saad et al., 2024), issuance is typically discussed only as an outcome rather than as a factor that shapes governance itself (Alsobhi et al., 2024; Halim et al., 2024). Studies of alliances offering micro-credentials mainly focus on alliance dynamics (Ipsilandis et al., 2024), with relatively little attention paid to the governance mechanisms required when issuance is coordinated across national and organizational boundaries. This dissertation identifies a new governance approach, centralized micro-credential issuance, where the alliance entity itself acts as the issuer on behalf of all partner institutions (Publication IV). This model addresses key implementation barriers such as uneven institutional readiness, legal authority, and platform integration. Drawing on a contingency approach to data governance, the study identifies the organizational and technical factors that make centralized issuance feasible in certain alliance contexts.

This is an important contribution, as this centralized approach has not been studied or documented in practice.

Furthermore, by applying institutional theory, the study shows how centralized data governance interacts with institutional autonomy and legitimacy concerns in alliances (Publication V). It identifies four "tension creators" that arise from regulative, normative, and cultural-cognitive pressures, such as misalignments in data protection expectations, varying interpretations of shared governance, and the continuous need to track changing national requirements. These insights contribute to alliance governance research by demonstrating how data governance models must adapt to evolving institutional pressures. It shows how alliances navigate institutional complexity through shared policies and coordination mechanisms. This contribution is important because it shows how centralized governance can help alliances scale micro-credential issuance while still respecting institutional autonomy and responding to legitimacy concerns.

It is worth noting that many of the contributions outlined above are not confined to a single domain but intersect multiple research areas. For example, insights related to digital infrastructure and platform integration contribute simultaneously to information systems and micro-credential literature. Similarly, the application of institutional theory not only adds to the information systems literature but also enriches alliance governance research by contextualizing governance tensions in inter-institutional collaborations. These overlapping contributions reflect the interdisciplinary nature of the research and its relevance to the broader discourse on digitally enabled transformation in higher education.

6.2 Practical implications

This dissertation offers several practical implications for higher education institutions, inter-institutional alliances, platform developers, and policymakers involved in the design, implementation, and governance of micro-credentials. Through five peer-reviewed studies, the dissertation addresses challenges and actionable considerations related to platform adoption, value communication, institutional readiness, alliance-level governance, and cross-border data practices. First, it identifies key technological features that can support secure, scalable issuance of micro-credentials and guide platform selection and development. Second, it highlights the importance of communicating value to learners and co-creating digital credentials to meet both institutional and learner needs. Third, the findings emphasize the critical role of institutional and national alignment in implementing digital credential systems, particularly in cross-border contexts. Finally, the research provides detailed guidance for alliances on selecting governance models, designing joint data policies, and anticipating institutional pressures when adopting centralized issuance approaches. Together, these findings provide practical guidance for the development of micro-credential ecosystems that are scalable, trusted, and responsive to stakeholder need.

One of the key practical implications of this dissertation is the identification of specific technological features and infrastructure considerations required for the issuance and management of micro-credentials. As higher education institutions begin to adopt digital credentialing, they must carefully evaluate platform capabilities such as metadata inclusion, learner control, verification mechanisms (e.g., eSeals or blockchain), and integration with local systems. This dissertation provides a structured overview of 38 platform features across 12 categories, helping institutions assess which solutions align with their goals, legal obligations, and operational constraints (Publication I). Particular attention should be paid to features supporting stackability, portability, and transparency, especially for formal or credit-bearing micro-credentials.

Beyond individual platform selection, the findings from this research also offer guidance for institutions evaluating the feasibility of more advanced credentialing infrastructures, such as blockchain-based systems like the EBSI. While such systems are technically viable, the study highlights several critical barriers to implementation, including integration with student management systems, alignment with national strategies, and organizational readiness (Publication III). Institutions are encouraged to monitor national developments, participate in policy discussions, and evaluate the technical dependencies required to engage with such infrastructures. For EBSI developers and technology providers, the findings emphasize the importance of standardization (e.g., W3C Verifiable Credentials), API compatibility, and support resources to improve institutional uptake. By addressing both platform-level and system-level considerations early in the decision-making process, institutions and developers can ensure the scalability and sustainability of their micro-credential ecosystems.

A second practical implication of this dissertation is the need for higher education institutions to actively communicate the value of micro-credentials and engage stakeholders, particularly learners and industry, in their design and use. Learners are more likely to adopt digital credentials when they are verifiable, portable, and contain rich information about learning outcomes, competencies, and assessment. The findings show that learners recognize the long-term utility of digital credentials for job searching, credit transfer, and self-reflection on skill development, but they also express a desire for wider availability and greater recognition (Publication II). To support wider adoption, institutions should explore opportunities to embed micro-credentials in existing academic offerings and ensure that each credential provides transparent, useful information for both learners and potential employers.

Beyond technical features, institutions are encouraged to gather feedback from learners on which types of metadata are most useful, how credentials are displayed, and how they can be linked to future learning opportunities or career pathways. Collaboration with industry stakeholders is also essential to align micro-credential content with current and emerging workforce needs. This dissertation highlights the growing concern around the skills gap in many sectors and the need for higher education to respond proactively. Institutions are encouraged to engage in structured dialogue with industry to better understand which competencies are most in demand and to design micro-credentials that reflect real-world challenges and expectations (Publication II). For example, embedding authentic industry problems into short learning modules can increase both the relevance and applied value of micro-credentials without compromising academic rigor. In parallel, awareness campaigns may be necessary to help employers understand the depth and reliability of verifiable digital credentials, which often surpass traditional transcripts in terms of detail and transparency. By aligning the content and presentation of credentials with stakeholder needs, institutions can improve adoption, trust, and long-term value.

A third practical implication of this dissertation concerns the importance of institutional and national readiness in the implementation of digital credentialing systems. Although micro-credential platforms and infrastructures may be technically available, their adoption depends heavily on how well they align with institutional strategies, resourcing, and broader national policy environments. The findings from this research show that implementation is often delayed not because of technical barriers, but due to organizational priorities, integration challenges, and uncertainty around national frameworks for credentialing (Publication III). For example, higher education institutions may be hesitant to adopt blockchain-based infrastructures such as the EBSI without clarity on national strategy, funding, or shared infrastructure responsibilities (e.g., creation of an EBSI node). Institutions must therefore monitor national developments and engage in dialogue with policy actors to ensure their efforts are aligned with evolving infrastructure requirements.

At the alliance level, institutional readiness also plays a critical role in determining the most feasible governance model for micro-credential issuance. In contexts where no single institution is willing or able to issue credentials on behalf of others, centralized models, where the alliance acts as issuer, may offer a more practical path forward (Publication IV). However, even centralized models require a baseline level of readiness at each member institution, including processes for data sharing, course-level validation, and platform interoperability. These findings highlight the importance of assessing not only platform suitability, but also organizational capacity and national alignment before launching large-scale credentialing initiatives. Institutions are encouraged to conduct readiness assessments, prioritize internal integration efforts, and coordinate with national and alliance-level stakeholders to create the structural conditions necessary for success.

The final practical implication of this dissertation relates to how multi-institutional alliances can manage micro-credential issuance through centralized governance structures and shared data practices. In contexts where credentialing must be coordinated across institutions with differing policies, systems, and levels of readiness, consistent governance becomes essential to ensure trust, legitimacy, and operational efficiency. This dissertation provides practical guidance by comparing governance models, including centralized, decentralized, and hybrid approaches, and highlighting which conditions favor each model (Publication IV). For alliances where member institutions face barriers to issuing credentials independently, a centralized model, where the alliance itself acts as the issuer, can offer a viable solution. This model simplifies credential management, supports alliance-wide branding, and creates opportunities for shared oversight. However, successful adoption depends on establishing clear processes, legal frameworks, and technical integration mechanisms across member institutions.

To ensure effectiveness, alliances must also design shared data governance structures. Drawing on institutional theory, this dissertation identifies key pressures: regulative, normative, and cultural-cognitive, that can create tensions in centralized governance (Publication V). To manage these, alliances are encouraged to establish joint data governance bodies responsible for setting consistent rules around data collection, access, and retention. Implementing standardized roles (e.g., data stewards, credential custodians), baseline compliance requirements (e.g., GDPR), and layered governance models can help accommodate both local autonomy and alliance-wide consistency. The findings also emphasize the need to embed data governance controls such as role-based access and audit trails into credentialing platforms from the beginning. By taking these steps, alliances can navigate institutional diversity while ensuring scalable, secure, and trusted credential issuance across borders.

6.3 Validity and credibility

This dissertation follows widely accepted qualitative research standards to ensure the trustworthiness and validity of its findings (Maxwell, 2012; Lincoln & Guba, 1986). Multiple forms of validity were addressed throughout the research process.

Descriptive validity was maintained by recording all interviews and transcribing them verbatim, ensuring accurate representation of participants' accounts. Interpretive validity was strengthened through an inductive coding approach and iterative discussions among co-authors regarding emerging themes and their alignment with participants' intended meanings. Thematic saturation was observed within individual datasets and triangulated across studies.

To enhance credibility, participants were selected based on their subject-matter expertise and institutional roles. For example, experts in the field of digital credentials were purposefully selected for Publication I, while institutional administrators from all alliance partner universities were included in Publications II–V to ensure breadth and diversity of perspectives.

Theoretical validity was supported by grounding the analysis in relevant theoretical frameworks, namely, institutional theory, expectancy-value theory, and contingency theory. Constructs were not imposed a priori but emerged through engagement with the empirical material and were refined iteratively during the analytic process. While this study does not aim for statistical generalizability, transferability was supported by providing thick descriptions of the alliance context, national policy settings, and institutional structures, enabling readers to evaluate relevance to other settings. Evaluative validity was ensured by contextualizing quotes to preserve meaning and presenting nuanced stakeholder perspectives rather than aggregating responses.

Together, these practices support the methodological integrity of the research and provide a solid foundation for interpreting the findings presented in this dissertation.

6.4 Limitations and future research topics

While this dissertation provides a comprehensive and multi-level perspective on the management and governance of micro-credentials, it also has certain limitations that create opportunities for further research. These limitations stem from the evolving nature of the technological landscape, the scope and structure of the empirical data collected, and the contextual focus on higher education institutions and alliances operating primarily in Europe. These limitations highlight areas where future research can build on the current work, offering opportunities to refine platform design, broaden stakeholder engagement, and deepen theoretical understanding of micro-credential ecosystems.

One limitation of this research is its timing within a rapidly evolving technological landscape. Several of the platforms evaluated in the early stages of this dissertation may have introduced new features or undergone significant development since the data were collected (Publication I). Similarly, emerging infrastructures such as the EBSI continue to evolve (Any et al., 2024), and future implementations may resolve some of the technical and organizational barriers identified in this study (Publication III). As the micro-credential ecosystem matures, new functionalities such as credential stackability, pathway visualization (Norman et al., 2024), or more sophisticated interoperability are likely to become increasingly important. Further research is needed to examine how these evolving platform features are perceived and adopted by higher education institutions, particularly from the perspective of institutional decision-makers and IT teams. Longitudinal studies could track how micro-credential platforms develop over time, and how those changes influence adoption trajectories, user satisfaction, and scalability. Comparative evaluations of platforms with end users, including learners and employers, would also offer valuable insights into feature relevance and perceived value in practice (Miao et al., 2024; Tee et al, 2024).

A second limitation of this dissertation relates to the scope and structure of its empirical sample. Several of the studies involved relatively small or geographically bounded participant groups, which may limit the generalizability of the findings. For instance, the learner and administrator interviews in Publication II were primarily conducted within Europe, where digital credential adoption is strongly shaped by EU policy initiatives and frameworks. Similarly, the platform-focused study (Publication I) relied on expert interviews from a limited pool of digital credential specialists and platform providers, many of whom were early adopters or involved in pilot initiatives. While these perspectives were appropriate for exploring an emerging phenomenon, future research should broaden the geographical and institutional diversity of participant samples. For instance, studies could explore how the findings apply across varied higher education systems in other regions such as North America, Asia, or Latin America. This would allow testing the relevance of the findings across different cultural contexts, governance traditions, and policy environments (Hamutoglu et al., 2025; Peters et al., 2025; Rami et al., 2025).

In addition, the case-based design used in Publications III, IV, and V provided rich detail but focused on a particular alliance and its member institutions. Although this depth allowed for the identification of governance models and institutional tensions in context, future studies should examine whether similar governance structures and pressure dynamics appear in alliances formed for different purposes or operating in other regions. Comparative research involving alliances across multiple countries, disciplines, or sectors could reveal additional models or adaptations that support scalable micro-credential governance. Expanding the sample size and variety would also support the development of more generalizable frameworks for stakeholder coordination, platform adoption, and governance decision-making (Charles et al., 2025; Osborne & Thirlaway, 2024).

A third limitation of this dissertation relates to the specific governance model and alliance context examined in the study. Publications IV and V focused primarily on a centralized governance approach within a legally established, multi-institutional alliance. While this setting enabled a detailed investigation of centralized issuance, shared data governance, and institutional pressures, it may not reflect the dynamics of alliances that are temporary, informal, or operate without centralized entity. Alliances formed for specific projects or with less formal governance structures may face different challenges, particularly in balancing standardization with institutional autonomy. Future research should explore how governance models function in diverse alliance types, including those that adopt hybrid or decentralized approaches, and assess how trust, legal frameworks, and coordination mechanisms vary across these models.

Additionally, the findings from this dissertation are drawn from a single case study of one alliance operating within a particular regional and regulatory context. While this case provides deep insights into cross-border governance under shared data regulations (e.g., GDPR), further research is needed to understand how governance decisions are shaped in alliances operating under different legal systems or cultural norms. Comparative studies across alliances in different jurisdictions could help clarify how regulative, normative, and cultural-cognitive pressures play out in practice, and whether the "tension creators" identified in Publication V appear in other configurations or intensities. Research in other sectors such as health, public administration, or cross-sector digital ecosystems could also offer valuable parallels to further develop alliance governance theory in digital credentialing (Allen et al., 2025; Aoyama et al., 2024; Li et al., 2024).

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PUBLICATIONS

Publication I	Kiiskilä, P., Hanafy, A. and Pirkkalainen, H. (2022). Features of micro-credential platforms in higher education, 14th International Conference on Computer Supported Education. Vol. 1, pp. 81-91.
Publication II	Kiiskilä, P., Kukkonen, A., & Pirkkalainen, H. (2023). Are micro-credentials valuable for students? Perspective on verifiable digital credentials. SN Computer Science, 4(4), 366.
Publication III	Kiiskilä, P., Hylli, O., & Pirkkalainen, H. (2023). How can European blockchain services infrastructure be used for managing educational digital credentials? In The proceedings of the 14th Scandinavian Conference on Information Systems (SCIS). Association for Information Systems.
Publication IV	Kiiskilä, P., & Pirkkalainen, H. (2024). Exploring Centralized, Decentralized, and Hybrid Approaches to Micro-Credential Issuance in HEI Alliances. 16th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management.
Publication V	Kiiskilä, P., Jalo, H., & Pirkkalainen, H. Balancing Centralized Control with Organizational Autonomy for Micro-Credential Governance in HEI Alliances. (under review).

PUBLICATION
I

Features of Micro-credential Platforms in Higher Education

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In Proceedings of the 14th International Conference on Computer Supported Education (CSEDU 2022) - Volume 1, pages 81-91
ISBN: 978-989-758-562-3; ISSN: 2184-5026
http://doi.org/10.5220/0011030600003182

Features of Micro-credential Platforms in Higher Education

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Keywords: Micro-credentials, Digital Credentials, Adoption, Features, Micro-Credential Platforms, Higher Education Institutions.

Abstract: Interest in and demand for micro-credentials in higher education institutions is on the rise. Although the concept of micro-credentials is still evolving, they can be seen as short learning opportunities that are accompanied by digital credentials that capture the proofs of the learning. These digital proofs of learning range from skills and competences acquired to information whether such skills were acquired via formal or non-formal learning activities. Micro-credential platforms are used for multiple purposes including issuing, viewing, and storing the digital credentials. Despite the growth in the number of micro-credential platforms in the recent years, literature is limited on the features offered by the platforms and how they are helpful for higher education institutions and learners. To address this gap in research, we employed a qualitative approach by semi-structured interviews and group discussions with platform providers and education experts. Our findings resulted in 38 features that can help higher education institutions, learners, and providers understand what kind of features are emphasized in micro-credential platforms and how they can be helpful for different use purposes. As practical implications, the findings of this study can help higher education institutions in considering adoption and usage of micro-credential platform.

1 INTRODUCTION

As the need for upskilling and reskilling gains importance, micro-credentials are becoming instrumental in the discourse of employability in 21st century (Wheelahan and Moodie, 2021). Accordingly, one of the top priorities of the European higher commission is that governments should aim for a paradigm-shift on skills and lifelong learning to drive Europe's competitiveness and innovation (European Commission, 2020). Micro-credentials are positioned within this paradigm shift and can be defined as "a qualification evidencing learning outcomes acquired through a short, transparently-assessed course or module" (European Commission, 2020).

Micro-credentials, as described by the European Commission, include digital proofs of the short and assessed learning opportunities such as course or module. These proofs are currently discussed as digital credentials which can include evidence of the skills and competences acquired through the learning opportunities. These digital credentials can relate to both formal and non-formal learning. In higher education institutions the learning opportunities range from short (micro) tor long (macro), and digital credentials can be awarded to any of these learning opportunities. Hence, the term "micro-credentials" has multiple meanings related to the short learning opportunities and the proofs. Accordingly, when discussing digital proofs, we are specifically referring to digital credentials in the remainder of the paper.

A supporting ecosystem for micro-credentials consists of the following: (a) an issuing organization such as an educational institution; (b) learners receiving them, (c) a verifying organization, such as another educational institution (Oliver, 2019) and (d) a micro-credential platform to issue the ensuing digital credentials. Many micro-credential platforms have emerged over the past years (Dimitrijevic, et al., 2016) and their numbers are growing still. Higher education institutions are progressively adopting micro-credentials and are establishing micro-credentials initiatives for them (Resei, et al., 2019). There are at least two large initiatives occurring in Europe that involve digital credentials. The European Digital Credentials for Learning (EDCL) programme offers higher education institutions an infrastructure (or components) that can be used to manage digital credentials. These are digital statements issued by an

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ISBN: 978-989-758-562-3; ISSN: 2184-5026

organization to a learner, documenting their learning (EDCL, 2021). This includes digital credentials for individual learning offerings, such as degrees, and diplomas awarded by educational institutions. The second initiative is the European Blockchain Services Infrastructure (EBSI) whose vision is "to leverage blockchain to the creation of cross-border services for public administrations and their ecosystems to verify information and make services trustworthy" (EBSI, 2021). This initiative includes higher education systems issuing digital credentials that are tamper-proof and verifiable by other educational institutions.

The adoption of micro-credential platforms could potentially support the unbundling of higher education degree programs to address the four issues: changing demographics, increasing the number of opportunities for learners (Hope, 2018), countering the decrease in popularity of academic degrees (Ehlers, 2018) and providing learners with an effective form of recognition for their skills and competences (Hall-Ellis, 2016). Micro-credential platforms play a pivotal role in facilitating the issuing, managing, and storing of digital credentials and the transfer of data between different stakeholders of the ecosystem (Araújo, et al., 2017).

Although there are many micro-credential platforms available, there is a lack of research about how they operate and what they offer for higher education institutions and their learners (Young, et al., 2019). Accordingly, these institutions need a comprehensive overview of these platforms to enable informed decisions about which one to adopt. The aim of this paper is to fill that research gap.

To address this issue, we asked the following research questions: "*What are the features of micro-credential platforms and how are they helpful for higher education institutions and learners?*" This paper presents a qualitative study based on conducting semi-structured interviews and group discussions with micro-credential platform providers and educational experts. The data were collected in the context of European Consortium of Innovative Universities (ECIU) project. The ECIU University is an initiative to establish a challenge-based European university where learners can earn micro-credentials from successfully taking part in real-life challenges and learning offerings. One of the main objectives of the project is to adopt a suitable platform for managing and issuing micro-credentials.

As a key contribution, we identify 38 micro-credential platform features in 12 categories that can help higher education institutions, learners and providers understand the types of features that are emphasized in micro-credential platforms and how they can be helpful for different use purposes.

The remainder of the article is structured as follows. Section 2 presents the theoretical background related to micro-credentials and platforms issuing them. Section 3 provides a description of the research methodology and the findings on the features of micro-credential platforms are presented in section 4. Finally, section 5 presents a discussion on how higher education institutions and learners can benefit from micro-credential platforms, followed by the contributions, limitations, and future research topics.

2 MICRO-CREDENTIALS

2.1 Overview of Micro-credentials

Micro-credentials have been the subject of broad and current interest in higher education over the course of the last decade (Kilsby & Fountain, 2019). Moreover, many higher education institutions around the world are experimenting with micro-credentials and are establishing micro-credentialing programs (Milligan & Kennedy, 2017). One major issue that arises when establishing these programs is the confusion and lack of common understanding around the concept of micro-credentials (Rossiter & Tynan, 2019).

As described by the European Commission micro-credentials can be seen as a combination of the following: (a) short learning experiences (i.e., micro learning opportunities) and (b) digital credentials issued for the short learning experiences that highlight the skills and competences acquired. Based on this perspective, digital credentials are considered as the certified skills, competences and achievements that prove that learners completed the necessary activities and met the required. In this paper, we focus on digital credentials as proof of learning, competences, and achievements (Oliver 2019; Tracey 2014) and the corresponding micro-credential platforms that are used to manage digital credentials irrespective of whether they relate to learning opportunities that are short (micro) or long (macro).

According to one study (Fong et.al., 2016), micro-credentials initiatives have almost doubled between 2016 and 2017. Further, three in every four higher education institutions regard micro-credentials as strategically important for their future (Fong, et al., 2016). Higher education institutions have realized that employers need to know the specific skills and competences that a potential employee possesses (Hope, 2018). While traditional degrees, certificates, and transcripts fail to convey this information, micro-credentials render this possible and manageable.

The diversity of learners' demographical composition and needs, in addition to the rise of non-traditional learners makes it nearly impossible for higher education institutions to adopt one model that fits all learners (Soares, 2013). For example, some learners prefer to take part in competence-based courses where they acquire very specific skills that are recognized, as opposed to traditional degrees. Further, some learners might prefer to obtain a traditional degree while others might prefer to attend university part-time. This is why higher education institutions need to have different offerings for different learners (Beilby, 2018). Micro-credentials increase the opportunities available for learners and provide increased flexibility within education (Bradley, et al., 2018; Hope, 2018). In particular, they provide learners the flexibility to individualize their experience and learn at their own pace (Crow, 2016).

Digital credentials facilitate the unbundling of higher education by providing an efficient alternative to traditional credentials (Ehlers, 2018). By awarding learners with digital credentials that specifically describe the skills, competences, and achievements they acquired using relevant metadata, higher education institutions can empower learners to demonstrate their abilities effectively to potential employers. (Hope, 2018).

Driven by digitalization and the need for faster and more secure ways of sharing credentials, the European Commission is co-creating infrastructures that will allow institutions to issue digital, tamper-proof credentials. These include diplomas, proofs from both formal and non-formal education, and certificates of participation. As mentioned previously, the EDCL and EBSI represent some of the latest examples of such new major initiatives to enable large-scale adoption of digital credentials. As the demand to issue digital credentials increases, it will be imperative for higher education institutions to take a much closer look at the available platforms and their features to make informed decisions on their adoption.

2.2 Features of Micro-credential Platforms

Over the last few years, multiple micro-credential platforms have surfaced. Further, their number and the variety of features offered are constantly increasing. However, the literature regarding the platforms is limited and many of the insights related to them only exist only in white papers, and blogs.

Table1 presents a compiled list of features from the current literature. The list includes platforms that can issue badges related to non-formal or extracurricular learning as well as platforms that can associate with formal learning, such as the European Credit Transfer and Accumulation System (ECTS) bearing courses from accredited study programs or institutions. The platforms discussed in the literature vary in both the number and depth of features.

Table 1: Features of micro-credential platforms in the literature.

Features	Author
Create templates for credentials	(AK Rottmann, 2021)
Visual development of badges	(Casilli, 2013)
Support standard frameworks	(Rehak & Hickey, 2013)
Search and view existing micro-credentials	(Devedzic & Jovanovic, 2015; Goligoski, 2012)
Register to available learning offerings	(SCLDA, 2014)
Integrity verification	(Grant, 2016)
Store and manage micro-credentials	(Glover, 2013)
Importing micro-credentials from other platforms	(Dimitrevic et.al, 2016)
Interactive visualization of micro-credentials	(Charleer et.al, 2013)
Validating micro-credentials	(Hickey & Otto, 2017)
Assessment (both automatic and expert)	(Carey and Stefaniak, 2018; Grant 2016))
Peer awarded credentials	(O'Connor, 2013)

Common features discussed in the literature include creating, storing, and managing digital credentials. Some platforms offer search functionality in addition to the ability to view all the credentials learners accrue (Devedzic & Jovanovic, 2015; Glover and Latif, 2013). In addition, some platforms offer extensions to these features, including the ability to customize credentials, support standard frameworks (Openbadges), and import credentials from other platforms. In the future, they might expand to offer recommendations of relevant study offerings and courses to students (Dimitrevic et.al, 2016; Rehak&Hickey, 2013; Rottmann, 2021)

Features for validating micro-credentials (by a trusted source) and integrity verification are also discussed in the literature. The concept of integrity verification is to ensure that the content of credentials is not tampered with in any way. The literature also highlights types of features that are conceptually new and have not yet been implemented and/or validated, such as badges awarded by peers and built-in assessment tools for the autonomous assessment of competences (Carey & Stefaniak, 2018; Grant, 2016; O'Connor, 2013).

Overall, the literature on digital credentials relies heavily on insights from non-formal settings, such as the use of badges to recognize extra curricula activities. However, literature on the different forms of digital credentialing for formal learning settings, such as recognizing proofs systematically from accredited study programs or institutions is largely missing.

3 RESEARCH METHOD

We sought to understand the features of micro-credential platforms by analyzing the platforms in detail. This was accomplished using walkthroughs of the solutions and by understanding their use through interviews with platform providers and educational experts. The data for this study were collected in the context of ECIU university which is an EU-funded project comprising of 12 European higher education institutions. One of the main objectives of the ECIU university initiative is to develop new ways of issuing micro-credentials to learners partaking in learning offerings from partner universities.

Literature and online searches were done to identify relevant platforms to be included in the study. Ten platforms were reviewed (eight based in Europe and two in the United States), and representatives of each company were interviewed either individually or in groups. The 10 studied platforms were EDCL (formerly Europass), Credentify, BadgeCollect, Digitary, VerifiEd, DiploMe, Accredible, BC Diploma, LinkedIn Learning and, Gataca. Additionally, the researchers took part in the EBSI early adopter program to examine its capabilities for managing digital credentials for learning.

Data were collected using semi-structured interviews and focus group discussions. Two key stakeholder groups were addressed for the research: (1) individuals with high expertise in micro-credentials and (2) micro-credential platform providers. The respondents were identified by using the snowballing sampling technique where initial respondents help to identify future study subjects from their acquaintances or based on their personal knowledge (Secor, 2010). Overall, 19 respondents took part in a total of 13 interviews, and 3 focus group discussions. Each of the three group discussions involved platform providers (two from Europe and one from the United Kingdom). One of the group discussions had two platform representatives and the other two group discussions had three representatives. Of the interviews, eight interviews were with platform providers and five were with digital credential experts. One platform provider and one expert were interviewed twice (and counted as separate interviews) to clarify and deepen some of the views regarding the features and the way they are used. Three of the experts interviewed were university lecturers from Europe and one was a primary consultant on micro-credentials from an education innovation consultancy firm in Australia. Most of the platform provider interviews were with the founders, account executives and chief operating officers. The interviews were mainly conducted online using Zoom and lasted between 41 and 122 minutes. The interviews and group discussions were all recorded and transcribed.

The first step of the analysis was to pinpoint the features of micro-credential platforms, followed by identifying any conceptual similarities between the features to categorize them. The next step was to name these categories and compare them with the literature. The findings of these three steps are discussed in Chapter 4. The final step was to identify how these features could be useful to both higher education institutions and learners. Here, we especially focused on the purposes for which the micro-credentials platforms were used and collected experts' insights on the benefits of using them.

4 FINDINGS

Our investigation of features offered by micro-credential platforms resulted in 12 categories and 38 features (Tables 2a and 2b). We acknowledge that all the platforms are evolving, each supporting an increasing number of features. This is why the aim of our analysis was to present a comprehensive overview of which features that are essential for micro-credential platforms, instead of simply indicating the features that are currently supported by specific platforms. Intrinsically, the results pinpoint the features that platforms offer for both the institutions and learners.

The micro-credential platforms and features offered differ depending on the target audience. Three main stakeholder groups were identified: issuing organizations, learners who receive the credentials and recognizers who verify the credentials (such as employers or other institutions). The research findings are divided into two sections. In the first (Table 2a), basic features such as user interface, types of digital credentials, and portfolio management are presented. The following section (Table 2b) refers to advanced features such as learning pathways, verification, and the validation of digital credentials.

User interfaces are the first and foremost feature offered to all users. Most platforms offer user interfaces designed for issuers, although learners and recognizers are allowed to view the digital credentials. Very few platforms (e.g., VerifiEd) offer user interfaces specifically for recognizers. While the interfaces are simple for learners, they can become complex for those platforms issuing digital credentials for formal learning. This is because of the proofs and assessments that are typically required to recognize formal learning activities in higher education.

The types of digital credentials issued depend on their purpose. All the platform providers realize the importance of digital credentials and how they add value to traditional degrees and diplomas. Digital credentials such as badges are used more for non-formal learning, to indicate a task that has been completed or an achievement. Within formal learning settings, they can also be used to indicate finishing a task or to identify a level that has been reached. Importantly, issuing a badge when a particular level is reached, or a skill is acquired would not require major changes to formal learning processes. Instead, it adds awareness and builds up work competences needed for the 21st century. E-certificates can be considered a simple change of medium (from paper to digital) when recognizing the completion of a course. It is also a common feature to allow issuers to customize the digital credentials, both visually and in terms of data included.

Viewing the digital credentials (including associated metadata) remains a crucial basic feature of any platform, especially for learners. Further, searchability of the credentials becomes especially critical as their number increases, such as when learners collect them from the majority of their studies.

All the platforms have more than one way of issuing the digital credentials. Even though issuing a credential to a single learner is possible as a manual feature on the web interface, more common ways of issuing seem to be semi-automatic, using tools such as Microsoft Excel to gather lists of learners to be issued the same credential. To issue credentials for larger groups, such as an entire class (bulk), the most common method is API integration into local systems (such as student management systems). This also includes automatic issuing at the end of learning periods to all students, in addition to automatic issuing when a request is received.

Portfolio management is a category that is still evolving. Moreover, although all the platforms offer a way of collecting digital credentials, only a few provide a way of importing them from other sources. Platforms are realizing that there is a greater need to provide different paths for organizing credentials and for visualizing the skills acquired while they were being earned.

The ability to share digital credentials on social media (especially on professional media such as LinkedIn) is offered by most of the platforms. Further, most platforms realize the value of being able to share credentials on social media and other formats (such as emails) for potential employers or educational institutions as proof of learning.

Visualizing the pathways is currently associated with bundled learning opportunities towards a larger credential and visually shows how these learning opportunities are connected. Bundled learning opportunities can be a group of learning offerings specific to a particular field or skill, and the pathway will show the order to complete the offerings to obtain larger credentials. These larger credentials might also include the badges or certificates from individual learning offerings within the bundle.

There are a wide range of proof types associated with digital credential, from simply adding viewable and searchable issuer-related data to adding formal learning related data. Most digital credentials can incorporate multiple types of proofs. Platforms that offer formal learning credentials include proofs of learning outcome related data, grading scheme data, and data regarding any standard frameworks used. Some platforms have started using competence frameworks such as European Skills, Competences, Qualifications and Occupations (ESCO) to support the addition of skills and competences into the digital credentials. Awards and achievements associated with a learning offering are captured and included by all the platforms. Moreover, allowing different types of proofs of learning to be submitted increases the credibility of the digital credentials, especially in higher education.

Table 2a: Basic features of digital credential platforms.

Category	Feature	Description	Emphasis by Platforms
User Interface	User interface for issuer	Interface for administrators and teachers	Supported by all the platforms
	User interface for earners	Interface for earners such as students in higher education	Supported by the majority of the platforms
	User interface for recognizers	Interface for recognizers such as institutions that verify credentials	Not supported by the majority of the platforms
"*The vision that we have for the future is that people can collect their certificates initially and then, we start to add in the metadata, and link them back to the courses that they have done.*" *- CEO*			
Types of Digital Credentials	Badges	Awarded for the completion of task or learning offering	Emphasized for non-formal learning
	E-certificates	Certificate of completion including diplomas	Emphasized for formal and non-formal learning
	Proofs with browsable data	Digital credential is text based and includes metadata	Only supported by a few platforms
	Custom digital credentials	Customize the content and look (AK Rottmann, 2021)	Supported by the majority of the platforms
	Peer awarded credentials	Awarded by Peers as part of the learning (O'connor, 2013)	Not supported by the majority of the platforms
View and search	Search function for learners	Search based on issuers (Devedzic & Jovanovic, 2015)	Supported by the majority of the platforms
	View metadata	View all the metadata associated with a credential	Supported by all platforms
	Custom display	Customizing how the digital credentials are displayed	Only supported by a few platforms
"Our platform can be used in two ways, we have a public version and a white label version for several institutes where we limit the search functionalities to the badges in their ecosystem" – Co-founder			
Issuing Digital credentials	Manually via web interfaces	Create and/or issue credentials for a single learner	
	Semi-automatic issue	Use tools to create list of users to issue digital credentials	Only supported by a few platforms
Bulk issuing	Automated awarding of digital credentials	Award digital credentials automatically when requested	Supported by the majority of the platforms
	Via API integrations	Issue digital credentials in bulk	Supported by all the platforms
Portfolio management	Collecting digital credentials	Portfolio of all earned digital credentials (Glover,2013)	Supported by the majority of the platforms
	Importing digital credentials	Importing from other sources (Dimitrevic et.al, 2016)	Only supported by a few platforms
	Organizing digital credentials	Organize by specific category (such as badges, diplomas)	Only supported by a few platforms
	Stackability	Ability to display collection of credentials for particular skills/field	Platforms understand the importance but don't have any concrete implementations yet.
"On the student's profile, they should see their basic data wallet and achievements, but we are still trying to understand what people should see and in what order and in what design" - COO			
Share digital credentials	Social media platforms	Share digital credentials on various social media platforms such as LinkedIn	Supported by the majority of the platforms
	With industry/institutions	Share digital credentials with potential employers and others	Supported by the majority of the platforms
"It is about being shared, secured and also as being rich in terms of data which enables cool things like job matching algorithms, predicted analytics when it comes to admissions and more streamlined admission flows" - ESO			

Table 2b: Advanced features of digital credential platforms.

Category	Feature	Description	Emphasis by Platforms
Pathways of Digital Credentials	Visualizing and documenting pathways for digital credentials	Collection of learning offerings that need to be completed to earn a larger degree or skill.	Only supported by a few platforms
"This is something everyone has been discussing that some credentials should be stackable and maybe build up to some sort of micro-degree depending on the objectives of the issuing institution"- COO			
Types of proofs attached with the digital credential	Issuer-related data	Allowing users to browse proof related to issuers	Supported by all platforms
	Skill-related data	Use standard frameworks as taxonomy for skills	Only supported by a few platforms
	Educational standards and frameworks	(e.g. EQF, NQF) (Rehak & Hickey, 2013)	Supported by the majority of the platforms
	Awards and achievements	Meta data specific to achievements and awards	Supported by all the platforms
	Learning outcome related data	Commonly associated with formal learning, includes skills learners will acquire	All the platforms associated with formal learning offer this feature.
	Formal learning related data	Commonly associated with formal learning, includes data such as ECTS and learning hours	All the platforms associated with formal learning offer this feature
	Grading scheme related data	Commonly associated with formal learning, includes data on scale applied to grades	All the platforms associated with formal learning offer this feature.
	Supplementary evidence of learning	Attaching appendices and supplementary evidence to the credential (Grant, 2014)	Supported by the majority of the platforms
	Support of learning assessment	Different versions of digital credentials for different levels of mastery	Only supported by a few platforms
	View metadata	View all the metadata associated with a digital credential	Supported by all the platforms
	Custom display	Customizing how the digital credentials are displayed	Only supported by a few platforms
"*Our platform is used by companies, consortiums and schools. So, we have a lot of different contexts and if we, prescribed one template for skills within our system, then it doesn't work for everyone" – Co-founder*			
Link with Learning offerings	Registration for learning offering	Search for learning offerings and register (SCLDA, 2014)	Only supported by a few platforms
Verification of authenticity	Blockchain	Use blockchain technology for authenticity of data	Emphasized by EBSI
	Electronic seal	An authenticator signature to ensure data origin and integrity	Emphasized by EDCL
"The fake degrees market is increasing and we have more and more false information. We need to check the authenticity of data and we need to find the best ways to share very valuable credentials, more easily" – Co-founder			
Validation features	Reviewing metadata	Review metadata digital credential submitted by the learner	Supported by all platforms
	Validating the digital credential	Validate the evidence of achieving the digital credential	Supported by majority of the platforms

Another feature that is gathering momentum (although still in its infancy) is a way of linking learning offerings from the platform based on various factors such as interests and learning offerings learners have completed. LinkedIn Learning seems to be offering something similar to this feature, although it is definitely not a common feature for most platforms.

One of the main features that every higher education institution pays special attention in a digital credentialing platform is verification method used to
make the credentials tamper-proof when they are about formal learning. Some platforms use blockchain technology for security authentication and data sharing. Although blockchain technology is recognized as an effective tool, platforms acknowledge a level of uncertainty due to its lack of widespread adoption. However, all the stakeholders admit there is a need for verification technology to ensure secure data transfer at all levels. Currently EDCL uses eSeal (electronic seal) as a security measure to verify the authenticity. Further, EBSI is working with different stakeholders (including higher education institutions) to use blockchain technology with standard data models such as EDCL for different types of digital credentials. The EBSI also enables verification of the digital credential and all involved stakeholders (i.e., the issuing organization and learner) seamlessly. Through EBSI, learners can create a "verifiable presentation" of any of the digital credentials to share. This verifiable presentation contains required proofs that can be signed with cryptographic keys to ensure the authenticity.

While the verification of digital credentials involves authenticating the credentials and the issuing organization (for example), the contents of the credentials should also be validated. This includes validating the evidence of achieving the digital credential. The EBSI model of viewer presentation specifically addresses this issue with standard data models and verification methods.

5 DISCUSSION AND CONCLUSION

This research focused on the features of micro-credential platforms that will benefit institutions as well as learners. Some of these features are recognized in the literature while others were drawn out from the interviews and group discussions held as part of this study. Based on the findings of this research, the aim of the next section is to answer the second research question pertaining to how the micro-credential platforms are helpful for both institutions and learners.

5.1 The Benefits of Micro-credential Platforms for Institutions and Learners

5.1.1 Institutional View

Micro-credential platforms help institutions in two key ways: (a) issuing digital credentials to learners and (b) verifying digital credentials issued by others. To issue digital credentials to learners, institutions might use websites or applications provided by the platform providers or they could integrate such applications into their IT infrastructure directly. They can issue the credentials for the following: (a) non-formal learning offerings such as extra-curricular activities (including hackathons), (b) formal learning offerings from study programs, which can also be credit bearing and count towards the formal degree program, and (c) diplomas related to the degree programs.

Different types of proofs can reside in different learning management systems, which need to be aggregated before attaching to the digital credential. Levels of proof depend on whether the learning offering is a non-formal or formal activity, such as recognizing ECTS or learning activities. Similar to the issuing of different types of credentials, platforms offer different ways of verifying credentials. However, this is not a common way of using digital credential platforms. The verification of credentials can be divided into two subtypes :(a) validating the issued credentials and, (b) verifying credentials issued by other institutions. Similar to the issuing of credentials, institutions might use platform websites or IT integration for verification and validation. The validation of the digital credentials could also include checking for proofs of learning and grading schemes.

Digital credentials can be applied to recognize both micro and macro learning offerings. By issuing digital credentials for all learning opportunities, institutions can provide a comprehensive view of skills and competences learnt for all students. When a digital credential is awarded for a longer program (such as a degree), it can contain a list of individual learning offerings and all the learning outcomes, skills, and competences associated with each of those learning offerings.

Issuing digital credentials will also help higher education institutions to unbundle and offer smaller group of offerings for larger credentials with a different focus such as field or skill specific. Unbundling also makes it easier for institutions to offer learning opportunities for "lifelong learners". These learners can be described as a learner who might have enrolled full-time in an educational institution or are interested in upskilling or reskilling for other reasons (such as career path, change of career).

As more educational institutions start issuing digital credentials, it will make validating them easier and render the entire admission process more streamlined.

5.1.2 Learner View

Learners can currently use the platforms to (a) view and (b) share the digital credentials they received. They can use either the platform websites or the platforms' mobile apps to view these credentials. The learners view of credentials also includes information on the issuing organization, awards, and achievements from the learning offering. In the case of formal learning, the view might also include grading schemes, learning outcomes and assessment criteria. With digital credentials, learners can accumulate all the individual learning offerings and show proof of what they have learnt.

Using the platforms in this manner help learners in at least two key ways. First, by taking ownership of educational credentials. The platforms enable them to collect, store and choose the credentials to share. This means that learners can share them on social media and with others (such as potential employers and other institutions). This essentially follows the principles of self-sovereign identity (i.e., the main objective of EBSI) and the national and European agendas of digitalizing educational credentials. Second, the platforms enable learners to prove the skills and competences they possess. Such proofs are becoming increasingly more important in job searching and during upskilling and reskilling. Additionally, this will enable educational opportunities to be more open and portable from one institution to another. Here, the types of credentials and proofs are critical features for realizing this function. On some platforms, learners can view their progress towards a larger credential or bundled learning opportunity. The visualization of accumulated data (e.g., competences or learning activity data from earned digital credentials) and categorization become highly critical features.

The interoperability of the systems was raised as a critical factor, as learners are unlikely to be tied to one system only. The portability of digital credentials (e.g., through common data models) is a critical upcoming development for realizing the benefits, especially for learners.

5.2 Contributions of the Study

The findings of this study can add significant value to the literature in these early stages of studying digital credentials. The relevant literature often discusses the challenges and potential benefits of digital credential implementation in higher education (Barnett, 2017; Clayton, et al., 2014; Halavais, 2018). The research around digital credentials remain scarce, especially from the perspectives of platforms and features. Through expert interviews, group discussions, and interviews with platform providers, our study identified categories and features that address these gaps in the literature.

This study contributed to filling these research gaps through two key theoretical contributions. First, by categorizing the features of micro-credential platforms and proceeding further into understanding what platforms emphasize the features. Second, we also identified the categories and features that are not yet fully understood and developed.

The findings of this study can help higher education institutions gain a broader understanding of the digital credential platforms and the features offered today. Based on experts' views, the study also provides a list of features that align with formal learning offerings of higher education institutions. Based on these findings, these institutions can make informed decisions about which platforms to adopt, depending on how they align with their vision, operations, and stakeholders' perspectives.

This study can also help digital credential platforms to assess their own offerings and solutions based on the needs of higher education institutions. As elaborated in the institutional and learner views, the required proofs are highly dependent on the context of use (formal to non-formal) and use purposes. For instance, a learner may require in-depth proofs from specific modules or study programs to showcase to a potential employer. This is why it is critical to understand the expectations and upcoming use purposes of micro-credential platforms which might not be identifiable as initial requirements the institutions might raise for such platforms.

5.3 Research Limitation and Future Research

We acknowledge certain limitations to our study. First, we acknowledge that platforms other than those reviewed for the study might have emerged after the data were collected. Such potential platforms should be included in future research. Second, the features identified in the study might already have changed as the platforms are continuously evolving and the study's findings need to be revisited in further research. Third, we used a relatively small sample size due to a lack of experts in digital credentials. Finding experts to participate in our study proved difficult, as most of the people contacted only had expertise in planning, designing, and managing study programs instead of the digital proofs and digital credential systems. With the major new initiatives such as the EDCL and the EBSI, awareness of digital credentials is likely to increase rapidly, and new expertise will emerge in the field. Fourth, the distribution of samples between providers and other experts is not even. This limitation relates strongly to the previous one and to the challenge of finding relevant experts for the study. Fifth, we did not account for the views of the end users, such as learners, administrators, and teachers. We chose to limit our sample to the providers and digital credential experts to gain an initial understanding of what these platforms have to offer. Further research should soon evaluate these platforms with end users, especially since major digital credential initiatives are emerging nationally and internationally. Despite these limitations, we consider this study to be relevant and valuable to both the research community and higher education institutions that are considering the adoption and use of digital credentials.

Based on the findings of this study, we suggest some areas that should be examined in the future. In general, more research is needed on micro-credential platforms from the higher education institution perspective to examine factors that enable or inhibits their adoption. Further research is also required to study some of the less developed features such as learning pathways, verification methods and how higher education institutions can adopt them in the future. In our study, experts also elaborated on features that do not yet exist. One of these is stackability of credentials and skills. The stackability of skill-related data refers to how skills and competences accrued in digital credentials over time can be represented in a meaningful way to help learner present a more complete picture of their skills and knowledge. Our investigation shows a need for further research on the ways of searching and presenting the credential information especially when the learners have multiple digital credentials with similar skills and competences. Finally, the insights from our findings show that the use of micro-credential platforms requires consideration of the technical, organizational, and even cultural aspects of higher education. Therefore, we encourage researchers to examine how institutions need to change to facilitate the adoption of digital credentials, such as invoking new administrative or technical roles to manage the digital credentials related to formal and non-formal learning opportunities.

ACKNOWLEDGEMENTS

This research was co-funded by ECIU University project (612521-EPP-1-2019-1-NL-EPPKA2-EURUNIV), European Universities funding and MicroBlock-project (2020-FI-IA-0096), CEF-TC-2020-1–Blockchain-funding.

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PUBLICATION
II

Are Micro-Credentials Valuable for Students? Perspective on Verifiable Digital Credentials

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SN COMPUT. SCI. 4, 366 (2023)
http://doi.org/10.1007/s42979-023-01797-y

SN Computer Science (2023) 4:366
https://doi.org/10.1007/s42979-023-01797-y

ORIGINAL RESEARCH

Are Micro-Credentials Valuable for Students? Perspective on Verifiable Digital Credentials

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Received: 17 September 2022 / Accepted: 16 March 2023

Abstract
Higher education institutions are investing more and investigating digital credentials as proof of learning upon completion of learning offerings, such as micro-credentials. Understanding what value these digital credentials hold for learners and what enables the learners to use digital credentials will help higher education institutions focus their efforts. Although there is research available on value of micro-credentials, there is a huge research gap in understanding the value of digital credentials and the metadata that can be included, especially from learner perspective. To address this gap, we conducted a qualitative analysis study with interviews of learners and administrators in higher education institutions. This study contributes to (1) what value do learners perceive of digital credentials, (2) what value digital credentials have compared to other forms of recognition, such as paper certificates, and (3) what factors enable greater adoption of digital credentials by learners. In terms of practice, our findings help higher education institutions in evaluating the use of digital credentials not only for micro-credentials but also extend them to other learning offerings.

Keywords Micro-credentials · Digital credentials · Verifiable digital credentials · Metadata · Features · Micro-credential platforms · Higher education institutions

Introduction

Multiple stakeholders, including higher education institutions (HEIs), leaders of national qualification reference frameworks, and policymakers, are working together to better define and create necessary frameworks for micro-credentials [22, 52, 56, 64]. This effort is leading to a more concise definition of a micro-credential: a credential or record of learning outcomes issued after a short learning experience or a module that focuses on specific knowledge [32, 58]. This concept of micro-credentials is causing a shift in practice by higher education institutions towards unbundling their learning offerings. A micro-credential can be credit bearing (such as ECTS) and include assessment and stackability [5, 16, 32] (Malaysian Qualifications Agency, 2020), but most importantly, they are developed considering the needs of industry, employers, and the community [57, 72]. Indeed, employer concerns about graduates' skills and competences along with diverse student needs are some of the reasons why higher education institutions are taking a closer look at micro-credentials [53, 58, 66]. They are viewed as a potential way for individuals to upskill or reskill themselves with competences that are in high demand in emerging jobs of the labour market [43, 47].

By separating a micro-credential into a short learning experience and the credential associated with it [15, 39], two distinctive efforts can be seen in the field of micro-credentials. First, the content discussion includes the design of the subject matter, including learning experiences, assessment practices and co-construction in collaboration with the industry [9]. The credential discussion of micro-credentials focuses on the evidence of achievement given at the completion of the academic endeavor. Currently, this can be a paper certificate, or a digital credential given after successful completion of the short learning experience.

This article is part of the topical collection "Advances on Computer Supported Education" guest edited by James Uhomoibhi.

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Published online: 29 April 2023

A digital credential can be described as a digital certificate that contain learner achievement, recognition of activities, assessments, competences that is tamper proof and has verification checks built in [3, 32]. The digital credentials can include in-depth information, such as learning outcomes, skills and competences and information on the awarding bodies [16, 32, 62], making them transferable and richer in content than paper certificates. At least two major technologies are currently available that offer authenticity and verifiability features. European Digital Credentials (EDC) have a rigid electronic seal and support instant verification [32], whereas the European Blockchain Services Infrastructure (EBSI) utilizes the blockchain for verification [22, 31, 63]. Regardless of the method used, it is agreed that verification is a key aspect of digital credentials to make them tamper-proof. Another form of recognition that is widely in use mainly outside higher education is a digital badge. A digital badge can be defined as an "online representation of a credential earned" [3]. While badges may contain metadata related to learning opportunities, they typically lack verifiability and are connected to non-formal or informal leaning. In this paper, our focus is on verifiable digital credentials, specifically in higher education institution settings and related to formal, credit-bearing learning opportunities and how they are valuable to learners. In this paper, the terms digital credentials and verifiable digital credentials are used interchangeably.

Currently, research on the benefits of micro-credentials tends to focus on the combination of short learning opportunities and credentials together and, the discussion tends to be more about digital badges than verifiable digital credentials. Even so, there is very little research on learners' perspective on how micro-credentials are beneficial to them. The little exploratory empirical research that is available indicates that students have positive attitudes towards micro-credentials in general and see their potential, especially for lifelong learning [2, 40]. Despite the worldwide efforts to develop digital and standardize digital credentials [22, 33], there is no empirical research currently available on how the digital proofs associated with credit-bearing short learning offerings (i.e., verifiable digital credentials) are beneficial to learners. Given the importance of the topic and the research gap, we ask the following research question: "*What is the value of verifiable digital credentials for learners?*".

To answer this question, we conducted a qualitative study with two sets of semi-structured interviews. We chose the qualitative approach to gain deeper understanding as micro-credential area is still a new area. Especially issuing/receiving micro-credentials with metadata such as learning outcomes, skills and competences is not widely done. With the availability of small sample size, qualitative approach provided us with an opportunity to have meaningful discussions that led to rich insights. The interviews were conducted in the context of a European University alliance project that pilots and experiments with micro-credentials. The first set of interviews was with learners ($n = 19$) from Tampere University who were participating in a course at the end of which they receive a digital credential. The interviews included asking a few indicative questions to add quantified way of validating the qualitative data. After the initial analysis of the learner data and practical insights from universities, we uncovered richer insights that needed to be addressed further with interviews. We decided to interview administrators from higher education institutions to gather the additional information. Since administrators issue and manage digital credentials, their insights were essential to obtaining a broader view of the value of digital credentials for learners. Consequently, we interviewed administrators ($n = 19$) from 11 higher education institutions. This provided us with another way to validate the insights from the learner interviews by data source triangulation.

We used expectancy-value theory (EVT) [27, 30] as our theoretical framework because it allows uncovering the different types of value and ability perceptions that hinder or enable the adoption of an innovation. Using Hulleman's modified model of EVT model, we were able to do empirical validation including cost as one of the constructs. This paper contributes to the literature on digital credentials' by (1) examining their value to learners from an empirical perspective, (2) explaining the value digital credentials have compared to other forms of recognition, such as digital badges, and (3) by revealing what factors enable greater adoption of digital credentials by learners.

The remainder of the article is structured as follows. First, we present the theoretical background. Second, we describe and justify our research methodological choices. Third, we report our findings, and finally we discuss our contributions, future research directions, practical implications, and limitations.

Theoretical Background

Digital Credentials

There is an increasing demand to fill the gap between the formal programs higher education institutions provide and the skills industry seeks from employees [47]. The new models needed to provide such skills tend to be short, flexible and include industry-embedded learning [17]. Micro-credentials fit such requirements and have become widely available, such as massive open online courses (MOOCs) [8, 11, 68].

Multiple studies have suggested that higher education institutions have a need and desire to offer micro-credentials [25, 65] and, this trend can be seen in practice globally. Formal qualifications frameworks are in place in Europe, Canada, Australia, New Zealand and most of Asia and Africa to align the micro-credentials with formal credits [6, 35, 71] (CDQF, 2007; NZQF, 2011). Even though such frameworks do not exist in USA, they are at the core of the micro-credential movement, partly due to already existing close ties between higher education and industry [54].

Traditionally, academic achievements have been recorded and issued as academic transcripts. While these transcripts provide verifiable proof of completing the courses, they are limited in their ability to demonstrate the skills and competences associated with those courses [46]. This applies to individual courses, entire degree programs and everything in between. Currently there is a movement in higher education to either replace traditional certificates or to complement them with a digital credential [22, 32]. Digital credentials can have the same information as the traditional diploma but also have the capability to include rich metadata, making them transferable between institutions and users [48]. Moreover, digital credentials are rendered to be immutable with built-in verification [10]. They also shift the ownership to learners (self-sovereignty), who are free to share as they deem necessary [32].

Before the emergence of digital credentials, digital badges were used for almost two decades as an indicator of achievements, especially in nonformal learning environments [6, 21]. A digital badge is a visual representation of skills and competences acquired by the learner [41]. They are typically used as an incentive to encourage and motivate students to learn [36] and can be shared on various social media platforms [26]. Digital badges became a gamification element, especially in online learning environments [24, 41, 73], to signify accomplishment. HEIs also started adopting digital badges in formal education in recent years [1]. In higher education, digital badges are mainly used to capture aspects of learning that cannot be recognized through academic accreditation processes (Devedzic & Jovanovic, 2015). Initial findings on digital badges have shown that learners have mixed reactions to them [26]. While learners are motivated by the badges, they regard the formal grade and course content as more important [18]. It is important to note that in higher education settings, digital badges are used as an addition or complement to the formal transcripts given for any course or program and not as a replacement for them. Meanwhile, verifiable digital credentials are digital versions of transcripts, which can include metadata in addition to the information that a formal transcript provides. The digital credentials given by higher education institutions include formal learning data, such as the number of credits (e.g., ECTS), grades along with learning outcomes, which can also include the skills and competences. This also means that the data included in the digital credential are verifiable and subject to the same accreditation standards as traditional transcripts [32].

There are at least two large initiatives occurring in Europe that involve digital credentials. The European Digital Credentials for Learning (EDCL) program offers higher education institutions an infrastructure (or components) that can be used to manage verifiable digital credentials. These are digital statements issued by an organization to a learner, documenting their learning (EDCL 2021). This includes digital credentials for individual learning offerings, such as degrees, and diplomas awarded by educational institutions. The second initiative is the EBSI whose vision is "to leverage blockchain to the creation of cross-border services for public administrations and their ecosystems to verify information and make services trustworthy" [31]. This initiative includes HEIs issuing digital credentials that are tamper-proof and verifiable by other educational institutions.

Similarly, Digital Credentials Consortium in USA was founded by several leading universities to build an infrastructure for verifiable credentials including, the design of the digital credentials [22]. RMIT creds (credentials) offered by RMIT university are industry-relevant digital certifications that can also be applied to formal education. In Malaysia, micro-credential certification programs are paired with digital badges in which metadata with details about what was accomplished are embedded. Since the main purpose of obtaining micro-credentials is to acquire skills and competences that are lacking or needed, including that data into the credential is imperative. The digital credentials issued upon completion of short learning offering provide several advantages over traditional transcripts or certificates. This includes easier sharing and storage of data as well as complete ownership on the data credentials.

Value of Digital Credentials for Learners

Micro-credentials have been seen as a potential way to allow learners to fill their skill gaps and receive proof of their newly developed skills [47]. This is crucial, as industry expects employees to either enter the workforce with necessary skills or take the responsibility for upskilling. As part of this, both learners (future employees) and industry need a more transparent view of the skills acquired by learners [37]. Traditional transcripts typically list the name of the course and formal academic information, including the number of credits and the grade achieved. Employers cannot view or validate the acquired skills and competences with such brief information [19]. The digital credentials given at the completion of a micro-credential can include information such as acquired skills and competences as part of metadata thus making it transparent to the employer.

Prior research has shown at least six major benefits of using micro-credentials overall for learners: personalization, cost efficiency [45], transferability [55], portability, transparency, and ownership [42], (ICDE report, 2019). Of these six benefits, transferability, portability, transparency, and ownership relate more to the digital credentials than the content of the actual learning offering (e.g., short course). Hence, the research and studies on the value of micro-credentials also extend to digital credentials. Learners can pursue micro-credentials for a variety of reasons. Depending on what stage of life they are in, it could be to seek new skills, to gain career advantage or simply because of personal interest [59]. They might pursue the them before, during or after the completion of traditional degree program [75] or completely outside the realm of formal education. Irrespective of the reason, the digital credential acquired will benefit the learner in understanding their current level of skills.

The emergence and growth of micro-credential platforms that are used to manage digital credentials [48] have helped to increase the awareness of verifiable digital credentials. The standardization of digital credentials into common data models or formats has been discussed around the world. The European Commission recently launched a standard for such digital credentials called European Digital Credentials [33], which is an extension of the worldwide standard, World Wide Web Consortium Verifiable Credentials (W3C VC). Digital Credentials Consortium in the US is also working on the same W3C VC standard for digital credentials. The main differences between these digital credentials and others such as digital badges, include (1) strong authentication and verification methods, such as advanced e-Seal or blockchain, making them immutable and easy to verify; and (2) the same qualification and accreditation frameworks are used for digital credentials as for traditional programs. Similar projects are in progress in other parts of the world [69] signaling strong desire to raise the standard of digital credentials to something educational institutions can trust.

Although some research has been done on the benefits of micro-credentials for learners, no empirical research exists today regarding the value of the digital credentials themselves from a learner perspective. What value do learners see in rich the metadata that digital credentials can have, how could they use digital credentials and what factors might affect the wide use of digital credentials by learners? Our empirical research focuses on answering these questions by studying the perception of the value of digital credentials by learners.

Research Method

Research Framework

We chose to use expectancy-value theory (EVT) [30] as research framework to study how digital credentials are helpful for learners. According to EVT, an individual's choice to participate in an activity (e.g., using digital credentials) results from an interplay between the value it brings and their subjective belief in their competence [14]. EVT also explains how these individual choice behaviors are affected by both personal and environmental factors, similar to the technology integration barriers [50]. Even though traditionally, EVT has been applied to understand the academic performance of students [61], it also determines the relationship between beliefs and choices to take part in an activity [30] and thus can also be used in innovation adoption processes to understand and predict the intentions of using an innovation [77], such as adopting a micro-credential platform.

Since higher education institutions issue and manage digital credentials, we believed the administrators of those institutions could provide a different and complementary perspective on the research question. Hence, although EVT is addressed for individuals [4], we believed the same model could be applied to administrators' viewpoints. We accomplished this by asking the administrators specific questions regarding the ways that digital credentials can benefit learners. For instance, specific questions included how the data included in digital credentials can help learners and where digital credentials can be used in practice.

In the EVT model [30], two key predictors influence an individual's choice: expectation for success, and value beliefs. Expectation for success is the perceived ability to succeed at a task now and in the future, and value beliefs, also known as subjective task value (STV), are conceptualized as task specific beliefs. In our study that task is using digital credentials.

Subjective Task Value

This key predictor includes four sub-constructs: intrinsic value, attainment value, utility value and relative cost.

Intrinsic value: This construct was defined as (a) the *enjoyment* individual gets from performing an activity or (b) the *interest* the individual has in the subject [29]. For this study, we chose the construct 'individual interest'.

Attainment value: This construct was defined as the 'value' an activity has for the individual. It includes how important successfully performing an activity is for the individual or how determined the individual is to succeed in doing so [27].

Utility value: Also known as the usefulness of the task, this construct is defined as how well an undertaking relates to current and future goals [29].

Cost: This construct is defined in terms of the negative aspects of participating in the task. It refers to the perception of effort and time invested [28]. It also includes other negative aspects related to performing the task, such as performance anxiety and lost opportunities [30].

Expectations for Success

The second key EVT predictor, also known as competence beliefs, is a combination of two related subconstructs: ability beliefs and expectancy beliefs.

Ability beliefs: This construct is defined as individuals' own evaluation of their current competence in the domain [30]. For this study, we selected the domain 'using the technology'.

Expectancy beliefs: This construct is defined as individuals' beliefs about how well they will do on future tasks [30].

The expectancy-value model for micro-credentials is built based on the Hulleman's EVT model [44]. In this model, cost has been promoted as a separate construct instead of as one of the value beliefs. This is due to both theoretical and empirical insights that demonstrate the direct influence of cost on intention to take part in an activity [44]. This model suggests that an individual can still choose not to take part in an activity even if the expectation of success and value perception are high if the individual perceives the cost of taking part in the activity to be too high [7]. Applying this model to digital credentials, learners' motivation to use digital credentials depends on not only how they perceive the expectancy of success and value perception but also on whether they believe the received value from these credentials is higher than the cost of adopting a new technology [70, 77]. We drew from Hulleman's model to examine value perceptions. Hulleman's paper doesn't directly address micro-credentials or using technological innovations in educational context. We were able to use the model for empirical validation and extend its use for adoption of new innovations especially in educational context from learner point of view. Using the Hulleman model, we also addressed what motivates learners to use digital credentials in the future and what factors can enable such use.

Data Validation

For validation of data collected from learner interviews, we chose to use data source triangulation method. Data source triangulation involves collection of data from different sources such as different types of individuals [13]. By gathering the information from two different types of sources (learners and administrators), we were able to validate the data collected and thus our analysis. Variance in persons, such as learners and administrators while keeping the same method (semi-structured interviews) adds to the study as it can reveal atypical data as well as the possibility of identifying similar patterns, thus increasing confidence in the findings [38]. By using the data source triangulation method of validation, we not only confirmed the findings from learner data but also found more insights from administrator interviews that enhanced our analysis.

Data Collection and Analysis

Data collection was done in two stages as part of a European University-project called ECIU University. ECIU stands for European Consortium of Innovative Universities. The project fits the study objectives well as ECIU University pilots micro-credentials in a higher education context and offers different types of learning opportunities for learners. First round of data collection was conducted in Spring 2021 with learners. Once the data analysis was done and compared to the literature, we concluded that interviewing administrators who are in a position to issue the digital credentials might give us more insights on the overall benefits of digital credentials. The second round of data collection was conducted in Spring 2022.

Data Collection—Learners

We chose to conduct semi-structured interviews, as they enable addressing new topics with multi-fold contributing factors via open questions [67]. For this study, we used purposeful sampling method [60] to select the interviewees. Since digital credentials are new, using purposeful sampling to find learners who just received digital credentials provided us with in-depth information. Learners were invited from a course offered by Tampere University for the ECIU project, and verified digital credentials were given after successful completion of the course.

Nineteen learners responded to the invitation. Of the 19 respondents, two were women (10.5%) and 17 were men (89.5%). Sixteen (84.2%) had a bachelor's degree and three (15.8%) had an upper secondary school certificate and were currently working towards their bachelor's degree. Nine (47.4%) of the respondents were between the age of 20 and 24, and ten (52.6%) were between the ages of 25 and 29, while the average age of the respondents was 24.5 years. All the respondents were students at Tampere University at the time of the interviews. We conducted the interviews during Spring 2021. They lasted from 33 to 75 min, with an average of 49 min. The interviews were conducted remotely using Microsoft Teams and were recorded with their permissions. The interview questions were based on EVT-based surveys used in the studies of Wigfield & Eccles, [74] and Kosovich et al. [49]. We adapted the questions to focus on the extent to which students found micro-credentials to be useful, interesting, and important. The questions also addressed how students perceive their competence to use micro-credentials embedded in corresponding platforms, and what costs do they associate in using them. Majority of the questions were open ended, but towards the end of the interview the respondents were asked to give indicative answers to questions, e.g. "How important are micro-credentials to you, on a scale of 1 to 7?". These answers were asked as respondents had limited experience with micro-credentials (even the most experienced respondents only owned a single micro-credential) and because of this most of their answers were estimates.

Data Collection—Administrators

In Autumn 2021, all the ECIU consortium partners participated in EDCL Early adopter program (EAP). We chose to expand the study and interview administrators from 11 universities who participated in the EDCL EAP. Nineteen people in administrative roles from 11 universities were interviewed. Of the 19 administrators, 12 were active participants in EDCL EAP meetings. Six women (31.5%) and 13 (68.5%) men were interviewed. The interviews were conducted between February and June of 2022 and lasted between 28 and 63 min, with an average of 52 min. The interviews were conducted remotely using Microsoft Teams and were recorded with the permission of the participants. Similar to the learner interviews, the structure and questions were based on EVT-based surveys and the questions were adapted to focus on what their beliefs are on the value of digital credentials for the learners.

The analysis of the learner data gave us input for expanding our questions for administrators. For example, regarding ability beliefs, along with the question about "how administrators feel about learners' ability to use the technology now and in future," we also asked a question of their ability to issue the digital credentials.

Data Analysis

All the interviews were transcribed. We chose to use a combination of deductive and inductive analysis as the approach for coding process. Specifically, we used EVT constructs as initial categories (Table 1). The transcriptions were reviewed, and the text data was sorted into categories matching the operationalized definition. Similar answers were grouped together until patterns started to evolve in the data. We repeated the same process for the administrator interviews.

Findings

The findings of the study are presented in two parts. The first section presents the findings from the learner interviews, and the second section presents the insights from the administrators, which enriched the prior findings.

Table 1 Categories and definitions

Category	Literature definition [27],Eccles et.al., 1983)	Operationalized definition (learner or administrator)	Example codes
Ability beliefs	Individuals' perceptions of their current competence to complete an activity	Individuals' perceptions of their current competences to use or issue digital credentials	I believe I am better than most of my peers at using digital credentials (learner)
Expectancy beliefs	Individuals' perceptions of their future competence to complete an activity	Individuals' perceptions of their future competences to use digital credentials	I think I am able to find a way to use digital credentials to benefit myself in the future (learner)
Utility value	How useful the individual perceives completing an activity to be	Perceived usefulness of digital credentials for the learner	Digital credentials can help me get a job (learner)
Intrinsic value	The enjoyment that participating in an activity brings or the interest in the activity	Interest in receiving digital credentials	I like receiving digital credentials (learner)
Cost	Things that the individual has to give up to participate in an activity	Things that the individual has to give up to use/issue digital credentials, including time and effort	I don't think I have to put in too much effort to use digital credentials compared to the value they provide (learner)

Value Perceived by Learners

Each of the learners received their first verifiable credentials in the study. For most, this was the first time they had seen a digital credential, the metadata it carries, and the storage and sharing features. Our findings indicated that the value of micro-credential comes from the digital credential itself rather than the platform used to issue it, which allows users to view or share it. The results of the indicative questions from the interviews are summarized in Table 2. Numerical values that the respondents provided were categorized indicatively to low, moderate, and high, to allow for easier pattern recognition.

All the learners were quite confident in their ability to navigate the technology, such as the platform where they could store, view, and share the digital credentials with 11/19 (58%) of them expressing high confidence. Most of the learners expressed technology not being a barrier currently to use digital credentials. In fact, they hoped there would be more digital credentials issued and expressed that their motivation to use them would increase as a result.

> "I feel that I can use these myself and I have some visions what I could do with [microcredentials]". – Fourth-year learner.

15/19 (79%) of learners placed the utility value to be moderate or high in short term and 17/19 (89%) learners in long term. The utility value of digital credentials expressed by students is higher for long-term than short-term. 9/19 (47%) of learners expressed 'high' value for long-term and only 3/19 (16%) for short-term. One of the reasons noted by learners for this variance is that digital credentials need to be widely used by institutions and recognized by employers which takes time. Only 4/19 (21%) of the learners found the utility value low in short-term and only 2/19 (10%) in long-term indicating the learners see this as a long-term goal.

The metadata included in the digital credential were the highlight of the digital credential for the learners. Our findings suggest learners like the idea of having descriptive data in the credential and find the descriptions valuable. The learning outcomes, which also include skills and competences associated with the course, gave them an overall view of what they just learnt. Although the data can be viewed in the learning management system, having them in the digital credential, which learners can access along with the course was a feature the learners appreciated.

> "I feel that if you pull a transcript of studies from [national information system] the course doesn't… well it's just the name of the course. Here [in the digital credential] you have clearly separated what did you learn on the course. So if you want to keep track of what you have already learned, and I have noticed this myself, that if you categorise the information like it's categorised here it does help you long-term in utilising the information. So you won't just forget about what was done on a course when it's finished. I think that's a useful utilisation of this system. Especially if you could plan out what you want to learn. So, in a sense, you could keep track of what you are and what you want to be." – Sixth-year learner.

Only 11/19 (58%) of them felt digital credentials have some importance to them (moderate and high). Our analysis shows that although digital credentials are currently not important to the learners but will be when they are widely available and accepted. 8/19 (42%) learners assigned low importance to receiving digital credentials. Reasons for the low attainment value includes, learners being in their last stages of their current studies and do not feel they can add value to them currently and no current way to share them. A wider array of digital credentials along with wider acceptance seems to be what learners would like

Table 2 Learner's perceived competence and value beliefs

Respondent	Ability belief	Utility value		Attainment value	Intrinsic value	Expectancy belief	Cost
		Short-term	Long-term				
A	MOD	MOD	MOD	LOW	MOD	MOD	MOD
B	MOD	HIGH	HIGH	MOD	MOD	HIGH	LOW
C	MOD	MOD	HIGH	MOD	MOD	MOD	MOD
D	HIGH	LOW	HIGH	MOD	HIGH	HIGH	LOW
E	HIGH	MOD	HIGH	LOW	MOD	MOD	LOW
F	HIGH	MOD	MOD	HIGH	HIGH	MOD	LOW
G	HIGH	MOD	MOD	MOD	MOD	MOD	MOD
H	MOD	MOD	HIGH	LOW	MOD	MOD	LOW
I	HIGH	HIGH	HIGH	MOD	HIGH	HIGH	LOW
J	MOD	MOD	MOD	LOW	LOW	MOD	LOW
K	HIGH	MOD	MOD	MOD	MOD	MOD	LOW
L	HIGH	LOW	LOW	LOW	MOD	MOD	LOW
M	HIGH	MOD	MOD	MOD	MOD	MOD	MOD
N	HIGH	MOD	LOW	LOW	MOD	MOD	MOD
O	MOD	LOW	MOD	LOW	MOD	MOD	LOW
P	MOD	LOW	MOD	LOW	MOD	MOD	LOW
Q	HIGH	MOD	HIGH	MOD	HIGH	HIGH	LOW
R	HIGH	MOD	HIGH	MOD	MOD	HIGH	LOW
S	MOD	HIGH	HIGH	MOD	HIGH	HIGH	LOW

and hope to have in future. The more digital credentials they can receive, the better their chances of learning and showing their skills to potential employers. Another practical aspect of digital credentials according to the learners is transferability. For example, to get credit for a course completed at a different institution, learners currently need to submit not only the transcript but also a description of the course, learning outcomes and other details about the course. Transcripts only include limited information, such as the name of the course, the grade, and the number of credits. Learners must find that information in the institution's learning management system. But with digital credentials, all that data already exists, making it much easier way to get credits transferred. Since the digital credential is issued by another higher education institution, which follows similar accreditation, it is trusted as well.

Learners who indicated low importance added that micro-credentials would be more important to them if they were more widely accepted and used or that if they had received micro-credentials from all the courses they had completed in the university. 2/19 (10%) learners indicated that they would consider micro-credentials very important to them if they had a wide array of them.

> "You would need to have them all in the same place. If there are only a few courses sharing, sharing them won't bring any benefits." – Third year learner.

18/19 (95%) learners expressed either moderate or high intrinsic value. Even the only learner who expressed low intrinsic value said while the digital credentials do not get them overly excited, it would be nice to have them still. We also noticed that 5/19 (26%) learners expressed high intrinsic value in learning about their current skills using digital credentials. They believe it will enable them to choose a path to achieve their final goal. Some of the learners also considered themselves to be early adopters of new technologies, which also plays a role in their higher intrinsic value. The interoperability of the systems was raised as a critical factor, as learners are unlikely to be tied to one system only. The portability of digital credentials (e.g., through common data models) is another feature.

> "because they lose value if they are exclusive [to a certain service]."—Sixth year learner.

While learners placed high confidence in their ability to navigate the digital credentials, their expectancy value was lower than their ability beliefs. While none of them expressed their future technological abilities to be low, only 6/19 (26%) of them expressed to be high. This is because digital credentials and the technologies used are relatively new in addition to the many unknowns regarding future technologies.

> In the long run I think using the system would be made so easy that it wouldn't differ from using the systems we have today. So, I would say it would not be limited by technological capabilities – Third year learner.

Our findings suggest that learners believe that digital credentials have high long-term value, and they would like to use them in the future. One of the most commonly reported uses of digital credentials was for job searching. Learners intuitively felt this would give them an edge since they could present more information about their abilities when applying for a specific job. Our data also show that learners believed that digital credentials with skill-related data would be especially useful when searching for work internationally.

> "I could imagine this would be useful when searching for a job. Job-hunting is what first comes to my mind" – Sixth year learner. "… you can't see what is included on a course from a transcript of studies, only thing visible is the name of the course and the grade. At least from this you can see that more clearly … an employer can't have a picture of the course based on the name, because they don't know what is included. For example, something like "Development 1": The name does not say what programming language was used. So, in those cases [digital credentials] would be useful." – Fourth-year learner.

Our data indicates learners perceive the cost of receiving and using digital credentials not to be a barrier. 14/19 (79%) learners indicated the cost is low in terms of time it takes to learn the technology and effort it takes to use them. The learners who rated higher cost indicated that they had to use multiple platforms to receive and manage digital credentials and that affects the value of digital credentials as well. Table 3 shows the themes that emerged from the analysis of learner data.

Our analysis further shows that learners' current intentions to start using digital credentials are also affected by factors other than those based on our EVT constructs. According to our findings, the high perceived value of digital credentials is weakened by other factors. We were able to narrow these to (1) personal, (2) institutional, and (3) external factors that affect the adoption of digital credentials. By working on these factors, the value perception could be increased.

Personal factors: the learners indicated that it is a problem that they lack a wide array of owned digital credentials. The adoption of digital credentials is new even for institutions, which explains the lack of a wide array of credentials. We believe that this reduces the learners' value perception since they cannot present their entire array of competences because few courses offer digital credentials'.

Table 3 Values perceived by learners

Category	Theme emerged	Example excerpt
Ability beliefs	Technology usage	"I feel I have the skills, or that I would learn them if I needed to." – Fourth-year learner
	Using digital credentials	"I think you could use this if you e.g. take courses through open university channels, or in the city centre campus and they require certain base level information, you could prove pretty easily that you have that information and you are qualified to take the course" – Fourth-year learner
Utility value beliefs	Job search	"if you are searching for work globally, or you are working in a company which has global competition, you can prove that you have a competent degree or that you possess qualified competence." – Fifth-year learner
	Applying for studies	"Applying for student exchange—that was agonising, I had to come up with all sorts of files for them and ask for signatures and stuff. But if all my courses would go straight to the "European Standard form", I feel the process to apply for an exchange would have been much easier. The exchange destination university could verify my information more easily … you could also use [micro-credentials] when searching for work, or if you want to apply to a different master's program in another university." – Fourth-year learner
	Transparency and descriptiveness	"you get a better overview of the course than in Sisu, where you see just your grade. For example we had to go through a lot to get individual grades from this course, which affect the overall grade, from the course personnel. But in here you can see them straight away, and they are explained clearly, so this is much better, clearly. That all the information is viewable in one place – Fourth-year learner
	Information overview	"There's always the trouble when you want to go look at your grade from a course and what affects it and where, because some of the information is in [national information system], some of it is in Moodle and some is in PDF documents in Moodle. So of course, when all of the information is in one place it speeds up and simplifies working." – Third-year learner
	Comparison with regular transcript	"Nobody asks for your transcript of studies, but maybe [micro-credentials] would be more meaningful to look at, as there is information besides just the name of the course." – Sixth-year learner
Attainment value	Importance	"I think they could help with your professional development, and help a person keep their own competence portfolio in check. You could notice what you are missing, and can help you if you are interested to learn more about something you see you are lacking in. On a short-term, when you are studying, it could help you think about what skills are supported with your current studies and it could maybe help you see what skills are lacking and then you could find studies to support those skills." – Fifth-year learner
	Learning motivation	"if this were to take off and gain a larger user base and it would really bring some benefits, then in the future I could actually see myself using micro-credentials as one criteria of choosing courses." – Fifth-year learner
Intrinsic value	Excitement about digital credentials	"It would be exciting to see that where I am currently with the skills I have and that I could be on a path where I would like to go, It would make it easy to be aware of what skills I need." – Sixth-year learner
Expectancy beliefs	Future abilities	"I believe it wouldn't be too difficult to use. I think I'd definitely know how to send them to whoever wants to view them." – Fourth-year learner
	Future use	"I think they are going to be useful in the future, so you could share them to your employer when applying for a job or changing study programs or going to get another degree." – Fifth-year learner
Cost	Compared to value	"Right now, it feels like a burden, because information is spread to so many places and you would have to amass it from so many places." – Sixth-year learner

Institutional factors: learners also indicated that it is problematic that institutions—or at least the one they attend—do not award digital credentials to learners to a large extent. This affects their value perception in two ways: (1) learners cannot show their wider range of competences through skill information from digital credentials and, (2) affects the utility beliefs (from STV), such as being able to use them for transfer of credits. This also suggests that if they could receive a wider array of digital credentials for their higher education courses, their perceived value of digital credentials will be higher, and the negative effects of personal factors would be reduced as well.

External factors: the learners felt it was necessary that digital credentials are accepted by the industry. Currently, industry awareness of digital credentials is rather low. One of the key takeaways of the learner interviews is that they believed they were useful for demonstrating their abilities while searching for jobs. Thus, if industry is not aware of digital credentials or does not appreciate their potential, it affects the value perception for the learners. Conversely, when industry recognizes digital credentials and appreciates the data learners can present regarding their abilities, the learners' value perception will be higher.

Insights on the Value of Digital Credentials by Administrators

The analysis of the administrator interviews confirmed many of the findings from learner interviews but also showed multiple other benefits. Regarding the ability beliefs, the administrators felt confident learners would be able to use the technology to navigate the digital credentials now and in the future.

Utility Value for Learners

The administrators expressed high enthusiasm and confidence in the utility value of digital credentials for learners. Our administrator data analysis also confirmed what the learners said about how they would use the digital credentials. The administrators felt this will give learners an edge, as they could present digital credentials and showcase their abilities better in the job market. With metadata on skills and other competences, the administrators felt the learners could better define their pathways to the final goals. This would help learners navigate academia and learn the skills they are lacking, enabling them to be more proactive in acquiring the skills they want or need. They also indicated that credit transfers and admission processes could become simpler in the future if more digital credentials were issued and used.

> "we have institutional strategies and there's a nice phrase one of our directors use – about preparing students for unscripted future" – Micro-credential content development officer.
> "It's really good because when the students want to take some credit transfer, it's not enough that they have transcript of records where is name of the course and how many ECTS points they have got. We also need information about learning outcomes. Today it doesn't exist in transcript of records. Students always have to when they apply for credit transfer, they always have to describe for themselves or take it from curriculum what is mentioned there. In DCs, if it's stated there, it will be easier for the students.." – Head of unit, Services for Educational Leadership.

Administrators also believe that in future learners need to be flexible and adapt continuous learning concept leading them to be more lifelong learners.

> "Working market is changing a lot. it's not like you learn this and you are an expert in this, and everyone needs you. You have to be flexible in what your interests are, what your competences are, and your skills are. Therefore, the verification of these kind of sorts, small micro-credentials in DCs are very high advantage for learners." – Project manager.

The administrators conveyed high attainment value for learners using digital credentials. We believe the active participation in the early adopter program gave the administrators much broader view of where and how the digital credentials can be used, and thus came to the conclusion that digital credentials would become important to the learners. They also stated that the interest in digital credentials would increase when more digital credentials are issued.

> "I think it will be very good for the students because one of the problems when they have the degree and have to apply for the job, they have difficulty explaining to the company what their skills and competences are. If they just have a piece of paper. sometimes it's not good enough and sometimes they have to dig deeper themselves to explain to the companies what they can and cannot" – Chief consultant and co-ordinator.
> "I really like this because it seems to me that students at different universities can take more of these modules and get credentials for them, which they then can also use their own home universities and so more students have more access to courses and modules and, you know, sources of knowledge. And, you know, what seems also to be a very strong European network. And it's good for them also to engage in these international activities. Because there might be possibilities to engage with other students at other universities through digital activities and what not, so you never know what comes out of this" – Project manager.

The administrators did feel the cost of issuing the digital credentials is currently high for the institutions due to the time and effort required to integrate the platform with local learning management systems. The data included in digital credentials, such as learning outcomes and competences, already exist in all the institutions involved in our study. These data have been part of the curriculum for learners. Adding that information to the digital credential is easy but requires some effort according to the administrators.

Easy because the data exist but takes effort at the same time because the data exist in different learning management systems and need to be consolidated. Despite the high cost, all the administrators felt the need to issue digital credentials and recognized the value.

In our administrator data analysis, more themes started to emerge, providing additional insights on how digital credentials are useful for learners and what educational institutions can provide with the help of digital credentials. These themes included not only benefits for the existing or traditional learners but also create opportunities for lifelong learners.

Digital Credentials Make Unbundling Easier

The administrators felt that issuing digital credentials would also help them to offer smaller micro-credentials to all students, including "lifelong learners." Lifelong learner can be described as learners who have enrolled full-time in an educational institution or are interested in upskilling or reskilling for other reasons (e.g., career path, change of career). The administrators also stated that learners from one field might wish to take a smaller number of credentials from another field or possibly even another institution. The inclusion of metadata such as learning outcomes, skills and competences and possibly even levels associated with the skills added to the digital credential provides a clear and transparent picture of each micro-credential and makes it easier for institutions to accept transfers of credits. This would extend the value of micro-credentials to more diverse types of learners including wider geographical area.

Verification of Credentials

One of the core aspects of higher education institutions is the trust and security of the transcripts the learners receive. Micro-credentials offered by higher education institutions are expected to have the same trust and verifiability. Digital credentials issued by these institutions could be made more transparent by including not only the learning outcomes but also the assessment criteria, accreditation, and a strong verification method such as electronic seal or blockchain technology, thus increasing the trust. The administrators felt having the ability to verify the credentials issued by other institutions and authenticate the ones issued by their institutions is an important feature of digital credentials. This would benefit the learners, as the verification is faster than the traditional method. Currently, for admission and similar situations, learners either have to request the issuing institution to authenticate or send credentials directly to the institution they need to present. This requires time and effort for both the learner and the institution. Issuing digital credentials that have the authentication and verification built in would make the process easier and faster. As more educational institutions start issuing digital credentials, the admission process will become more streamlined.

The institutional and external factors we observed in the learner analysis that affect the adoption of digital credentials also emerged in our administrator data. The administrators also felt that not issuing a wider array of digital credentials and the lack of adoption by industry affect the utility value for learners and thus negatively affect the usage of digital credentials. Another external factor also emerged from the analysis of the administrator data. The administrators expressed that the adoption of digital credentials within their own countries would also affect how and when their institutions could issue and use such credentials. Some of the administrators shared that they also have national registries for students and credentials they issue, such as degree certificates and transcripts, and a major change like issuing digital credentials would depend on national program as well.

As with the learners, the administrators also believed that when the factors that negatively affect the usage of digital credentials are resolved, the value perception for learners will increase. Table 3 shows the analysis of administrators' data for the same themes as the learner analysis.

Discussion and Contributions

Our analysis based on EVT provided insights on the value perception of learners as well as on some of the enabling factors that could further increase the value perception. Figure 1 depicts the modified Hulleman model [44], including the enabling factors that would influence learners' value perceptions and intentions to continue using digital credentials. Our findings are consistent with prior research on the influence of ability beliefs on learners' use of digital credentials in future [29]. The learners' high confidence in their ability to use technology now and in the future indicates it will not be an obstructive factor in their adoption of digital credentials in future. Similarly, the data show that learners perceived the cost of digital credentials to be low compared to the value and so would influence positively on future adoption [7]. The learners recognized the value of digital credentials for their future activities, such as job searching, viewing their abilities and transfer credits [47, 58]. The modified model shows that when the expected success in using the digital credentials and value perception are high along with a low perceived cost, the adoption of digital credentials will be higher. This is a significant insight, especially for higher education institutions in their overall planning of micro-credentials and verifiable digital credentials. Our analysis highlight that the learners recognized the value of verifiable digital credentials and would like to receive a wider array of them. The enabling factors that our analysis found also

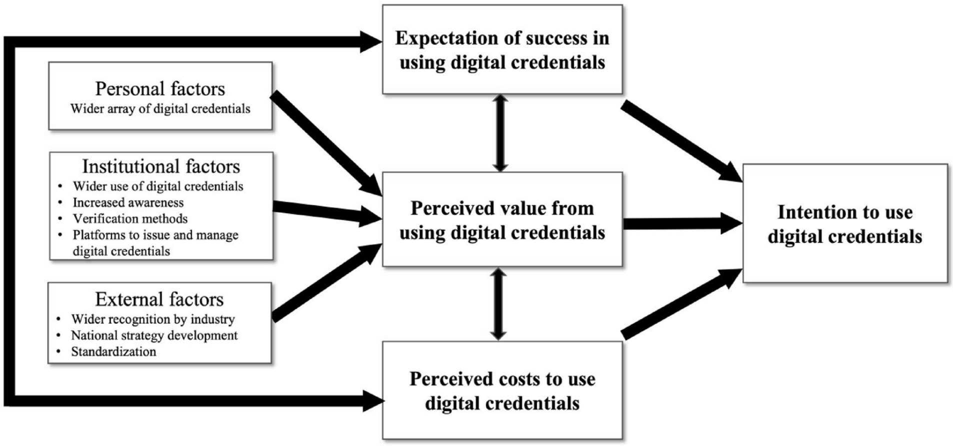

Fig. 1 Summary of the research findings on the enabling factors of digital credential value and use intention formation (modified from [44])

provide insights into the value perception of digital credentials. The interest in and importance of digital credentials will increase when learners receive more digital credentials allowing them to gain a more comprehensive view of their abilities and proof of their learning. *Our first theoretical contribution to the literature on verifiable digital credentials is improving the understanding of the relationship between different factors that influence learners' adoption of digital credentials*.

One of the major benefits learners perceived with digital credentials is that they can share information about their abilities with employers. This implies that recognition of digital credentials by industry will contribute to an increase in the value beliefs of learners. It is worth noting that while research on micro-credentials has shown that potential employers might not trust the credentials [47], this only applies to credentials such as digital badges, as they can be issued by any organization. We would like to highlight here that verifiable digital credentials are issued by higher education institutions and include the same or more information than paper transcripts. These transcripts are accepted by industry as a measure of quality. The learning outcomes and associated skill and competence data are developed in higher education institutions following pedagogical guidelines and quality frameworks. Hence, we argue that the inclusion of these metadata in digital credentials will increase their value beyond that of paper credentials and differentiate them from digital badges. One of the factors the administrators felt equally important is authentication and verifiability using methods like strong electronic seal or the blockchain. This would ensure that the data are not tampered with and can be easily verified. These features of digital credentials also differentiate them from digital badges. In addition, the evolution of standards around the world based on W3C Verifiable Credentials data model [22, 34], also confirm that the digital credentials differ from digital badges. *Our second theoretical contribution to the literature on digital credentials is demonstrating that verifiable digital credentials are different from digital badges*.

Our data and analysis demonstrate that digital credentials issued by higher education institutions provide value to learners. This is significant in at least three ways. (1) It confirms through empirical research what experts and exploratory research have shown regarding learners' positive view of micro-credentials [2, 40, 47]. (2) It also confirms the emerging definition of a micro-credential as a combination of a short learning offering with proof of learning, including the competences acquired [22, 32]. Learners participate in a particular learning offering knowing what content they will learn, but our data suggest that receiving a digital credential with descriptive and transparent data for that learning offering is also perceived as valuable by the learners. This is because, they could, at a later day, review what knowledge or skills they learnt in that learning offering. The administrators from higher education institutions also agree with this observation. This leads us to the third significant observation: (3) Learners would like to receive a wide array of digital credentials. From this, we can deduce that they would like to receive digital credentials with rich data, for example, data on learning outcomes and competence related data. Importantly, the administrators' data analysis revealed that such data might already exist for every learning offering in higher education institutions. By receiving the verifiable digital credentials for every learning offering, including micro-credentials, learners can build their portfolio of skills and competences. Further, we argue that by including digital credentials in more of their learning offerings, institutions would provide learners with more information on how and which skills they are accumulating and allow them to better showcase their abilities. This would also allow higher education institutions to plan and unbundle their offerings to create flexible learning paths for learners. *These findings make a significant theoretical contribution by adding to the empirical research on verifiable digital credentials and their value to learners*.

As a practical contribution, we believe our findings provide insights for higher education institutions regarding attaching verifiable digital credentials to credit-bearing short learning opportunities to properly develop micro-credentials. We also strongly suggest that higher education institutions consider different ways to attach skill- and competence-related information to digital credentials, as it would be highly appreciated by learners. Digital credentials could also be used for other types of learning offerings besides micro-credentials. We recommend exploring the options together with students. Although our study illustrates many learners' value perceptions, we recommend cocreating digital credentials together with learners in order to promote wider adoption of digital credentials, awareness of their value and further planning and development.

Based on our findings, we also believe there is a need for discussions between higher education institutions and industry in two equally important areas. (1) Discussions are needed to better understand the skills gap that industry is currently facing and anticipating in the near future. As part of that understanding, in order to prepare future employees for work, higher education institutions should work with industry more closely in designing micro-credentials, including the addition of real-life industry problems for learners to solve. This would enrich the short learning courses with real-life industry needs without sacrificing the high quality expected from higher education institutions. (2) Increase awareness in the industry regarding digital credentials and the rich data it can provide. This will enable employers to see the comprehensive abilities of potential employees, which go beyond a diploma or a transcript.

Research Limitations and Future Research

We acknowledge certain limitations of our study. First, we acknowledge that the data sample for the learner perspective is limited. This was because awareness of digital credentials is currently low among learners, which affected our ability to find participants. Similarly, the administrators we interviewed, although pioneers in the field of digital credentials, currently have limited experience in issuing digital credentials in practice. Second, due to the lack of empirical research on verifiable digital credentials, we relied on comparing our data with the literature on micro-credentials and digital badges. Third, verifiable digital credentials have multiple aspects, including the verification methods used [23, 32], but we focused on the data the digital credentials carry and the value that learners attribute to the data. The administrator data show that the authentication and verification are important enabling factors and should be examined in future research. Fourth, the learners as well as the administrators recruited for the study were all located in Europe and so limited in geography. Despite these limitations, we believe the results of this study to be highly relevant and valuable to both the research community and higher education institutions providing insights on digital credentials and value seen by the learners.

Based on our analysis, there are areas for further research. Broader empirical research is needed to further study the potential value of verifiable digital credentials both for learners and higher education institutions. In addition, research is needed on how digital credentials can be extended to other learning opportunities offered by higher education institutions. As the Micro-credential-area grows and more micro-credentials are issued, future research should emphasize surveys with larger number of learners. Not only learners from higher education institutions but also lifelong learners should be included to study how and what aspects of the micro-credentials are valued. Theoretical research on how verifiable digital credentials differ from other forms of recognition is also required to obtain a broader understanding of their value proposition. As our analysis pointed out, receiving a wider array of digital credentials is of interest to learners. This emphasizes the need to study the stackability of these credentials to allow learners to view the abilities and competences they have acquired. Finally, the findings reveal enabling factors that could increase learners' value perception of the digital credentials. Therefore, we encourage researchers to examine how institutions and external sources (e.g., councils) could increase the adoption of digital credentials by learners.

Funding Open access funding provided by Tampere University including Tampere University Hospital, Tampere University of Applied Sciences (TUNI). This research was co-funded by ECIU University project (612521-EPP-1–2019-1-NL-EPPKA2-EURUNIV), European Universities funding and MicroBlock-project (2020-FI-IA-0096), CEF-TC-2020–1–Blockchainfunding.

Data availability The data that support the findings of this study are available from the corresponding author and Tampere University, but restrictions apply to the availability of these data, which were used for the current study and so are not publicly available. The data are, however, available from the authors upon reasonable request.

Declarations

Conflict of interest All the authors received funding from European Commission grants through ECIU University project (612521-EPP-1–2019-1-NL-EPPKA2-EURUNIV), European Universities funding and MicroBlock-project (2020-FI-IA-0096), CEF-TC-2020–1–Blockchainfunding.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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PUBLICATION
III

How can European Blockchain Services Infrastructure be used for Managing Educational Digital Credentials?

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Proceedings of the 14th Scandinavian Conference on Information Systems. 7.
(SCIS- 2023)
ISBN: 978-952-64-9639-9
https://aisel.aisnet.org/scis2023/7

14th Scandinavian Conference on Information Systems

Scandinavian Conference on Information Systems

9-22-2023

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Research paper

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Abstract

Self-sovereign identity deals with the way individuals can manage their identity in the digital world. This is high in priority for European Blockchain Infrastructure (EBSI) that is leveraging blockchain technology and offers a decentralized solution that enables higher education institutions (HEI) to manage sensitive digital data that shouldn't be forged, such as digital credentials (e.g., diplomas and proofs of studying). This simplifies the way digital credentials can be issued and verified by HEIs while giving the ownership of them to the learner. However, there is an absence of empirical research using EBSI ecosystem for cross-border verification of digital credentials. To address this gap, we used design science research method and developed an artefact. A study between two HEIs was conducted, and the artefact was evaluated through qualitative analysis by interviewing 19 administrators from HEIs. As a contribution, our study identifies 14 considerations that might affect the implementation of such a system in practice. However, we conclude that institutional and national strategies towards digital credentials play a bigger role than technical considerations for implementation.

Keywords: digital credentials, higher education institutions, EBSI.

1 Introduction

Digitalization has had a significant impact on different sectors including education in recent years. Higher education institutions (HEI) are increasingly implementing digitalization of services that enhance learning and teaching such as remote communication tools (Grosseck et al., 2020) but also updating administrative processes with paperless documents, certificates such as diplomas issued to learners (Bacharach, et al., 2021; Lepiane et al., 2019). However, these digitization efforts have also brought out concerns on validation and verification of digitally issued credentials.

Prior literature and large international initiatives highlight interesting new ways to manage educational data (Digital Credentials Consortium, 2021; European Commission, 2020; RMIT, 2021). Self-sovereign identity (SSI) is proposed as a solution to give the users control over all of their data including identity (Allen, 2016; Pöhn et al., 2021; Tobin & Reed, 2016) and educational credentials such as diplomas (Queirugaa-Dios et al., 2022; Sedlmeir et al., 2021). European Blockchain Services Infrastructure (EBSI) is a large-scale initiative by the European commission which leverages the blockchain technology and enables institutions to issue verifiable credentials for various purposes including educational credentials such as diplomas and micro-credentials (EBSI, 2022). Learners can store these verifiable credentials in a digital wallet and have complete control over them as to who and when to share them (Sporny et al., 2019). The main value proposition of EBSI is to simplify the way digital credentials can be issued, managed, and verified by higher education institutions while giving the ownership of them to the learners.

The recent increase in the discussion around micro-credentials has also contributed to the need to issue different forms of digital credentials in higher education, such as diplomas, certificates, or badges (Ahmat et al., 2021; Oliver, 2019; Pirkkalainen et al., 2022). From HEI perspective, in this paper, digital credentials and verifiable credentials are used synonymously. The emphasis on micro-credentials and interest by learners of all ages including traditional students, lifelong learners (for upskilling and reskilling) to take micro-credentials makes it even more important for HEIs to have a system for cross-border verification and validation of digital credentials. Most of the research on digital credentials (including badges) has focused on how they are issued (Ghasia et al., 2019; Hickey & Chartrand, 2020) and used (Iwata et al., 2019). Very little research focuses on the ways how blockchain (e.g., EBSI) can support organizational processes within organizations or HEIs to manage digital credentials. Specifically, empirical studies are missing for evaluating EBSI for cross-border verification and validation of digital credentials. The objectives of this study are:

(1) To design and develop a blockchain-based solution as proof of concept for managing cross-border digital credential exchange.

(2) To evaluate the feasibility of implementing such solution(s) for higher education institutions' utilization

To address the above research objectives, we take a Design Science Research Methodology (DSRM) approach (Peffers et al., 2007; Hevner et al., 2004). DSRM (Peffers et al., 2007) is used to design EBSI-based IT artefact for managing digital credentials. The solution was evaluated with interviews with administrators of HEIs, development logs and EBSI literature. This study contributes to information systems (IS) literature with an improved understanding of blockchain infrastructure utilization, and in practice to educational technology community to build better services and solutions for HEI processes. The rest of the paper is organised as follows: In section 2, we cover research methodology followed by presenting the related work in section 3. In section 4, we describe the design and development of an artefact for issuing micro-credentials using EBSI framework. In section 5, we share the demonstration and evaluation of the artefact followed by discussion and conclusion in section 6.

2 Research methodology

We chose to follow DSRM approach (Peffers et al., 2007) for this case study. DSRM allows us to address unsolved problems in an innovative way leading to artefacts that can be evolved further (Hevner & Chatterjee, 2010). The artefacts could be a model, construct, or a better method (Baskerville et al., 2018). DSRM is also a way to question existing structures and processes, and not just the technical implementation (Pirkkalainen, 2015). The main DSRM phases (Peffers et al., 2007) start with (1) identifying the problem and motivation, (2) defining the objectives for developing a solution, (3) designing and developing, (4) demonstrating, (5) evaluating the solution. For this study, the design and development phases are carried out by developing an artefact and demonstrated through a case study between two HEIs in two different countries. For evaluation, we used, (a) semi-structured interviews with administrators, (b) development notes and logs of EBSI, and (c) literature in understanding if this proof-of-concept system can be scaled to production and used by the institutions.

Qualitative data collection and analysis:

19 individuals in administrative roles were interviewed from 11 universities to understand the feasibility of implementing such a cross-border digital credential scenario in practice. The two institutions who participated in this case study are also included in the interviews. Six women (31.5%) and 13 men (68.5%) were interviewed. The interviews were conducted between February and June of 2022 and lasted between 28 and 63 minutes, with an average of 52 minutes. The interviews were conducted remotely using Microsoft Teams and were recorded with the permission of the participants. The focus of the interviews was to understand if a system like the proof of concept built here can be used in their own institutions to issue digital credentials. The roles of administrators ranged from project managers to head of services in educational leadership in the institution. The administrators were aware of the micro-credentials, what is needed to be done at institutional level to use such a system as the artefact built.

All the interviews were transcribed. We chose to use interpretive study for our qualitative analysis (Sarker et al., 2018). Data were labelled, and similar answers were grouped together until patterns emerged. The emergent themes were then placed into two data-driven categories, technical and organizational considerations affecting the feasibility of EBSI implementation. During the entire process, we continuously reflected on the findings in the context of previous research.

3 Related work

Blockchain and EBSI

The use of blockchain based systems in the HEI context has gained increased attention recently due to its unique features such as decentralization, verifiability, and privacy (Vidal et al., 2019). Blockchain's distributed ledger characteristic provides a significant advantage for HEIs as it eliminates the need for a trusted third party to perform verification. Extant research highlighting blockchain solutions for higher education shows various benefits including transparency, increasing human resource effectiveness, extending the digital credentials to include short learning experiences such as micro-credentials and even facilitating student mobility (Raimundo & Rosario, 2021). The blockchain mechanism relies on several nodes that are linked in a peer-to-peer network of participating entities thus making it decentralized and harder to modify or forge documents. Anyone looking at the transactions would not be able to read any personally identifiable information thus protecting student privacy (Grech & Camilleri, 2017). Standards such as Blockcerts (MIT, 2016), and platforms such as EduCTX (Turkanović et al., 2018) were developed to issue and verify academic records with blockchain as the underlying technology. Digital credentials along with digital wallets provide learners with a secure and portable alternative to physical certificates. Blockchain technology promises to be a potential tool to achieve the SSI goal (Alexander et al., 2019; Grech & Camilleri, 2017) by creating a decentralized and distributed environment making the digital credentials immutable and portable.

Extant research on blockchain technologies in the HEI context has mainly focused on the technology's application areas and potential in general (Awaji et al., 2020; Grech & Camilleri, 2017). There is limited research available on constraints and issues with blockchain protocol level (Rossi et al., 2019) and on the barriers and challenges of using blockchain in higher education (Kamišalić et al., 2019; Park, 2021; Steiu, 2020). Even at the blockchain level, very limited research is available on aspects that affect its the adoption by HEIs (Li et al., 2022; Mohammad & Vargas, 2022) that covers technological barriers with a few environmental and organizational issues covered. There is a lack of research done on wider organizational concerns and aspects that will hinder such adoption.

EBSI is designed to deliver cross-border services deployed on a blockchain network with nodes distributed across the European Union. EBSI is an initiative from the European commission and at the heart of it is to implement SSI in Europe allowing users to create and own their identity and data across borders (EBSI, 2022). EBSI developed several frameworks to address different use cases including digital credentials for verification. These digital credentials can be used for different cross-border scenarios including education, social security, and identification. EBSI uses W3C Verifiable Credentials data model (W3C VC, 2022) for creating a set of tamper resistant claims with specific properties set for each claim (Laborde et al., 2020). For HEIs, solutions such as EBSI which offers the combination of digital credentials and blockchain can not only provide advantages such as trust and immutability, but also facilitate administrative processes in verifying the credentials (Kamišalić et al., 2019). Whether the verification needs to be done for the credentials issued by own institution or validate the credentials issued by other HEIs, EBSI ecosystem can help with its Issuers Trust Model and Decentralised Identifiers (DID) methods (EBSI, 2022).

A few pilot projects using EBSI for cross-border use cases have surfaced in recent years including issuing verifiable ID for citizens, issuing diplomas for university graduates and municipality credentials, all focusing on the importance of managing personal data and immutability. One such use case was for sharing health care data across the EU using EBSI (Bittens et al., 2021). Studies on EBSI have focused on proposing a reference model architecture (Turkanović & Podgorelec, 2020) and converting or extending existing digital credentials to be SSI compliant using EBSI (Buchanan et al., 2022; Herbke & Yildiz, 2022). Some of the research focuses on how EBSI can help students with skill certification (Azan et al., 2022) and student mobility (Strack et al., 2022). However, there is no empirical research done so far with EBSI system specifically for micro-credentials.

Therefore, this paper aims to address these gaps in research by uncovering the wider organisational issues as well as technological issues specific to EBSI and as an extension to blockchain technology that might affect adopting such a system on a wider scale. In addition, this paper will help academics, administrators, and policymakers interested in gaining knowledge about this technology as well as barriers that need to be overcome to promote its wider use.

4 Design

Developing a system with new technologies and integrating them with existing systems always encounters challenges both technical and organisational. The objective is to understand what it takes to build and adopt a system like EBSI to issue digital credentials. What standards such as data models are available to use and do they meet all the needs for issuing micro-credentials. What are the different criteria that might impact such adoption. Is it feasible for institutions to adopt systems such as artefact built on EBSI framework easily into production? Is it easy to integrate with existing systems and if not, what are the factors that might impact?

The main objective of this artefact is to understand how the information flow works in EBSI ecosystem and components that need to be developed for this interaction. Information flow occurs between all the three actors, (a) holder – who has a digital wallet to receive, accept and share digital credentials, (b) issuer – who can issue digital credentials and (c) verifier who can verify the digital credentials that holder presents.

4.1 Artefact development and demonstration

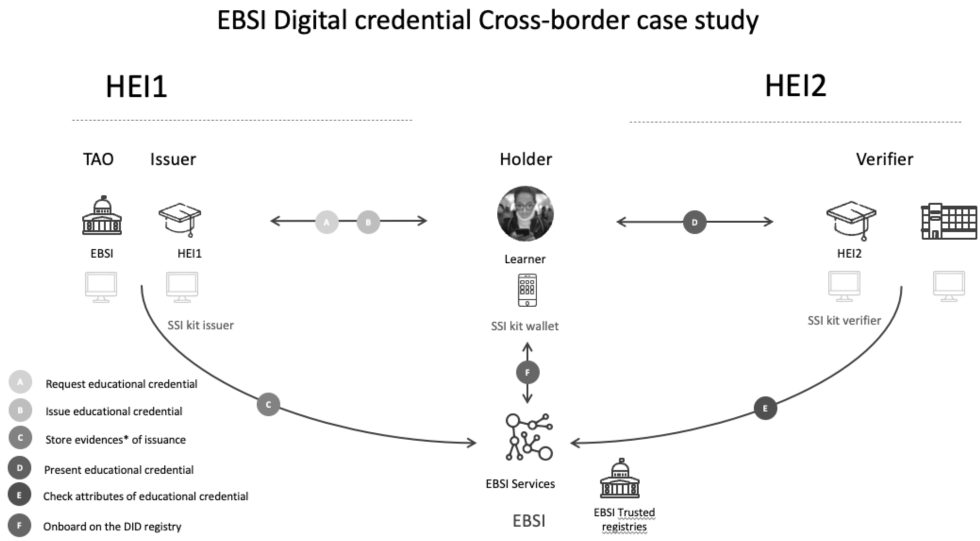

Figure 1 – EBSI information flow (credit: EBSI, 2022)

The artefact built revolves around the 3 actors with the roles of (1) holder, (2) issuer and (3) verifier (Figure 1). The system consists of a web wallet for the holder and two portals (issuer and verifier) for both institutions. In this artefact, issuer portals for both institutions could issue academic IDs and digital credentials. Verifier portal for both institutions could verify digital credentials issued by their own institution or by the other. In addition, the verifier portal for HEI2 could also verify academic IDs as required for the case study. Standard EBSI flows were used for communicating with the wallet for issuing verifiable digital credentials as well as for verification of presented credentials. The wallet as well as the portals were accessed through website.

An open-source solution provided by Walt.id, a company specializing in identity and trust in the web was used in development of this system. Development of issuer and verifier were done by both HEIs representing their own institution. The wallet for the holder was an unmodified version of the walt.id web wallet hosted by HEI1 although in practice, wallets are not hosted by institutions. Issuer and verifier portals for both institutions were based on the reference implementation by Walt.id. Issuer and verifier portals were combined into a single student portal by each institution and customized for their part in the case study. The web wallet and the student portals were all part of the walt.id Wallet Kit1.

The browser-based frontends of the components were implemented with the Nuxt web application framework, which in turn was based on the Vue web user interface framework. These frontend applications then use a server-side backend via a RESTful HTTP API. For simplicity Walt.id implemented all the backend functionality needed by the frontend components into a single server application called Walt.id wallet backend. It was implemented using the Kotlin programming language in the Javalin web application framework.

EBSI and verifiable credential related functionality in the backend, Walt.id SSI Kit2 was used including creating, issuing, storing and verifying digital credentials. It was also used to handle the storage and use of cryptographic keys and communication with the EBSI services such as the DID registry. Although it was a software library, it could be used via command line or as a web service.

Adapting the Walt.id demo portals to our case study required changes to both frontend and backend software. Once the issuer and verifier frontends were combined into a single application, modifications were made to simulate a real student management system and the workflow was adjusted as required for the case study. In the case of HEI2, the workflow was more complex as it involved additional steps of (1) to verify the academic ID issued by HEI1 and (2) to verify the micro-credential submitted by the learner as a prerequisite and (3) to simulate the learner registering to a course. Modifications required at the backend included listing the correct available credentials, creating the appropriate credentials, and verifying the credentials including checking for proper accreditation of the issuer from the EBSI trusted issuers registry. For issuing the digital credential, HEI1 modified the backend to automatically convert the Excel file containing European Digital Credential (EDC) into EBSI compliant verifiable credential as both use the same W3C verifiable credentials data model. While developing the artefact, code contributions were made to the Walt.id open-source wallet and the SSI Kit verifiable credentials library to add proper support for the EBSI verifiable diploma schema used in our micro-credentials.

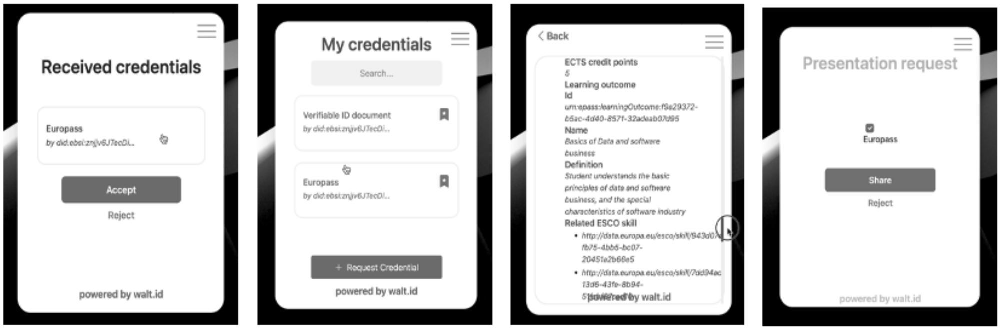

Figure 2 – Wallet views – receive credential, list of credentials, details of credentials and sharing a credentials

Figure 2 shows wallet user interface (UI) for four significant steps. First, when the learner received the credentials and given the option to either accept or reject it. The second one shows the list of all the digital credentials learner requested and received including academic IDs. The next one shows rich metadata included into the digital credential showcasing specific use of the system for micro-credentials. And the last one is when any of the digital credentials are shared from the wallet using the presentation UI.

4.2 Demonstration - Case study with two universities

The case study is done to demonstrate a cross-border scenario between two HEIs in two different countries. Learner is a fictional student in a PhD program at HEI1. Learner manages her digital identity by creating a wallet through EBSI compliant agent. Through the wallet, she can request for credentials, receive, accept or reject them, view and share the credentials.

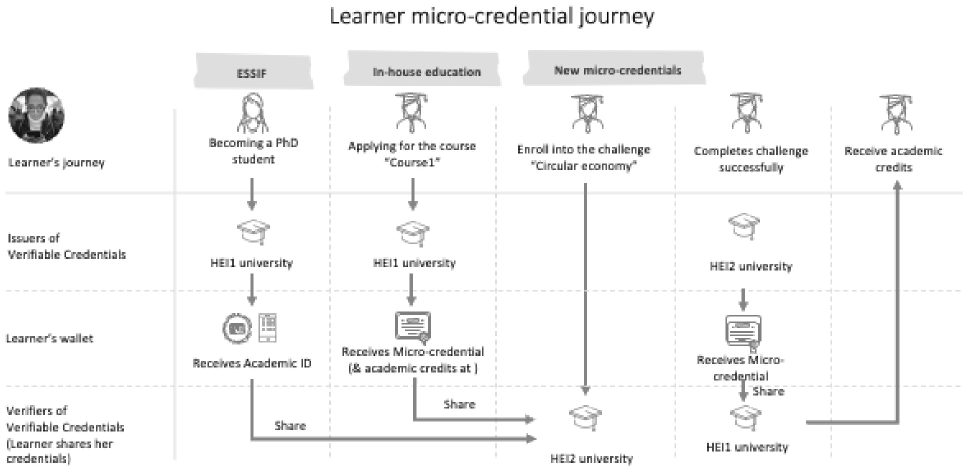

Figure 6 – Learner micro-credential journey (credit: EBSI, 2022)

The case study represents a cross-border scenario with another institution in a different country. The flow of information in this case study includes (Figure 6)

(1) Learner requests and receives her academic id from her institution, HEI1.
(2) Learner views and accepts academic id into her EBSI complaint digital wallet.
(3) Learner registers for a micro-credential "Course1" from her own institution and receives a digital credential upon successful completion.
(4) Learner receives and accepts the digital credential from her institution for the above micro-credential.
(5) Learner finds an interesting micro-credential "circular economy" at institution HEI2 in a different country.
(6) Learner shares her academic ID with HEI2 to prove her identification.
(7) Learner shares her "Course 1" digital credential with HEI2 institution to fulfil prerequisite for the "circular economy".
(8) Upon successfully completing the micro-credential, she requests and receives a digital credential from HEI2 institution.
(9) Learner views the digital credential in her digital wallet and accepts it.
(10) Learner then shares this new digital credential with her own institution (HEI1) to get academic credit.

5 Evaluation

During the development of artefact and all through the case study, continuous evaluation was done with (1) literature available on the technologies, and semi-structured interviews with administrators in the higher education institutions. The evaluation was done to understand the feasibility of building such a system into production from both technical and organizational points of view. The summary of it is that technically, it is possible but still need the technology to mature and cover some key issues such as all aspects of GDPR. Organizationally, the integration to daily processes of an entire institution is less likely especially in the short term. The findings show several impact criteria due to current technology, the current status of micro-credential adoption as well as other organisational aspects. These are summarised in Table 1 and discussed below.

Table 1 - Considerations for feasibility of implementing the system in practice.

Category	Considera-tion	Description	Source	Severity for im-plemen-tation	Explanation
Technical	EBSI node strategy	Members of the European Blockchain Partnership (EBP) have to commit support including creating and operating an EBSI node following the guidelines for GDPR compliance.	ESSIF documentation (Du Seuil, 2019), literature (Buchanan et al., 2022)	High	This becomes a national strategic decision of each country as the EBSI node is operated at national level.
Technical	GDPR compliance	GDPR compliance includes not storing personal data and have right to cancellation of one's own personal data.	EBSI documentation (EBSI, 2022), literature reviews (Mecozzi et al., 2022; Poelman and Iqbal, 2021)	High	Data stored such as personal information can be made GDPR compliant by following a set of procedures. Currently, some rights such as the "right to be forgotten" are not possible with the underlying blockchain technology.
Technical	Accreditation to be an issuer of verifiable credentials	Each HEI needs to be in EBSI trusted issuers registry and their entry there should contain the accreditation VC the (trusted accreditation organisation) TAO issued. TAO can be their national entity such as the ministry of education or EQAR if that entity is registered in DEQAR already.	EBSI and EQAR documentation (EBSI, 2022), artefact	Medium	Not all institutions or the national entities that can act as TAO in each country are part of EQAR and might depend on national strategy and interest in setting this up.
Technical	Using W3C Verifiable Credentials standard	Data model used for a set of claims and properties of each claim in a verifiable credential	W3C documentation (W3C, 2022) and administrator interviews	Medium	If there is a project at national level underway, it requires national strategic decision and work towards interoperability with EBSI.
Technical	Digital Wallet choice for learners	Learners need to have a digital wallet to request, manage, share their credentials	EBSI documentation (EBSI, 2022), literature review (Jørgensen and Beck, 2022), artefact and case study	Low	The concept of universal wallets and interoperability is ongoing. Standardization of data model (W3C VC) and blockchain frameworks will help lead to wallets interoperable irrespective of underlying architecture
Technical	Verification and validation including eSealing	Verify if the digital credential issued is valid both for information and for issuer	EBSI (EBSI, 2022), artefact and case study	Low	EBSI framework makes it easy to verify the issuer, and blockchain technology assures the immutability of the credential. If cross-border issuing requires, adding eSeal is easy, as the data model has the capability.

Category	Considera-tion	Description	Source	Severity for im-plemen-tation	Explanation
Technical	Request for credential by learners every time they complete a mi-cro-credential	With SSI, control over data lies with the learner, so the request needs to be initiated by the learner	EBSI (EBSI, 2022), SSI docu-mentation (Du Seuil, 2019), and artefact	Low	If the system is integrated with student management systems, automatic issuing of digital credentials when learner requests doesn't add a lot of extra overhead
Organiza-tional	Integration with student management systems – **In-stitutional strategy**	Issuing digital creden-tials as the default pro-cess in the institution	Administrator in-terviews	High	Unless institutions make the strategic decision to is-sue digital credentials for all the learner credentials, integration with student management systems might not be realized.
Organiza-tional	National adoption of micro-creden-tials	National level strategy on micro-credentials and align digital credentials with national qualifica-tion systems	Administrator in-terviews, literature review (Pirk-kalainen et al., 2022)	High	Without a nationwide strategy and support, wider implementation is not possible and will stop at the piloting and experi-menting stage.
Organiza-tional	Integration with student management systems – **into IT pipeline**	Getting the integration effort into the pipeline	Administrator in-terviews	High	Integration effort such as this can be a large endeav-our. Getting such a project into the IT pipeline with other high impact projects already in line is harder.
Organiza-tional	Where the dig-ital credentials are issued from	Issued centrally from in-dividual institution or nationwide system	Administrator in-terviews	High	This goes hand in hand with nationwide strategy and what policy and im-plementation that strategy defines. A nationwide sys-tem to issue any digital credentials centrally is be-ing considered at least in some countries.
Organiza-tional	Integration with student management systems – **amount of work**	Amount of effort needed to integrate with all the student management systems	Administrator in-terviews	Medium	Even though the amount of effort needed is high, the factors mentioned above are higher in sever-ity whether this system will be implemented full scale.
Organiza-tional	Interoperabil-ity with other platforms in use	Some of the institutions already adopted badging systems	Administrator in-terviews	Medium	Either the current badging systems need to be in-teroperable with EBSI system using same data model or live with two separate systems.
Organiza-tional	Choosing a commercial solution or us-ing open-source and de-velop all the individual components	Using open source gives flexibility in customiz-ing the solution, while commercial products give ready to use solu-tion	Artefact, EBSI documentation (EBSI, 2022) and administrator in-terviews	Medium	The decision to use open source of a commercial product depends on insti-tution and national strate-gies, financial and tech-nical capabilities and availability

Technical considerations:

EBSI technology is still evolving and building awareness within Europe. For the blockchain technology decentralization aspect to work effectively, multiple nodes need to be in operation possibly in every country that would consider using EBSI framework. From our administrative interviews, it looks like the solution for it depends on each country's strategic decision of using blockchain for higher education and other purposes. Since Decentralised Identifiers (DIDs) are considered as personal information in Europe, saving DIDs is considered to not comply with GDPR. Solving GDPR in blockchain is an ongoing discussion and some of the aspects are resolved yet some of the aspects such as the "right to be forgotten" still needs consideration. The new version of DID from EBSI for natural persons (EBSI DID, 2022; Gataca, 2022) is aimed at resolving these GDPR issues might have other unintended effects such as recovering from losing one's private key. With the new DID version, if learners lose their private key, they will have to request all their verified credentials again as the VCs are tied to the DID when issued.

From technical point of view, we used EQAR as a trusted accredited organization (TAO) since our ministry of education is already a registered member there, but it is also possible to use the ministry of education itself or another national entity as a TAO. Building TAO registry becomes a key aspect in building trust between institutions especially for cross-border use. Using the W3C VC data model, which is a world-wide standard, helps especially with interoperability at international level but might also add additional work in every nation that hasn't adopted that data model already. As digital credentials continue to gain momentum, interoperability of wallets using different frameworks might surface, but might not affect the choice of framework to use by institutions. Although this might not affect the institutional decision to use the system in issuing the digital credentials, the fact that learners have to request each and every credential might become cumbersome for the learners in the long term. Especially as HEIs start offering more micro-credentials, this might be a contention point for learners.

Organizational considerations:

From the organizational point of view, the strategic choice of implementing DCs throughout the institution was found most critical. According to the administrators, most of the organizational factors to consider (Table 1) for wider scale implementation depend on this strategic choice. This includes integration with local student management systems to access data to issue digital credentials. Our interview data shows that there are nation-wide discussions especially regarding micro-credentials happening at the moment and institutions at individual level might be waiting for a nation-wide strategy to evolve before implementing these solutions. Our findings show that some countries already use nation-wide systems for student and learning management. Moreover, some of the countries are currently working on a national strategy to integrate student and learning management systems for all institutions within the country into a central system. These suggest that implementing the system to issue digital credentials at institutional level might not be feasible and depend on the national strategy, and timeline and so we gave the impact severity high.

"*we are getting ready for cross -institutional studies in XX national service, and we are now starting to adopt it. The universities IT systems are quite soon at the level where they will have automatic processes set up. When a degree student takes some courses in other universities and comes back, they will have the credits already to their home university automatically….. Now that we are developing ways to transfer this data to multiple services, there is a good chance we can also make integration for European systems at national level. Each university doesn't have to do it by themselves as we gather all the data into one place nationally, we can make one integration*" – Senior specialist, educational services.

Our findings also suggest that depending on the maturity of micro-credential adoption within the nation, institutions will end up issuing paper certificates along with digital credentials if implemented today, which would duplicate the work. Since issuing credentials in two ways (current method and digital credentials) might be a short term till more institutions adopt and accept, we considered this factor severity to be medium.

"*Probably in many universities, they ask for paper, with a stamp and manual signature. Probably in some of them they might be accepted, but most of them not yet. Right now, even our university doesn't accept them*" – Project manager for DC and admissions officer.

One of the administrators commented that currently any development effort to integrate with student management system might not even be possible due to other high priority projects underway. Since integration to local student management and/or curriculum management systems is already identified as a major development work, any major projects already in the pipeline might need to be factored in for consideration of such integration.

"*there is a big development going on in the student management system regarding accessibility. There is a big rework being done currently to meet regulations for that feature and perhaps take large part of development resources this year and follows to next year as well. Even if some feature is relatively small, but it doesn't fit into the development roadmap*". – Senior specialist, educational leadership.

Once these strategic decisions are done, consideration needs to be given to whether to use open source technology and custom develop the implementation or go with a commercial solution which reduces development time. The effort required to integrate the solution remains mostly the same, irrespective of the solution being open source or commercial. Our findings from interviews suggest that institutions are currently testing multiple options including alternatives to EBSI as well as commercial solutions before deciding.

6 Discussion and conclusion

The purpose of this study was to evaluate the artefact built on EBSI ecosystem to explore the factors that will hinder the feasibility of implementing it in practice. A total of 14 considerations were uncovered, divided into two categories, technical and organizational. In the technical category, two of them are high in severity, while 4 of the organizational factors can have high severity in realizing such a system in practice. Our findings on considerations augment the literature on institutional perspective. Our study adds to the understanding of the drivers that might affect the implementation of such systems on a wider scale.

6.1 Theoretical contributions

Our first key contribution is the empirical validation of EBSI use for managing educational digital credentials, and is specifically for EBSI literature. Our artefact and case study demonstrates that implementing such a system is feasible technically, provided the factors uncovered by our findings are addressed. Some of the technical factors such as need for EBSI node, and GDPR compliance support the previous studies (Mecozzi et al., 2022; Van Eecke & Hale, 2018). However, our findings extend the current literature showing the impact of these factors goes beyond the technology or the institution itself. For example, the need for an EBSI node at a national level is not an institution's decision or capability but rather a national strategy and commitment to create, operate and manage such a node. This is a significant insight, not only for higher education institutions but also for national agencies whose commitment is needed to realize these solutions and EBSI to realize the wider commitment needed from a country for individual institutions to implement such a solution. The empirical validation also contributes the design knowledge (Baskerville et al., 2018) of EBSI implementations.

This is our second key contribution to IS literature on institutional strategies in implementing a digital credentialing system such as EBSI. Current studies (Chakroun & Keevy, 2018; Selvaratnam & Sankey, 2021) confirm with our findings that there is a need for a strategy at national level and even global level. Most of the institutions and countries are currently piloting or issuing digital credentials at a much smaller scale or as part of a consortium (Turkanović et al., 2018; EBSI, 2022) without full scale integration into their student and learning management systems. There is a consensus among the administrators interviewed for this study regarding the effect of institutional and even national strategy in considering implementation of such a system in practice. And they are interlinked with each other. Institutional strategy often goes hand in hand with national strategy and policies. If the national strategy is to issue digital credentials from one central system, or use a particular platform, all the institutions follow suit. Our findings suggest institutions are currently awaiting to understand their national strategies before undertaking such implementations.

Our third key contribution to IS literature comes from identifying the adoption related factors for implementing EBSI solutions in higher education. Similar to studies on blockchain (Mohammad & Vargas, 2022; Park, 2021), complexity of integration was considered as a major factor by the administrators. However, our findings suggest it goes beyond just the technical aspects of integration itself. In some cases, the IT pipeline might already have major impact projects lined up for the short-term and adding one more major project such as integration and implementation of this system can be unrealistic. Adding to that, if the institutions already implemented any digital credentialing system such as badging systems, interoperability between both the systems also needs to be taken into consideration.

6.2 Practical contributions

This study makes several practical contributions that will be discussed separately for different audiences.

Higher Education Institutions:

Our findings focused on how higher education institutions can take a proof of concept into realization. From our study, HEIs can understand the factors that will affect such an undertaking and focus on the aspects that need their attention the most. For example, paying attention to the national and international scene on micro-credentials and digital credentials to understand and align the interests. HEIs who are interested in using EBSI system can also initiate/participate in discussions at national level as it requires effort and co-operation at that level, such as creating and operating an EBSI node. By understanding the different organizational considerations to integrate such a system into local student management systems, HEIs can prepare and succeed.

EBSI developers and community:

Although the artefact is developed using EBSI ecosystem, evaluation was done from the perspective of realizing it in practice by HEIs. By understanding the different factors that are in the play, EBSI can help mitigate some of the technical barriers and provide guidance and support to HEIs. By realizing that for any individual institution to realize such a system might depend on a national strategy and policy, EBSI and EU policymakers can help individual countries to understand and provide support. EBSI can help educate the importance of using standard protocols such as W3C VC and blockchain framework to product developers, thus helping to integrate those products into EBSI implementation easier.

CIS/LMS developers:

From our study, one of the key aspects that might hinder the feasibility of such a system is integration with institution's local student/learning management systems. By understanding these factors, management systems and student information systems developers can investigate the possibility of providing interfaces to integrate these systems. They can even consider implementing some of the features required to issue digital credentials built in, making it easier to integrate the systems.

6.3 Limitations and Future research

There are some limitations with our present study. One of the limitations is that the EBSI artefact couldn't be implemented with real user data. Although the proof-of-concept allowed us to evaluate the feasibility of the solution, upcoming studies should explore production-versions of EBSI with real student data. In addition, not all administrators who participated in the interviews have been exposed to EBSI. However, each administrator comes from an institution who are also investigating into the possibility of issuing digital credentials. This is why they fit the study well. We also believe that in addition to technical studies, investigation of strategies and policies on digital credentials at national level is crucial for cross-border use. In addition, the artefact focus was on issuing digital credentials for short learning experiences, i.e., micro-credentials and not for any other credentials such as diplomas or student IDs which might also uncover other factors. We recommend further studies expanding the artefact to include other types of digital credentials that HEIs can issue to get a broader understanding.

6.4 Conclusion

The purpose of our study was to design and develop an artefact using EBSI ecosystem and evaluate the feasibility of implementing it. With the help of administrators from higher education, several considerations that might affect the feasibility were uncovered. The findings indicated that the institutional as well as national strategy plays a big role in realizing such a system into production. These include micro-credential adoption at national level, institutional strategy on issuing digital credentials on a bigger scale. We believe our analysis can enable discussions at institutional and national level on digital credentials, as some of the features of implementation require national level support and commitment.

Acknowledgements

This research was co-funded by ECIU University project (612521-EPP-1-2019-1-NL-EPPKA2-EU-RUNIV), European Universities funding and MicroBlock-project (2020-FI-IA-0096), CEF-TC-2020-1–Blockchain-funding.

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PUBLICATION
IV

Exploring Centralized, Decentralized, and Hybrid Approaches to Micro-Credential Issuance in HEI Alliances

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In Proceedings of the 16th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K 2024)- Volume 3: KMIS, pages 238-245
ISBN: 978-989-758-716-0; ISSN: 2184-3228
http://doi.org/ 10.5220/0012946700003838

Exploring Centralized, Decentralized, and Hybrid Approaches to Micro-Credential Issuance in HEI Alliances

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Keywords: Micro-Credentials, Digital Credentials, MC Governance, Knowledge Management, Data Governance.

Abstract: Micro-Credentials (MCs) are seen as a way by Higher Education Institutions (HEIs) to equip learners with the essential skills for their careers or professional development. In Europe, HEIs are joining forces to form alliances to offer a broad range of MCs and make them tamper-proof, verifiable, and shareable. Although extensive research is being done on MCs, there is a major research gap in identifying and comparing different ways alliances can manage issuance of MCs. We identified two approaches in practice and through a case study, identified a third approach alliances can utilize. This paper also addresses this gap by using the data governance contingency model to provide a comparison of all three approaches that alliances can utilize in selecting the most suitable one for their business strategy. To achieve this, a qualitative case study is conducted with in-depth interviews with administrators from HEIs that are partners of an alliance. This study contributes to the governance of MCs through identification and comparison of the three approaches - centralized, decentralized, and hybrid in the context of MC issuance by HEI alliances.

1 INTRODUCTION

In recent years, interest in micro-credentials (MCs) has been on the rise for multiple stakeholders, including higher education institutions (HEIs). Multiple alliances have formed in Europe, consisting of HEIs and other institutions to pilot MCs at different levels (ECIU, 2023; ENHANCE 2022; Una Europa, 2022). MC governance depends on management of data, processes and technology within an alliance (Doering et al., 2022). Current research focuses mostly on the implementation (Abdullah & Ghazali, 2024), security and recognition (McGreal, 2024; Saad et al., 2024), and affordances (Reed et al., 2024) of MCs but discussion on issuing MCs is limited to technology used such as blockchain (EBSI, 2022; Kiiskilä et al., 2023) and platforms (Saad et al., 2024). Two approaches, as referred in this study as hybrid and decentralized, can be found from practical examples (ENHANCE, 2022; SDG Campus, 2024; Una Europa, 2022) for MC governance by alliances. In the hybrid approach, one or more partners in the alliance issue on behalf of all partners and in decentralized, each partner issue on their own. However, empirical studies evaluating different approaches for MC governance in alliances including how to issue MCs that satisfy the MC recommendations are missing.

Issuing MCs require knowledge of data such as student data, MC data, institutional data and processes to use specific technologies such as EDCL platform. Through knowledge management, alliances can develop the required processes to offer and issue MCs that might not be possible as individual institutions (Jiang and Li, 2009). The complexities of HEI alliances, combined with the need to use platforms and the data residing in multiple systems in multiple HEIs need to be taken into consideration for MC governance. MC governance in an alliance can also depend on the scope of the alliance (Oxley and Sampson, 2004).

Traditional data governance involves structured data managed locally (Al-Ruithe, 2018) and presume that the same model can fit any organization (Weber et al., 2009). While research on using contingency factors to find the right data governance approach is available (Chelliah et al., 2016; Lee et al., 2017), empirical studies evaluating contingency factors

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relevant to alliances issuing MCs is missing. Moreover, current studies do not address how these contingency factors can be used in choosing the right approach for MC governance in an alliance setting. To address these research gaps, the following two questions are studied:

RQ1: *What are the different approaches alliances can issue MCs to their students?*

RQ2: *Based on the data governance contingency factors, how do different approaches compare for an alliance to issue MCs?*

Through the qualitative case study, we present a new centralized approach that is currently not utilized in the issuance of MCs by alliances. Taking inspiration from Weber et al.'s (2009) contingency model, the factors for the governance of MCs are identified and used for comparison of all three approaches in issuing MCs by alliances. Because issuing MCs, especially by alliances, is a rapidly growing practice-based area with limited theoretical understanding, we chose qualitative approach to gain a deeper understanding of this important area for HEIs.

The present paper contributes to MC literature by identifying a third approach that alliances can use and also to compare the three approaches for issuing MCs by alliances using data governance contingency factors. As a practical contribution, this can help HEI alliances understand the pros and cons of the three approaches to issuing MCs using the data governance contingency model. The rest of the current paper is organized as follows: Section 2 provides a theoretical background related to MCs and data governance models. Section 3 presents the data collection and analysis, which is followed by the findings in section 4. Section 5 covers the discussion and conclusion.

2 BACKGROUND

2.1 Micro-Credentials

After an extensive effort that was coordinated by the European Commission, MCs have been defined as *"the record of the learning outcomes that a learner has ac-quired following a small volume of learning*" (European Commission, 2022). Along with these efforts, the frameworks, and related technologies of MCs (DCC, 2023; Digivisio, 2023; MicroHE, 2021) started developing, and the metadata that they should contain have been described (European Commission, 2022). Within the context of HEIs, most of the literature focuses on the content, importance, and implementation of the MCs (Flynn et al., 2023; Oliver, 2019). Although some studies have explained the features needed in MC platforms, (Kiiskilä et al., 2022), and new technologies are emerging to facilitate some of those features such as tamper-proofing and verifiability (EBSI, 2022; EDCL, 2022), there is a limited understanding of how they can be used in an alliance setting for MC governance.

Most of the literature is focused on what type of MCs are offered by the alliances (Shanahan and Organ, 2022), why alliances offering them benefit learners and HEIs (Romiță et al., 2021) and recognition of MCs (Ashizawa et al., 2024). From knowledge management perspective, literature also covers how alliances can be a differentiating factor in offering unique products such as MCs (Parise and Sasson, 2002), how alliances can leverage strength from the partners to create new opportunities (Inkpen, 1998) and governance adaptation at alliance level (Reuer and Zollo, 2000). Literature on how alliances can issue MCs and their strategy for MC governance is, however, limited to a few practical examples (Una Europa, 2022; ENHANCE, 2022). There are two approaches that can be seen in these practical examples for alliances to issue MCs.

(a) Hybrid approach: One or more of the alliance partners issue MCs on behalf of all the partners. This requires one or more of the partners to develop a system internally to issue MCs for all the partners (Una Europa, 2022). It includes a system in place for alliance partners to offer the MCs in a mutually agreed platform or their own internal platform (SDG Campus, 2024) and clear path for students how to apply for the MC (credential portion) when they successfully complete it.

(b) Decentralized approach: Each partner issues their MCs. In the decentralized approach, the MCs might be offered through the alliance, but each partner need to develop the MC issuance system internally or use commercial systems such as BC Diploma (BCDiploma, 2023). The decentralized approach is similar to existing practices in HEIs in issuing study records to students coming to their institution to study a single course or a fixed amount of time for mobility (Cuzzocrea and Krzaklewska, 2023). While in normal mobility programs, regular study records are issued to students from other HEIs, for MCs partners need to either enhance their existing systems or partner with external systems to issue MCs.

In both cases, issuing MCs should include the requirements such as making them tamper-proof, for example, by using an electronic seal to sign the credentials (eSealing). Depending on a variety of reasons such as institutional or national strategy for MCs, institutional bandwidth to enhance existing systems or partner with external systems (Kiiskilä et al., 2023), these options might not work for all alliances.

2.2 Data Governance

Data governance can be described as a framework of policies, processes, and guidelines for managing data as a strategic enterprise asset (Abraham et al., 2019). It specifies rights and accountabilities for an organization's decision-making about its data (Khatri & Brown, 2010). Different frameworks have been proposed with a focus on traditional IT assets (Weill and Ross, 2004), and domains relevant to data (Khatri and Brown, 2010; Otto, 2011).

Possible data governance approaches include centralized, decentralized and hybrid (Asgarinia et al., 2023; Colona & Jaffe, 2016; Xie et al., 2024). Although most of the data governance models presume the same model can fit any organization, Weber et.al. (2009) proposed a model that takes contingency factors into account for data governance. By using these contingency factors, organizations can determine the right data governance approach (Otto, 2011). The data governance model for any organization depends on the external and internal organizational factors that determine the organizational context related to data governance (Otto, 2011). According to the Weber's contingency model (Weber et al., 2009), a specific data governance configuration needs to be designed so that it fits the organization's context factors. It consists of two distinct parameters (a) organizational placement of data quality management (DQM) activities and (b) coordination of decision making for DQM.

However, the factors proposed by Weber do not consider external contexts such as platforms used by organizations. For institutions and alliances to issue MCs, platform(s) are a key component and so the governance factors related to platforms should also be considered. Lee et al. platform governance model (Lee et al., 2018) is an extension to the Weber model that includes factors specific to organizations using platforms. For this case study, we adapted Weber's contingency factors and two of the factors from the platform governance model namely, Open strategy and Platform maturity that contribute to the MC governance. For alliances offering and issuing MCs, open strategy can open the platform for multiple use cases and platform maturity ensures strict data governance.

3 DATA COLLECTION AND ANALYSIS

A case study was conducted with an alliance of multiple HEIs offering MCs to students of the alliance partners. At the time of data collection, there were 12 HEIs in the alliance from 12 different countries throughout Europe. All the partners were already offering courses through the alliance and issued a certificate of completion, along with the required academic transcripts to the students.

Multiple sources have been used for data collection, here following the recommendations of Yin (Yin, 2009). These include internal documents, project documents, white papers, and external documents such as platform documentation. However, data from the interviews are the major source. 19 individuals in administrative roles were interviewed. The interviews lasted between 28 and 63 minutes, with an average of 52 minutes. The interviews were conducted remotely using Microsoft Teams and were recorded with the permission of the participants. Furthermore, all the institutions participated in an early adopter program with EDCL.

All the interviews were transcribed. The research approach can be considered as an interpretive case study (Elliott & Timulak, 2005). In the present study, the three coding procedures proposed by Strauss and Corbin (1990) were used: open, axial, and selective coding. NVivo software was used to identify concepts from the interview transcripts. The incident(s), action(s), or event(s) from the raw data were given conceptual labels (Strauss & Corbin, 1990). Then the identified concepts were compared with the emerging theories and the most relevant and acceptable concepts were categorized. These categories were further developed into subcategories, ensuring the existence of linkage between them.

The two approaches, named in the present study as hybrid and decentralized, were derived from the practical examples as mentioned in section 2, and the third approach is derived from the empirical analysis. The contingency factors were used as influencing factors in providing the comparison of all three approaches for MC governance.

4 FINDINGS AND ANALYSIS

4.1 Approaches for Credential Governance

As described in section 2, the issuance of MCs can happen in two ways for alliances. (a) Hybrid approach, where one or more of the alliance partners issue MCs on behalf of all the partners or each partner issues their MCs. (b) Decentralized approach which requires all the partners to build the capability to issue MCs. *In our case study, during the EDCL early adopter program and our interviews it became evident that no one institution from the alliance would like to take the responsibility to issue for other institutions nor have the capability to issue MCs.*

It became clear that neither hybrid nor decentralized approaches would work for this alliance. This resulted in the need to identify a different approach to offer and issue MCs for alliances such as the one in the present study. Based on the empirical analysis, a third approach is identified:

(c) Centralized approach: The alliance seals and issues the MCs on behalf of the partners.

The centralized approach requires the alliance to have a central platform to offer and issue the MCs. This platform becomes the central management and governance entity for all the MCs offered by the alliance. The central platform becomes the repository of all the MCs offered by the partners, ensuring all the information required to issue a MC is captured. This approach requires the central platform to provide a way for the partners to indicate when students complete the requirements to issue the MCs. The central platform also needs to have a mechanism to re-issue the same MCs if the need arises in the future.

4.2 Contingency Factors for the Governance of Credentials

4.2.1 Comparison of approaches

To understand and evaluate the best approach for the governance of MCs by alliances, the contingency model was applied. As discussed in section 3, the contingency factors include both organizational as well as platform context factors. Table 1 shows the comprehensive contingency factors and the comparison of all three approaches.

Certain contingency factors such as the degree of market regulation stay the same for all three approaches because, irrespective of how the MCs are issued, all the data regulation policies need to be followed. The centralized approach provides an open strategy because the platform is specifically designed to offer and issue MCs and customizing to a different market is easier. Similarly, it is easier to expand the portfolio of MCs offered in the centralized approach because it is a cumulative effort of all partners. The quality of the portfolio can be higher in both hybrid and centralized approaches because interoperability and uniformity are inherent.

Table 1: Contingency factors and comparison of the three approaches for MC governance

Contingency factor	Hybrid (A)	Decentralized (B)	Centralized (C)
Performance strategy *(High<->Low)* *Quality* *Growth*	High Low	Low Low	High High
Diversification breadth *(High<->Low)* Portfolio/Market	Low	Medium	High
Organizational structure *(Centralized<->Decentralized)*	Centralized	Decentralized	Centralized
Competitive strategy *Branding (High<->Low)*	High	Low	High
Process harmonization *(Global<->Local)*	Semi-global	Local	Global
Degree of market regulation *(High<->Low)*	High	High	High
Decision making style *(Hierarchical<->Co-operative)*	Hierarchical	Segmented	Co-operative
Platform maturity *(Robust<->Scalable)*	Robust	Scalable	Robust & scalable
Open strategy *(Open<->Closed)*	Closed	Closed	Open

4.2.2 Case study

The contingency factor matrix shows the comparison of the three approaches to issuing MCs. The alliance in the present case study chose centralized issuance as the best approach because it solved the issues identified earlier and opens other opportunities. As mentioned in the previous section, none of the partners in this alliance were ready to take up the responsibility of issuing MCs on behalf of all the partners, and not all the partners were ready to issue MCs on their own. When asked for preference in the method of issuing MCs, administrators from all the partner institutions responded with a unanimous vote for the centralized issuance of MCs. The reasons included administrative ease and control over what is issued.

"Administratively, it makes much more sense to have a centralized process and to have one place that issues all the credentials and has the control of accreditations and all the parameters that you need to issue the credentials". - National co-ordinator.

Administrators felt issuing from the central platform would ensure all the MCs would be consistent. Each institution can provide the same information for all the MCs that can be stored in the central platform.

"It would make it equal and not different from each university". – Chief consultant

Institutional strategy and the work needed to convince and organize is another factor mentioned by administrators. The strategic vision for the alliance and making it a good user experience for the students were at the top of the list for all institutions.

"If you look at the administrative process, then centralized would be better because it is much more work if you have to organize this within your own university". – Educational consultant

Another factor mentioned by administrators is branding. It helps with the strategic vision and branding of the alliance as the individual institutions can focus on offering high-quality MCs under the alliance brand.

"Centralized marketing, centralized administration, enrolment, record, and storage, and so on". – Teacher and work package contact for MCs.

The alliance being a legally registered entity, acquired a Qualified eSeal and acted as the "issuer" of MCs by eSealing them, and the institutions offering the MCs acted as the "awarding body". In every MC, an evidence statement confirming the issuer and awarding body roles and responsibilities was included by EDC.

To facilitate this, the alliance added an addendum to its existing accord for recognition of credits. stating that all partner institutions agreed on the alliance to eSeal and issue all the MCs on behalf of the partners. This addendum was saved on the central platform server and a link to that document was included in every MC. This new ability to let an alliance issue MCs on behalf of all the partners also led to identifying steps in the MC process and responsibilities at the institutional and central alliance levels.

4.2.3 Potential Barriers for Centralized MC Issuance

Although numerous advantages were cited for issuing MCs centrally by the administrators, certain limitations also exist in the approach. The platform is central but there are no IT pipeline integrations done from partner institutions to the central platform to streamline data transfer. Therefore, all the relevant information for MCs including content related information, and admissions requirements for each MC, need to be entered into the central system manually. This includes the mandatory information to be included into a MC such as learning outcomes, description of the course, and workload. This can be time-intensive and requires dedicated resources from each institution to manage the information.

Because most of the MCs offered by this alliance can be formal and credit-based, the grade was an important factor to include in MCs. Due to lack of IT integration, they need to be entered manually by each institution into the central platform. Grades are sensitive information for a student and so a decision was made not to include grades in the MCs as it is considered too risky and error-prone to enter them manually. Since the students need a proof of completion including the grade to receive credit in their own institution, all the institutions still need to provide proof of grade, such as transcript of records. This renders MCs complementary to the existing process, a digital proof of participation and not replacement of current study record

Even though students register to a MC in the central platform, the admission process is done by the institution offering the MC and students receive access to their learning management platform. Since the MCs are created and issued from the central platform, there is a need to establish the identity of the students to ensure the MCs are issued to the right students. A process was established to obtain the level of security for the students either from their home institution or the host institution who is offering the MC by conducting an identity check. In cases where host institutions do not conduct an identity check if partner students register and home institution doesn't have an established process to set the security level for the students, the level of security remains low which results in MCs not issued to those students. This requires either an additional workload for IT team in the institutions or an additional process to be followed in the central platform to do manual identity checks for those students with low level of security through video chats. This adds additional burden either on the institutions to ensure the level of security is added or on the central staff to perform manual checks. This may also increase privacy and security related issues for the students with additional identity checks.

Centralized issuance of MCs can add additional privacy and security related governance issues and need to be carefully considered including discussions with data protection officers and designing comprehensive policies.

5 DISCUSSION AND CONCLUSION

5.1 Theoretical Contributions

The first key contribution is the identification of a new approach in the context of MC issuance by alliances. Studies have examined MCs and their potential in various fields for career development (Vordenberg et al., 2024) and possible hurdles in implementing them from HEI perspective (Raj et al., 2024; Saad et al., 2024). Issuing MCs is discussed only as an end to means rather than as an important influencing factor (Alsobhi et al., 2023; Halim et al., 2024) especially in the case of alliances. Few studies that are available on alliances offering MCs (Ipsilandis et al., 2024) focus on dynamics of alliances themselves. MC governance required to issue MCs is critical and needs thoughtful consideration for the success of alliances in offering MCs. The two approaches we identified through practical examples work for certain alliances but not for all. Factors such as an individual institution's ability to issue MCs and willingness to take the burden of issuing MCs on behalf of all the partners determine whether either of the approaches can be used. Alliances where neither option is viable are left with no solution. With the centralized approach that we identified, alliances can consider building a central system and using the alliance legal entity to eseal and issue MCs for all the partners. This gives the institutions the flexibility to build the capability of issuing MCs in step with their institutional strategy. This centralized approach for the alliances to issue MCs has not been used in practice or studied to our knowledge. This contributes to the MC literature to include different approaches for MC governance.

The second key contribution is the comparison of the three approaches in the context of MC issuance. Although the three approaches namely: hybrid, decentralized and centralized can be found in existing literature in the data governance context (Coche et al., 2024; Lemieux et al., 2020), the same cannot be applied to MC governance. Existing studies offer knowledge about technology to use for MC governance (Subramanian et al., 2024). Studies involving governance in alliances also discuss about governance mechanism that promote knowledge sharing (Eden et al., 2011) and how governance form can enable partners to develop, transfer and protect knowledge (McGill, 2007). However, our findings illustrate that in an alliance setting, who and how MCs can be issued using the technology is still needed. To meet requirements such as making the MCs tamper proof and include certain information mandatory in each MC, every alliance needs to look at how management and governance can be done and choose the right approach for them. This paper provides an understanding how the contingency factors from data governance can be used to find the right approach for any given alliance. To the best of our knowledge, this is one of the first studies to provide a comparison of all three approaches in the context of MC governance which includes issuing MCs. This contribution extends extends the MC literature to compare different approaches alliances can take. This also contributes to the data governance literature to use contingency factors in determining the right approach for alliances to take.

5.2 Practical Contributions

The findings make practical contributions by explaining 1) reasons why certain approaches such as hybrid and decentralized, might not meet the needs of some alliances for MC governance and 2) provide comparison of approaches from data governance perspective so alliances can make informed decisions. MC research has lacked empirical studies that could inform alliances different approaches feasible for MC governance or how to choose the right approach. Only a handful of practical examples are available and the approaches from those examples, don't necessarily fit for all alliances as was evident from the findings. The present case study presents a centralized approach for MC governance and a comparison of all three approaches provided in this study from data governance perspective can help alliances when considering the right approach for their MC governance.

5.3 Limitations and Future Research Topics

The present study has certain limitations that warrants further research. First, the interviews were done during spring 2022, when MCs were still new for the administrators who were interviewed. However, all the administrators had considerable knowledge of the early adopter program in which the alliance participated in and helped in understanding the institution's ability to issue MCs at that time. Second, the comparison of the three approaches was done specifically, with a focus on the issuance of MCs by the alliances. Upcoming studies should also explore the validation of these approaches for other business strategies. Third, the contingency factors considered for the case study were specifically for an alliance of HEIs. Further research is needed to better understand the influence of contingency factors on data governance for other types of alliances as well. Fourth, the alliance in this case study is an established entity with an existing history. Further research is needed to understand whether a similar approach would work for alliances that form just for a single project.

ACKNOWLEDGEMENTS

This research was supported by ECIUn+ (101089422) European Universities funding.

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PUBLICATION
V

Institutional Pressures and Tensions Shaping Cross- Border Data Governance: Lessons from a Centralized Micro-Credential Consortium

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Manuscript submitted for publication