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FEATURES AND AFFORDANCES OF MICRO-CREDENTIAL PLATFORMS IN HIGHER EDUCATION

Master of Science Thesis
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ABSTRACT

Ahmed Hanafy: Features and Affordances of Micro-credential Platforms in Higher Education
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The adoption of micro-credentials in higher education could potentially support the unbundling of higher education degree programs, increase opportunities for learners, counter the decrease in popularity of academic degrees and provide learners with an effective form of recognition for their skills and competences. This explains the rise of micro-credential popularity and interest in higher education. The increasing interest in micro-credentials adoption in higher education has led to the emergence of a large number of micro-credential platforms. Although there are many micro-credential platforms available, little is known about how they operate and what do they offer for higher education institutions. Subsequently, these institutions need to have a comprehensive overview of these platforms in order to make informed decisions on which one to adopt.

The objective of this thesis is to provide institutions that are adopting micro-credential with a comprehensive overview of the different technologies, features and practices of the micro-credential platforms and to highlight their affordances for higher education. A literature review, semi-structured interviews and group discussions were used to achieve that objective. Ten different micro-credential platforms were used during this study as well and a comparison was drawn to understand their features and the impact of those features on the affordances of micro-credentials. Based on the findings of this thesis, four affordances were identified and analysed to help higher education institutions in their micro-credential adoption processes.

Keywords: Micro-credentials, Affordances, Higher Education

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

PREFACE

In today's fast changing world, the topic of micro-credentials presents plenty of potential to solve many challenges in higher education. The ECIU University project aims to capitalize on that potential. Since the topic is relatively new, I consider myself fortunate that I got the opportunity to be part of this process from early on.

I would like to thank Associate Professor Henri Pirkkalainen for having faith in me and giving me this wonderful opportunity. His guidance, feedback and motivation were pivotal for my professional and personal development. I would also like to thank everyone at the TIJO unit for the warm welcome and encouraging working environment. To the ECIU University family, thank you for the continuous cooperation and indispensable exchange of information and ideas, I am more than glad I will continue working on this project.

This year has been a very special year for me, I am grateful to my parents for their love and support throughout everything, my brother who is currently serving in the army but always takes the time to send out words of encouragement and my wonderful girlfriend for her patience, love and for always being there through the ups and the downs of this process. I would also like to thank all of my colleagues, my friends and every single professor and administrator who is part of the industrial engineering and management program for all the knowledge and experience they have passed on to us. I am beyond blessed to have all the support I had.

Tampere, 7 December 2020

Ahmed Hanafy

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LIST OF SYMBOLS AND ABBREVIATIONS

ECIU	European Consortium for Innovative Universities
API	Application Programming Interface
IS	Information systems
IT	Information Technology
MOOCs	Massive Open Online courses
E-seal	Electronic seal

1. INTRODUCTION

There is an increased demand for micro-credentials in European higher education. It is on top of priorities of the European higher commission that aim for a paradigm-shift on skills and lifelong learning in order to drive Europe's competitiveness and innovation (Ralston, 2020; European Commission, 2020). In this thesis, micro-credentials can be defined as "certification of learning that can accumulate into a larger credential or degree, be part of a portfolio that demonstrates individuals' proof of learning, or have a value in Itself" (ECIU, 2020). Higher education institutions are progressively adopting micro-credentials and establishing micro-credentials initiatives (Resei, et al., 2019). However, in order for micro-credentials to have value, there has to be a supporting ecosystem consisting of an issuer, a user and a recipient (Beverley, 2019) along with a micro-credential platform dedicated for managing and issuing micro-credentials. A large number of micro-credential platforms have emerged over the past years (Dimitjevic, et al., 2016).

The adoption of micro-credential platforms could potentially support the unbundling of higher education degree programs for more efficiency and profitability, increase opportunities for learners (Hope, 2018); to counter the decrease in popularity of academic degrees (Ehlers, 2018) and to provide learners with an effective form of recognition for their skills and competences (Hall-Ellis, 2016). Although there are many micro-credential platforms available, little is known about how they operate and what do they offer for higher education institutions. Subsequently, these institutions need to have a comprehensive overview of these platforms in order to make informed decisions on which one to adopt.

Micro-credential platforms play a pivotal role in the micro-credentials ecosystem by facilitating the issuing, managing, storing of micro-credentials and the transfer of data between different stakeholders of the ecosystem (Araújo, et al., 2017). There have been

some attempts to explore different aspects of micro-credential adoption in different contexts and from different perspectives (i.e. Mischewski, 2017; Gauthier, 2020; Young, et al., 2019). However, there is a lack of research discussing the features and affordances of these platforms for higher education and how they differ from one another (Young, et al., 2019). This thesis aims to fill that research gap.

The objective of this thesis is to provide institutions that are adopting micro-credential with a comprehensive overview of the different technologies, features and practices of the micro-credential platforms and to highlight their affordances for higher education. Therefore the research questions of this thesis are:

- How do micro-credential platforms compare to each other?
- What are the affordances of micro-credential platforms?

This research is an empirical study where the researcher uses a combination of qualitative data collection methods and academic literature to answer the research questions. Semi-structured interviews with micro-credential platform providers and indirect experimentation of each platform are used to answer the first research question. To answer the second research question, this study will draw from the affordance theory (Gibson, 1977) to examine the affordances of the micro-credential platforms.

This research is conducted as part of the ECIU (The European consortium of innovative universities) University project. The ECIU University is an inititative to establish a challenge-based European university where learners 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. For this reason, this study context provides a good opportunity to investigate micro-credential platforms adoption.

This thesis consists of six chapters. Chapter 1 is an introduction where the motivation for conducting this study, objective and research questions are presented. Chapter 2 and 3

include the theoretical background of the thesis. Chapter 2 presents the concept of micro-credentials and the adoption of micro-credentials in higher education. The chapter focuses on the lack of common understanding around micro-credentials and provides a literature review on the definition of the term from different perspectives; the chapter also discusses the motivations and challenges that arise from adopting micro-credentials in higher education. Chapter 3 focuses on the affordance theory and provides a framework for drawing out the affordances from the micro-credential platforms.

Chapter 4 introduces the case organization and the research process. The chapter also discusses the data collection methods used during this study and how the data was analysed. Chapter 5 discusses the results of the study. The first section includes a comparative analysis of different aspects of micro-credential platforms based on the interviews and indirect experimentation, while the second section discusses the affordances of the platforms based on the affordance theory framework. Chapter 6 provides the answers to the research questions and a discussion of the research findings and contributions. The chapter is concluded with the research limitations and future research suggestions.

2. MICRO-CREDENTIALS

2.1 The concept of micro-credentials

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

Different groups of stakeholders within the micro-credentials ecosystem have different definitions and perceptions on micro-credentials (MicroHE, 2019). The term micro-credentials is often used interchangeably with other terms such as digital badges (Clayton, et al., 2014). Table (1) showcases the different perspectives and definitions of micro-credentials in literature.

Table 1. *Different perspectives and definitions of micro-credentials in literature.*

Perspective	Definition	Author
Micro-credentials as learning offerings	Packages of learning designed to meet specific learner needs that are smaller than conventional qualifications packages of learning designed to meet specific learner needs that are smaller than conventional qualifications	(Mischewski, 2017)
	Any credential that covers more than a single course but is less than a full degree	(Pickard, et al., 2018)
Micro-credentials as proof of skills, competences and achievements	A visual representation of your capability	(Tracey, 2014)
	Certification of learning that can accumulate into a larger credential or degree, be part of a portfolio that demonstrates individuals' proof of learning, or have a value in Itself	(ECIU, 2020)

	A micro-credential is a certification of assessed learning that is additional, alternate, complementary to or a formal component of a formal qualification	(Beverley, 2019)
	A microcredential represents a judgment by an organization or individual regarding a person's experiences, abilities, knowledge, or qualifications	(Riconscente, et al., 2013)
	Credentialing systems that follow competency based professional learning to recognise a learner's skills, achievements, and accomplishments	(Kilsby & Fountain, 2019)
A combination of both perspectives	A microcredential can take many forms. At its smallest, it is a single module, subject, skill or competency, but it can also be a suite of skills or knowledge, or a skill set. Some micro-credentials may have a form, such as skill sets , while others could be specific to an individual company or an individual learner	(Business Council of Australia, 2018)

As the table shows, micro-credentials are discussed from several perspectives in literature. One perspective perceives micro-credentials as learning offerings that are smaller than traditional qualifications. While the most common perspective in literature perceives micro-credentials as proof of learning, competences and achievements (e.g., the definitions from Tracey (2014) and Beverley (2019)). Based on this perspective, micro-credentials are considered as the certified skills, competences and achievements that prove that a learner completed the necessary activities and met the standards for earning them. The last perspective perceives micro-credentials as specific skills or skill sets degraded from any form of recognition or detached from any learning offerings (e.g., the definitions from Business Council of Australia (2018)).

In this thesis, micro-credentials are viewed as proof of skills and competences that students have achieved in their learning experiences, aligned with the commonly agreed view demonstrated in Table 1. There are so many aspects that remain unsolved when

discussing micro-credentials even from the same perspective, the type of learning that leads to micro-credentials, the type of issuing organization, the type of skills or achievements to be recognized and whether an assessment is required or not are all elements of micro-credentials that are not agreed upon and that is why more research concerning micro-credentials is necessary.

2.2 Adoption of micro-credentials in higher education

Higher education institutions play a pivotal role in the development of society and the creation of economic growth (Cortese, 2003; Brezis & Crouzet, 2006). They are constantly asked to provide learners with high quality education and equip them with skills and competences in a more affordable and efficient manner (Lemoine, et al., 2018). Digital technology offers higher education institutions the necessary tools to improve its operations and provide those societal needs (Di Stasio, et al., 2016), and micro-credentials is one of the highly regarded technology-backed tools in higher education.

According to a study conducted by Fond, Janzow and Peck (2016), micro-credentials initiatives have almost doubled between 2016 and 2017, while three in every four higher education institutions regard micro-credentials as strategically important to their future (Fond, et al., 2016).

2.2.1 Motivation for adopting micro-credentials in higher education

There are plenty of motivations for higher education institutions that led to the rise of micro-credentials in the last decade (Clayton, et al., 2014; Halavais, 2018), even though some argue that this rise is only a fad or a marketing hype in the learning innovation world (Doran, 2017; Maloney & Kim, 2019).

Using micro-credentials for unbundling higher education

The unbundling of goods and services has proved its success across multiple industries, it inevitably results in lower costs and more flexible offerings for consumers (Horn, 2014;

Ferreira, 2014). Yet, unbundling has been significantly delayed in higher education compared to other industries and sectors (Robertson & Komljenovic, 2016; McCowan, 2017). Higher education institutions have picked up to the fact that employers need to know the specific skills and competences that a potential employee possesses (Hope, 2018). Traditional degrees, certificates and transcripts fail to do so, while micro-credentials make that possible and manageable.

Micro-credentials facilitate the unbundling of higher education by providing an efficient alternative to the traditional credentials (Ehlers, 2018). By awarding learners with micro-credentials that specifically describe the skills, competences and achievements that the learners have using relevant metadata, micro-credentials becomes a powerful tool that facilitates the unbundling of higher education, increases the awareness of learners of their own abilities and answers to the employers' needs (Hope, 2018).

Increasing opportunities and flexibility for learners

The diversity of learners' demographical composition and needs, as well as the rise of non-traditional learners makes it nearly impossible for higher education institutions to have one model that suits all (Soares, 2013; Mintz, 2015). For example, some learners prefer to take part in competence-based courses where they acquire very specific skills and get recognized for them, as opposed to traditional degrees. Others prefer to have a traditional degree and others prefer to attend university part-time. That is why higher education institutions need to have different offerings for different learners (Beilby, 2018).

Micro-credentials increases the opportunities available for learners and provides an increased flexibility to education (Bradley, et al., 2018; Hope, 2018). They offer learners the flexibility to individualize their experience and learn at their own pace (Crow, 2016).

Providing an alternative to academic degrees

Traditional academic degrees and certifications are decreasing in popularity (Ehlers, 2018). For a long period of time, academic degrees were essential for job applications,

but this has recently begun to change. Employers are more and more pursuing skilled individuals rather than degree holders (Horton, 2020). This led to the rise of MOOCs (Massive Open Online Courses), where providers offer learners a wide variety of affordable courses over the internet. MOOCs give learners the flexibility to choose their subjects of interest and after they complete the courses, they are awarded with an online certificate that attests their achievement and completion of the course (Vardi, 2012) and employers were positively perceiving the change through their hiring decisions (Radford, et al., 2014).

Higher education institutes are now exploring alternatives to their traditional degrees that did not undergo any changes in a long time (Gallagher, 2019). Micro-credentials provide an effective alternative that fulfils the needs of employers by providing a detailed view of the learner's skills and relevant evidence regarding how the learner earned those skills.

Using micro-credentials for filling the skill gaps

The skills gap is a term used to describe the difference between the skills that are required to do a certain task and the skills that the employee possesses (Hanser, 1995). Higher education institutions have a responsibility to provide employers with learners that are well equipped with the relevant skills and competences to the job market (Cooke & Zaby, 2015). A vast majority of employers believe that there is a significant skills gap and they expect this gap to grow in the future (Salin, 2019). Growing skills gap are another key motivation for the adoption of micro-credentials (Lockley, et al., 2016). To address the growing skills gap, micro-credentials can be linked to competence-based learning, and relevant core skills across different subjects. By doing so, learners are able to acquire the necessary skills for the job market and universities can close the skills gap. Micro-credentials can also improve the existing learning experience by providing learners credentialing of specific skills within programs as well as complementary skills and competences from extracurricular activities (Taylor, 2018).

2.2.2 Challenges of adopting micro-credentials in higher education

There are also plenty of challenges facing higher education institutions adopting micro-credentials, especially at this early stage (Barnett, 2017). This chapter explores the key challenges that face policy makers and higher education institutions when implementing micro-credential inititiatives. The challenges of micro-credential adoption are discussed In literature more than other aspects of micro-credentials.

Lack of common understanding around micro-credentials and the chaotic terminology confusion

One of the major issues that hinders the adoption of micro-credentials in higher education is the lack of common understanding of the concept of micro-credentials (Resei, et al., 2019; MicroHE, 2019; ETUC, 2020). While policy makers might be more familiar with the term, there remains to be significant confusion around what micro-credentials really are and how they are defined within higher education. There is an evident need to clearly define micro-credentials and communicate it across the adopting institutions in order to reach a common understanding.

Low standardization and high variability of micro-credentials lead to low recognition

For micro-credentials to have value, it needs to be backed up with reliable standardized information regarding the relevant skills and competences it showcases (Resei, et al., 2019; Kato, et al., 2020). The lack of standardized information of micro-credentials decreases their credibility and results in recognizers depending on other sources of information to verify the individual's skills and competences (Kässi & Lehdonvirta, 2019). That is why several organisations in higher education are working on developing criteria for standardizing micro-credentials (Nuffic, 2018). Those criteria can be related to the assessment process, level of study programme, learning outcomes and EQF (European Qualification Framework) level.

The adoption of micro-credentials might require changes to the institutional structure

In order to set up a successful micro-credentials program, higher education institutions might need to make necessary changes to the institutional structure to get the most value of micro-credentials as it stands today. Since micro-credentials are still fairly new to higher education, there is not a clear understanding of what aspects of higher education institutions should be changed and how. Literature suggests that curriculum design, assessment structures, the definition of pathways and IT infrastructure are among the key aspects that should undergo change when adopting micro-credentials (Lockley, et al., 2016). This structural change represents a major issue to the adoption of micro-credentials in higher education, especially with resistance to change (Lane, 2007).

3. AFFORDANCES OF MICRO-CREDENTIAL PLATFORMS

The affordances of micro-credential platforms are currently unknown in the literature but many of the essential features and characteristics can be identified (Dimitjevic, et al., 2016). The actual affordances of micro-credential platforms will be the main focus of the empirical part of this study and therefore reported in chapter 6. This section discusses the affordance theory, micro-credential platforms and their features. The theoretical framework is presented at the end of this section.

3.1 Affordance theory

The concept of affordances has sparked plenty of debate across different disciplines (Wang, et al., 2018). In information systems discipline, affordances are defined as possibilities for goal-oriented actions afforded to a specific user group by an artefact (Markus & Silver, 2008). These possibilities emerge from the relationships between the features of IT artifacts and the organization where the artifact is used (Zammuto, et al., 2007). Since affordances are merely possibilities for actions, it is often argued whether actors are needed to trigger or actualize them to accomplish different objectives (Volkoff & Strong, 2013; Strong, et al., 2014).

Pozzi et al. (2014) developed a theoretical framework for the affordance theory in the discipline of information systems based on the work of Bernhard et al. (2013). Figure (1) shows that the framework has four steps: (1) affordances existence, (2) affordances perception, (3) affordances actualization and (4) affordances effects.

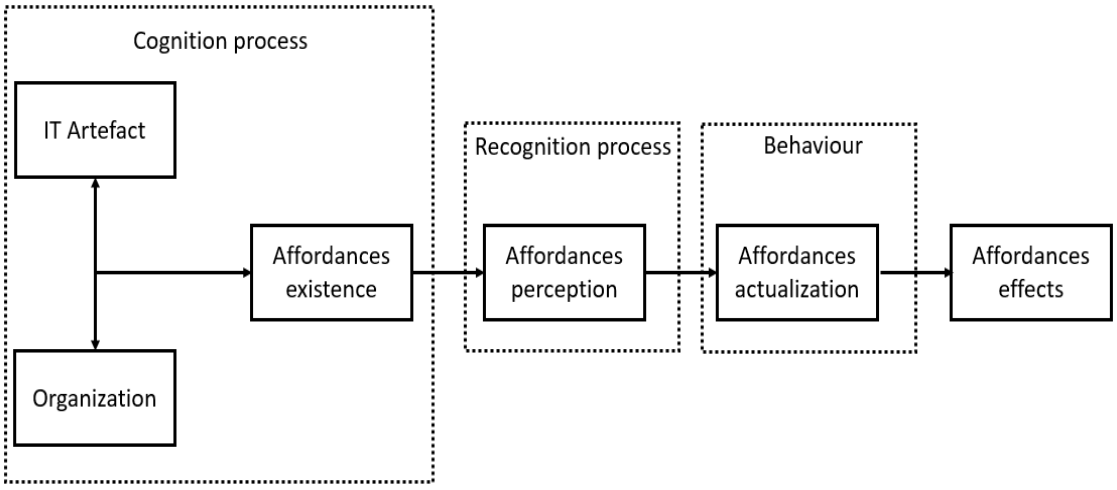

Figure 1-Theoretical framework of affordances theory in information systems discipline (Pozzi, et al., 2014).

The first step of the theoretical framework is the cognition process of affordance existence, which shows that the affordances emerge from the interaction between the organization and the IT artefact features in a specific context. The organization's perception does not affect the cognition process. In the context of information systems, the organization is often looked at as groups rather than individuals. The second step is the affordances perception process, which indicate that the organization has to recognize the affordances based on the first step. The third step is the affordances actualization, which means that the organization use the affordances that they perceived in order to achieve the organization's objectives. The last step is the affordances effect, which relates to the outcomes of actualizing the affordances by the organization (Pozzi, et al., 2014). This thesis focuses on the first step of the theoretical framework in order to identify the affordances of micro-credentials.

3.2 Overview of micro-credential platforms

A significant number of micro-credential platforms have increased over the past few years. The main purpose of these platforms is to collect, store, manage and share micro-credentials. Each platform offers a different set of features for its users depending on

their intended needs (Dimitjevic, et al., 2016; Grant, 2016). Most of the existing micro-credential platforms are relatively easy to access for the users.

The growing -credential platforms are not discussed in literature since the topic remains relatively new and they interest in micro-credentials have led to the development of open infrastructure technology that aims to help micro-credential platforms' users to have APIs, metadata standards and other software tools. Micro-credential platforms are often referred to as digital badging platforms as well. This might be due to the lack of understanding related to the topic and the terms being used interchangeably. When a higher education institution decides to implement a micro-credential initiative, a micro-credential platform is essential to the process. Since the topic is not often discussed in literature, it becomes challenging for higher education institutions to choose between the existing platforms. That is why it becomes significant to have a broad understanding of these platforms and their features in order to make informed decisions for the success of the adoption process (Araújo, et al., 2017).

3.3 Features of micro-credential platforms

In general, micro-credential platforms are designed to allow users storing, managing, sharing and creating micro-credentials. To achieve the users' needs, micro-credential platforms provides sets of features for users. These features differ from one platform to another (Glover, 2013). At this stage of micro-credential adoption, a deeper understanding of these features and how they compare is needed, since it is still unknown why some platforms allow some features while others do not. The following table provides information about some of the features supported by micro-credential platforms from relevant literature.

Table 2- Feature of micro-credential platforms identified from literature

Feature	Description	Reference
Creating templates for micro-credentials	Allows issuers to create standardized templates of micro-credentials that can be accessed and edited later on	(Willse, 2014)

Visualising and documenting pathways for micro-credentials	Allows issuers to add information regarding how micro-credentials relate to each other and visualise that process	(Casilli, 2013)
Standardized framework-related data (e.g. EQF, NQF)	Supporting standardized frameworks for input as supporting data when creating a micro-credential	(Rehak & Hickey, 2013)
Searching for micro-credentials from earner perspective	Allows earners to search and view existing micro-credentials on the platform	(Devedzic & Jovanovic, 2015; Goligoski, 2012)
Registration for learning offering	Allows earners to register to learning offerings (e.g. courses) that are available on the platform	(SCLDA, 2014)
Submitting evidence of learning	Allows earners to attach supporting documents for their achievements when applying for a micro-credential	(Grant, 2014)
Collecting micro-credentials earned in a portfolio	Allows earners to store and manage their earned micro-credentials in their own portfolio on the platform	(Glover, 2013)
Importing micro-credentials from other sources	Allows earners to import micro-credentials that they earned from other sources other than the ones available on the platform (e.g. another organization or platform)	(Dimitrevic et al., 2016)
Visualisation of micro-credentials and their metadata	Allows access and visualizing the micro-credentials when received	(Charleer et al., 2013)
Reviewing metadata of the learner's micro-credentials	Allows access to the metadata of micro-credentials	(Otto, 2015)
Validating the evidence of achieving micro-credentials (Otto, 2015)	Allows recognizers to validate the evidence of achieving the micro-credentials by using a trustworthy process	(Otto, 2015)

The table highlights the features of micro-credential platforms identified from relevant literature and a brief description for each feature. The features differ from their level of complexity, some of them are very basic and simply relate to the creation of a micro-credential on a platform or visualisation of micro-credentials and their metadata, while others are a bit more complex and relate to the validation of evidence that led to achieving the micro-credential, supporting standardized frameworks for the metadata and importing micro-credentials from other sources to the platform.

These features can be identified when using different micro-credential platforms. Most platforms communicate these features on their websites and marketing material as well. Understanding these features, how they compare to each other and the reason why they are supported by the platform can shape up how the platform is used by different groups of stakeholders and can affect the affordances (Dimitjevic, et al., 2016).

4. RESEARCH PROCESS AND METHODS

4.1 Case Organization

The ECIU is a European consortium consisting of 14 partner universities. The consortium was founded in 1997 with the objective of developing an innovative culture within each partner university and to encourage innovation in industry and society. Members of the consortium have been collaborating across management, academics and administration levels throughout research and joint projects.

The ECIU has launched an initiative for a European university adopting a challenge-based educational model. The main objective of the ECIU University initiative is to have learners, researchers, public organizations and industry work together to provide innovative solutions for real life challenges, in order to make a real societal impact. Figure (3) showcases the ECIU university model.

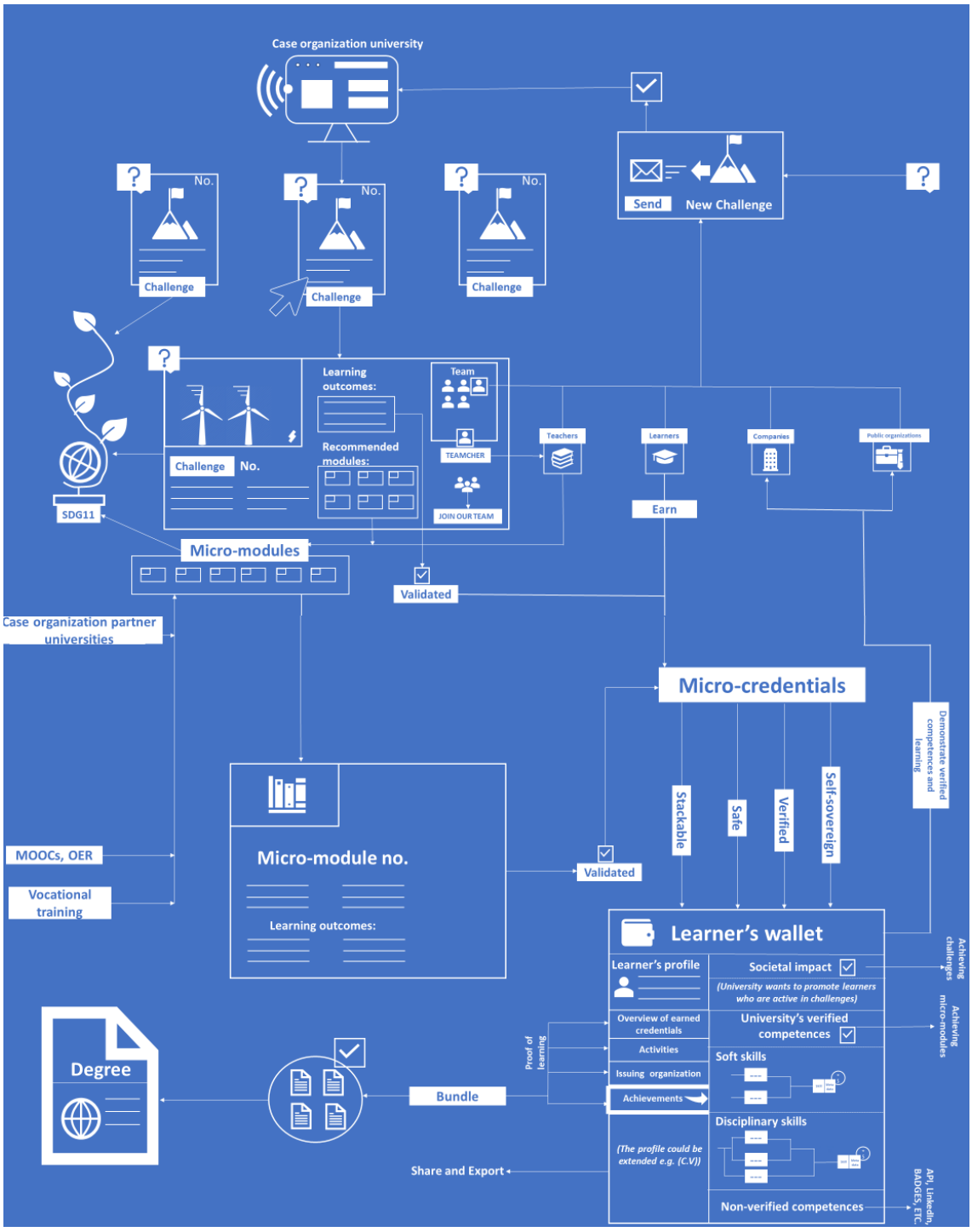

Figure 2. *ECIU university model* ***(ECIU, 2020)****.*

The figure shows the case organization's university model where companies and public organizations provide the university with real life challenges. Learners from different backgrounds collaborate to solve the challenges and make a real societal impact. Different learning offerings will also be available for learners who are interested in acquiring

new skills and competences and enhancing their portfolio, those learning offerings are referred to as micro-modules, and they are offered by partner universities, MOOCs (Massive Open Online Courses) and vocational training providers. Learners will have their skills and competences that they earned from completing challenges and micro-modules recognized through micro-credentials which they can store in their learner's wallet. The learner's wallet is the digital certification tool and wallet that displays various information about the micro-modules attended and challenges completed along with the achievements related to such learning, e.g., the competences that were acquired in the process. This enables a credible, relevant and transparent method to proof the skills of learners of the ECIU university.

This research is part of the piloting process used for reaching an understanding for what features should the learner's wallet include and what will add value to different groups of stakeholders within the ECIU university. The case organization is not developing a solution from scratch, but rather testing out multiple existing platforms dedicated for managing and storing micro-credentials and making the necessary adjustments that match the case organization's vision and add value to its stakeholders. Figure (4) illustrates the piloting process of the learner's wallet for reaching that understanding.

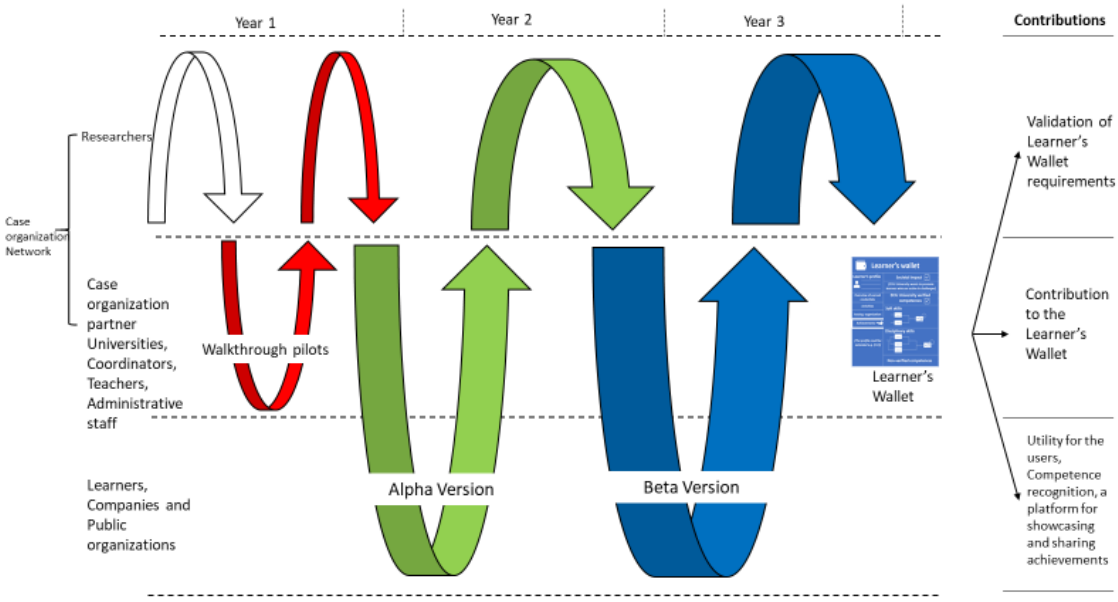

Figure 3. Piloting process for learner's wallet.

The piloting process of the learner's wallet consists of three main stages: walkthrough pilots, Alpha pilots and Beta pilots. The walkthrough pilots are conducted once a potential platform is identified, the platform providers offer the researcher with an overview of the platform and its features, and how it can be used by different groups of stakeholders. Based on the results of the walkthrough pilots, a number of digital platforms will be included in the Alpha pilots to be implemented on a wider scale within the ECIU university, during the Alpha pilots, teachers, students and administrative staff will use the platforms in real life and mock-up contexts and they will give feedback through semi-structured interviews. Based on the results of the Alpha pilots, relevant modifications will be made to a smaller number of platforms and the process will be repeated to make necessary adjustments for reaching an understanding of what the learner's wallet features would include and how will it add value to different stakeholders of the case organization. This research is part of the initial walkthrough piloting process.

4.2 Qualitative research

Conducting empirical research requires making decisions concerning the methods used to collect data during the research process. Data collection can be carried out using

quantitative methods, qualitative methods or a combination of both (Gummesson, 1993). Neither quantitative nor qualitative data collection methods are superior to one another, and the decision on which method to choose depends on the researcher and the nature of the research (Bartezzaghi, 2007). This research is conducted as a case study where a combination of qualitative data collection methods is relied on. According to Gummesson (1993), there are five main methods for collecting data: (1) using existing material, (2) questionnaire surveys, (3) qualitative interviews, (4) observation and (5) action research.

Using existing material is an integral part of empirical research gathering and is used during this research to provide the criteria for comparing between platforms. Literature, books, reports and statistics are examples of existing material used to collect data. Questionnaire surveys are usually used to collect qualitative data from larger samples. Using questionnaire surveys for collecting qualitative data requires making a formal standardized list of questions that is circulated among the target sample. This method provides researchers with a large amount of data that is relatively easy to analyse.

Qualitative interviews are used to reach a deeper level of understanding of a particular topic based on the respondent's experiences, feelings and opinions. They are mostly conducted as one on one verbal conversations. Interviews can be structured, unstructured or semi-structured (Gill, et al., 2008). Observation is a qualitative data collection method where the researcher observes a phenomenon or a situation with the objective of collecting data. The last method is action science where the researcher is involved in a certain process and they can acquire data and knowledge by influencing and inflicting change on the process.

This research relies on a combination of qualitative data collection methods. Existing material and semi-structured interviews are relied on heavily during the research process. Group discussions are also used in this study.

Another methodology used to collect data during this research is indirect experimentation. According to Maier & Fadel (2007), there are four main strategies used to identify the affordances of an artefact: (1) predetermination, (2) direct experimentation, (3) indirect experimentation and (4) automated identification. Indirect experimentation is a method used by researcher to draw out the affordances of an artefact when a physical mock-up of the artefact cannot be created due the nature of the artefact or due to lack of resources to create one. The researcher uses indirect experimentation since the nature of the artefacts in this research does not allow the creation of a physical mock-up that can be examined. Exploring the environment of the artefact leads to identifying its affordances (Maier & Fadel, 2007).

4.3 Data collection and analysis

Qualitative data was mainly used to conduct this research. Due to the nature of research questions, semi-structured interviews were the main method used to collect qualitative data. A combination of other data collection procedures was also conducted during this research such as data from indirect experimentation and existing literature concerning micro-credentials, the features of micro-credentials platforms and the affordance theory.

Two key stakeholder groups were interviewed for the thesis: (1) Individuals with high expertise in micro-credentials and (2) micro-credential platform providers. Expert interviews were addressed in order to develop an understanding of the topic, due to the common lack of understanding of the topic and the confusion surrounding micro-credentials. The experts interviews also helped to identify micro-credential platforms to interview and try out. The micro-credential platform providers were identified by using the snowballing sampling technique where initial respondents help identify future study subjects from their acquaintances or based on their personal knowledge (Secor, 2010). Snowball sampling begins with identifying one entry point to a group and requesting to interview a

member of that group. The respondent is then asked to refer other respondents from their circle of acquaintances.

Micro-credential platforms' providers were interviewed in order to get a walkthrough of each platform and an overview of its features and its value for different users. The researcher tried a total of ten platforms and conducted eleven interviews with the platforms' providers. The interviews were mainly conducted online using Zoom since most interviewees were based overseas. Table (2) provides an overview about the interviews and the respondents.

Table 3. *Information about the interviews and respondents.*

S. No.	Role of respondent	Organization	Number of respondents	Location	Length of interview (mins)	Interview type
1	Senior lecturer	Technical University	1	Finland	57	Micro-credential expert interview
2	Principal consultant on micro-credentials	Education innovation consultancy firm	1	Australia	70	Micro-credential expert interview
3	Principal consultant on micro-credentials	Education innovation consultancy firm	1	Australia	57	Micro-credential expert interview
4	University lecturer	Technical university	1	Finland	58	Micro-credential expert interview
5	University lecturer	Technical university	1	Finland	79	Micro-credential expert interview
6	Research and development associate/Policy consultant	Platform A	2	European Union	103	Micro-credential platform group discussion
7	COO	Platform B	1	European Union	49	Micro-credential platform interview

8	COO	Platform B	1	European Union	60	Micro-credential platform interview
9	Co-founder	Platform C	1	Netherlands	72	Micro-credential platform interview
10	Exponential serendipity officer	Platform D	1	Ireland	122	Micro-credential platform interview
11	CEO/Senior technical officer/Developer	Platform E	3	United Kingdom	96	Micro-credential platform group discussion
12	Head of credential information services/Director/Developer	Platform F	3	Italy	98	Micro-credential platform group discussion
13	Account executive	Platform G	1	United States of America	41	Micro-credential platform interview
14	Co-founder	Platform H	1	France	61	Micro-credential platform interview
15	Account executive	Platform I	1	United States of America	59	Micro-credential platform interview
16	Founder & CEO	Platform J	1	Spain	62	Micro-credential platform interview

A total of five micro-credential experts interviews, three micro-credential group discussions and eight micro-credential platforms interviews were conducted for this study. The interviews lasted from 41 minutes to 122 minutes. The expertise of platform providers interviewed varied widely, some were more education oriented, others were experts in the field of information technology and website development and others were data researchers. A total of ten platforms were included in this study, eight of those platforms

were based in Europe while two were based in the United States. The interviews and group discussions were all recorded and transcribed. Since each platform was different and offered different features and affordances, the interview questions varied accordingly, but still tried to cover the research questions. The questions of the micro-credential experts interviews are attached as appendix A and the questions used for the micro-credential interviews and group discussions are attached as appendix B. The results of the initial interviews with experts aimed to reach an understanding of the topic and to identify micro-credential platforms. While the results of the micro-credential platform group discussions and interviews were analysed in order identify new features of micro-credential platforms and to carve out the affordances based on the affordance theory.

The first step of the analysis was to pinpoint the new features that were not included in literature. All the features that were identified in this study were then categorized to help draw the comparison between different platforms. During the analysis of the results, the possibilities of action of the features were focused on in order to identify the affordances and how they relate to the relevant features. Finally, the findings of this thesis were discussed to shape up the final conclusions.

5. COMPARISON OF MICRO-CREDENTIAL PLATFORMS

This section of the findings expands the features of micro-credential platforms and compares them in regards whether they support these features or not. There were some features that were derived from literature while others were identified from the interviews, group discussions and interaction with the micro-credential platforms. Table (3) lists out broad feature categories, each category is broken down to specific features offered by the micro-credential platforms included in this study. If the platform offers the specific feature, a check mark is included in the corresponding box, if not, the box is left empty to indicate that the platform does not offer that feature.

Table 4. *Summary of comparison between the features of micro-credential platforms.*

Category	Feature	Platform A	Platform B	Platform C	Platform D	Platform E	Platform F	Platform G	Platform H	Platform I	Platform J
User interface	Issuers (Teachers & administrators) user interface	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Earners' users interface	✓	✓	✓	✓	✓	✓			✓	✓
	Recognizers' user interface					✓					
Creating MCs	Creating badges			✓	✓	✓		✓			
	E-certificates	✓			✓	✓	✓	✓	✓	✓	✓
	Text with metadata	✓	✓			✓					

	Creating templates for MCs (Willse, 2014)	✓	✓	✓	✓	✓		✓	✓		
	Customizing the display of micro-credentials			✓	✓	✓		✓			
Pathways of micro-credentials	Visualising and documenting path-ways for MCs (Casilli, 2013)		✓	✓	✓			✓		✓	
Supported data (Metadata)	Issuer-related data	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Skill-related data	✓	✓	✓							
	Standardized framework-related data (e.g. EQF, NQF) (Rehak & Hickey, 2013)	✓	✓		✓		✓		✓		✓
	Awarding-related data	✓	✓	✓	✓				✓	✓	
	Learning outcome-related data	✓	✓	✓						✓	
	Volume of learning related data (e.g learning hours, ECTS)	✓	✓			✓	✓				✓
	Grading scheme-related data	✓	✓						✓	✓	
Search function	Searching for mi-cro-credentials from earner per-spective (Devedzic & Jovanovic, 2015; Goligoski, 2012)		✓	✓		✓		✓	✓		✓

	Viewing the metadata of micro-credentials	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Link with learning offerings	Registration for learning offering (SCLDA, 2014)									✓	
Provision of proof of learning	Submitting evidence of learning (Grant, 2014)		✓	✓			✓	✓	✓	✓	✓
	Support of learning assessment	✓	✓		✓	✓	✓				
Bulk issuing micro-credentials	Automated awarding of micro-credentials when applied to		✓			✓		✓	✓	✓	
	API integration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Verification technology	Blockchain		✓		✓	✓	✓	✓	✓		✓
	Electronic seal	✓									

Portfolio management	Collecting micro-credemtials earned in a portfolio (Glover, 2013)	✓	✓	✓	✓	✓	✓			✓	
	Importing micro-credentials from other sources (Dimitrevic et al., 2016)			✓			✓		✓	✓	
	Organizing micro-credentials into collections	✓	✓	✓			✓				
	Visualisation of micro-crednetials and their metadata (Charleer et al., 2013)	✓	✓	✓	✓	✓	✓	✓	✓		✓
	Tailoring the micro-credentials display (Otto, 2015)	✓			✓		✓			✓	
Sharing micro-credentials	Sharing micro-crednetials on social medial platforms	✓		✓	✓	✓	✓	✓	✓	✓	
	Sharing micro-credentials to other parties	✓	✓	✓	✓	✓	✓	✓	✓		✓
Validation features	Reviewing metadata of the learner's micro-credentials (Otto, 2015)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

	Validating the evidence of achieving micro-credentials (Otto, 2015)	✓	✓		✓	✓	✓	✓	✓		✓

Each of the following sub-sections explains in detail the findings of this study and compares between the features identified in table (3), as well as include an justification as to why different features are not supported by some platforms while other features are overwhelmingly represented by the majority of the platforms included in this study.

5.1 Comparison of micro-credential platforms

5.1.1 User interface

The results of the thesis show that micro-credential platforms support different user interfaces designated for mainly three stakeholder groups: issuers, earners and recognizers where they can have their own accounts to access and use the platform. From the table, it is clear that most platforms are dedicated for two user groups: issuers and earners. In addition to these two user groups, only one platform included in this study (Platform E) provides recognizers with their unique user interface. The reason for that is that the platform providers want their platform to provide value for higher education institutions, students and recruiters alike, which is achieved by allowing all stakeholders to be part of their platform's ecosystem. The CEO of platform E has highlighted his platform's vision for being a value creator for all stakeholder groups.

"*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. So, we create mutual benefits to both institutions and individuals as well as recruiters, and ultimately getting to that point where the credentials can align to show the pathway and learning journey that the student has been taking over a period of time, rather than just showcase a single certificate that shows them limited data*"-CEO of platform E.

Other platforms only provide issuers with a user interface as the creation process of micro-credentials takes place on the issuer's side. It is notable to say that the platforms that do not offer user interfaces for earners or recognizers still allow them to view the micro-credentials if they are sent to them.

5.1.2 Creating micro-credentials

When it comes to creating micro-credentials, all the platforms that were part of this research allow the creation of at least one type of micro-credentials, either digital badges,

electronic certificates or as text with metadata. It was clear that digital badges and electronic certificates were more likely to be supported by platforms than showcasing the micro-credentials as plain text with the metadata attached to it. At this point, it is still not clear whether one type of micro-credentials is superior to the other, but there was an agreement that they are more value adding than traditional degrees. Exponential serendipity officer of platform D emphasized the superiority of micro-credentials to traditional degrees as a they are data-driven and can represent a solution for skill gaps and enable more efficient admission processes.

"These are not degree certificates that you want to post on the wall, they have another purpose and another life. 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"- Exponential serendipity officer of platform D

It is however notable that every platform that offers digital badges, also allows the customization of micro-credentials when created. The customization might include adding the issuer's logo, adding information related to the micro-credential and customizing the visual aspects of the badge or electronic certificate such as colour, font size and shape.

Another aspect that needs to be taken into consideration is the ability to create templates of micro-credentials, which can save time and resources from the issuer's side.

5.1.3 Pathways of micro-credentials

One of the most popular potential benefits of micro-credentials discussed in literature is that they can be stacked to represent a larger degree or skill and to show the pathway that the learner took to achieve them. This research confirmed that the providers of micro-credential platforms are taking notice of those potentials as half of the platforms included in this research offer the possibility to visualize or document pathways for micro-

credentials. The COO of Platform B confirmed the ongoing discussion about the stackability of micro-credentials and that it can help issuer organizations in establishing micro-degrees.

"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 of Platform B

One interesting point that there was not a consistent way of creating or visualizing those pathways, as different platforms use different techniques to do so. For example, platform B allows issuers to include data on how one micro-credential relates to another in their metadata standard but there is no way of visualizing these pathways without accessing the metadata itself. Platform G allows creating groups of micro-credentials that can be stacked together to form a larger credential but users of the platform can see the badges and certificates that are part of that group. Exponential serendipity developer of platform D expressed the benefits of stacking micro-credentials and how issuers can use it to better communicate a broader view of the learners' pathway.

"So issuers have degrees, certificates, transcripts, and badges and they can really stack them together because they already have them in the system in order to see what is the pathway for learners, and then they could either represent it as credentials that learners already acquired and they will see those credentials in their wallet, or they could project it as a visualization of the pathway to completion"- Exponential serendipity developer of platform D

5.1.4 Supported data

Metadata are the information embedded within micro-credentials and are often described as the backbone of micro-credentials. The main issue that faces the micro-credential ecosystem is which information should be linked to micro-credentials to provide value to stakeholders. From the platforms included in this research, the metadata standards

ranged from very extensive to basic. Only two platforms included all the data identified to undergo the initial comparison in their metadata standard. Other platforms' metadata standards were not as extensive, but it was interesting to note that the platforms were showcasing flexibility to modify their metadata standards to meet the stakeholders' needs. The co-founder of platform C confirmed that they did not include a particular taxonomy of skills in their metadata standards as different stakeholders have different needs when it comes to metadata, so it would not be convenient to have the same taxonomy for everyone.

"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 of platform C

At this stage, platform providers are more focused on the technology and user interface development more than their metadata standards while they acknowledge their importance to the success of micro-credentials. That was confirmed by the CEO of platform E.

"The only thing that we have been thinking about is something around Blooms taxonomy , but it is not embedded in the platform yet. Of course, we are very much focused on the issuance of the certificates, leveraging blockchain and the user interface and experience has been our priority. At this point, we have a really solid foundation and we are starting to look at the next level for recognizing skills"- CEO of platform E

One key metadata which is skill-related data was not included as much as it would be expected. Only three platforms included information about skills in their metadata standards and linked existing skill taxonomies to their solution, while others justified the lack of skill-related information in their metadata standards as it should be decided by the platform's users, since adding one taxonomy of skills will not be suitable to all users of the platform.

5.1.5 Search function

The results of this research showed that not every platform allowed earners to search for micro-credentials themselves. There were two main approaches from the platforms included in this research: the platforms that do allow the search functionality usually requires earners to apply for the credential, while in case of the platforms that do not, earners received the credentials once it was issued to them. Platform C had a very interesting approach to search functions which is a combination of the two approaches mentioned above, where they have two versions of the platform, a public version where earners can search for the public micro-credentials and another white label version that is dedicated for issuer institutions who would like to make their micro-credentials available only to earners within the institution. The co-founder of platform C further explained their approach to searching for micro-credentials.

"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, so if the earner searches for micro-credentials they are only able to see the ones available through their network"- Co-founder of platform C

5.1.6 Link with learning offerings

From the micro-credential platforms included in this research, only platform I allows linking the micro-credential to the learning offering itself. The platform's approach is to allow earners to explore the existing micro-credentials, their learning paths and the learning offerings they need to complete to receive the micro-credentials. The learner is able to apply and access the learning material directly on the platform, including the necessary exercises. Once the learner completes the necessary requirements for achieving the micro-credentials, they are automatically issued to them. Other platforms on the other hand do not include the learning offerings from their side, as they tend to focus more on the micro-credential issuing and management part. The learning offerings are more expected to be available from the issuer's side, maybe on another platform.

5.1.7 Provision of proof of learning

One of the biggest challenges facing the implementation of micro-credentials in higher education is its credibility. It is still not yet clear how to ensure the credibility of micro-credentials. However, one of the interesting features that might play a significant role in achieving that, is to allow submitting a proof of learning as evidence along with the micro-credentials. The nature of this proof can be an attached report, learning diary or other documents that might help instil confidence and credibility in the micro-credentials. Almost half of the platforms included in this research have taken that approach and allow submitting documents to micro-credentials as evidence.

The issue remains that it is still not clear which type of documents would be more suitable and whether it actually adds any value to stakeholders. There still needs to be more research done that includes different groups of stakeholders in order to understand what are the elements that can help with micro-credentials' credibility.

Another important feature that can also add value to stakeholder groups and to back-up micro-credentials with proof of learning is to include information about the assessment and grading process. From this research, we can see that it is another feature that is not ignored but still not widely implemented, that might be due to the fact that the value of this feature remains unknown to platform providers as well as to different stakeholder groups within the micro-credential ecosystem. However, platform G had a very interesting approach that allows the visualization of the earner's grade. The platform allows the creation of micro-credential groups consisting of different versions of the same micro-credential, where each micro-credential relates to a level of mastery. The account executive of platform G gave an example of that approach.

"You are able to create groups of credentials, for example, if you create a credential for mathematics and a student gets a score from 70 to 80 they get one credential from that group and if they get a score from 80 to 90 they receive another level from the same group"-Account executive of platform G

5.1.8 Bulk issuing micro-credentials

The ability to issue a large number of micro-credentials in the most efficient manner is important for issuers. Issuers will mostly send out more than one micro-credential at a time, so streamlining that process is crucial to their operations and resources. Micro-credential platforms providers are well aware of that since all of the platforms included in this research allow API integration between their platforms and the issuer's information systems platforms. The API integration facilitates the transfer of data between the issuer's information systems, eliminates double work and makes the issuing process much easier. The account executive of platform G emphasized those benefits and recommended API integration with the issuer's existing information systems.

"We also recommend using the APIs that comes with our solution to connect to the issuer's platform to automate the issuing process and make it much easier"-Account executive of platform G

There is another approach that a few platforms have to issue a large number of micro-credentials without the use of API integration. These platforms allow issuers to download a pre-set excel sheet including all the metadata of the micro-credential, earners and their grades; and then upload it back to the platform where they can then issue all the micro-credentials at once. Consultant at platform A describes how that process works and confirms that convenience of that approach since there are already existing organizations using that approach to issue a large number of micro-credentials.

"Issuers will often have the credentials information available in XML format, and that is something that is exportable from various existing systems. Two of our existing piloting participant organizations are already exporting XML files from their existing databases. Issuing organizations can simply copy and paste information from their database to fill the metadata about the credentials"-Consultant at platform A

5.1.9 Verification technology

The results of this research show that micro-credential platforms use different technologies to confirm the validity of credentials and its issuers. It was clear that most platforms included in this study recognized blockchain technology as the most effective technology for securely authenticating and sharing data while maintaining a cautious level of uncertainty due to the lack of adoption of the technology. The co-founder of platform H has highlighted that blockchain technology can be the answer to the issue of fake degrees as it ensures the security of data transfer.

"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. So that's why we used blockchain technology to build a solution that would solve these problems"-Co-founder of platform H

Other respondents have emphasized the benefits of blockchain technology and its effectiveness in transferring data while expressing that its actual adoption is key to overcome any uncertainty surrounding it.

"When it comes to that the scalability of blockchain and the ability for it to do multiple transactions instantly and very quickly, the technology has not really been well understood as to how that can be leveraged. And I think we're now at a really nice place where we have had our research the year before and then founded the company because we could see how easily we could make leverage the technology and use the scalability that I think was lacking before that"-CEO of platform E

Only platform A was not using blockchain technology. Instead, electronic seals were used to authenticate the credentials issued. The electronic seals cannot be forged and once the credentials are sealed, the recognizers can also access the accreditation information and status of the issuer organization. A check mark also appears next to the credential to indicate that it was sealed. In general, no technology was confirmed to be

superior when it comes to verifying micro-credentials and data transferred but blockchain was more popular and there was a shared sense of optimism about its adoption.

5.1.10 Portfolio management

Allowing earners to own a portfolio where they can view, store and manage their earned micro-credentials can be seen as part of all the platforms included in this research. These portfolios are significantly different from each other though, since each platform allow a different set of features for its users. It was noticeable that platform providers did not perceive any features as being more valuable than others since none of those features was significantly more recurrent. However, the platform providers are aware that they are still at a stage where they understand that there is a need for a portfolio for the earners, but they still need a broader understanding of what exactly are the elements of the portfolio that users would value and how they should be presented.

"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 of platform B

The results of this study show that platform providers generally perceive learners' portfolios as an effective and centralized tool where they can store all their earned credentials. This perception was highlighted by the exponential serendipity developer of platform D.

"We have integrated a badge backpack inside the wallet. And so effectively, a learner has one place, one wallet where they could keep their degrees, certificates, transcripts as well as their badges"-Exponential serendipity developer of platform D

One very interesting issue was highlighted by the co-founder of platform C, where he addressed that the learners' e-mails usually expire after they leave their university or organization. So, they cannot access their portfolios once they leave. In order to make the portfolio accessible to learners beyond their institution, his platform allows them to

link different e-mails and identities to their portfolio. As a result, learners can still have control over their credentials even after they leave their organization.

"Learners will not keep their university accounts for life. So, the problem is what if they take away my email from the university institutional email, and I can no longer access my credentials. So immediately here, that challenge is addressed by allowing learners to link different profiles or identities onto their wallet"-Co-founder of platform C

5.1.11 Sharing micro-credentials

The majority of the micro-credential platforms included in this study allow earners to share the micro-credentials they earned. Generally, earners have the ability to share their micro-credentials either on social media platforms or directly to third parties. Platform providers highlighted the benefits for incorporating this feature as it gives earners a flexible tool that allows them to build their reputation and market their skills. It also helps draw traffic to the earners portfolio. This was highlighted by the account executive of platform G.

"In the social media aspect of our solution, where learners have the ability to share these digital credentials to build their personal brand and showcase their new skills; but additionally, from here, of course, they can also add it in a PDF, attach it in an email or even embedded into a signature, a website or a blog post. So, this is really meant to do two things. First off, provide learners with a tool that they can take with them and use in the best way that they see fit. And then simultaneously what also allows us to do is really draw as much foot traffic to these recipient pages as possible. Everybody posting their digital credentials to social media is shouting out their new achievement, building their personal brand, and simultaneously spotlighting their issuer as someone that's not only providing them this community and this much needed knowledge, but also celebrating the achievements of their learners"-Account executive at platform G

5.1.12 Validation features

There are two main features related to validation of micro-credentials identified in this study: (1) reviewing metadata of learners' micro-credentials and (2) validating the evidence of achieving micro-credentials. The findings of this thesis confirm that most of the platforms included in this study offered both features for their users. This shows that platform providers are aware of the significance of having tools for users to instil trust in micro-credentials. These two features are the main tools users have to make sure that micro-credentials are credible and to show the earner's achievements that led to earning the micro-credentials. At this stage, it remains unclear for platform providers whether these features will have the intended purpose or not, or whether they need to modify them further ahead based on their users' needs.

6. DISCUSSION

This thesis focused on the features of micro-credential platforms and provided a comparison between them. There were some features recognized by literature while others were drawn out from the interviews and group discussions held in the process of this study. Based on the findings of this thesis, the next section describes how the features of micro-credential platforms enable affordances of micro-credentials to higher education.

6.1 Affordances of micro-credentials

Table (4) showcases details about the affordances that micro-credential platforms allow to higher education, a brief description of each affordance, the features that allow the affordance, the stakeholders involved and the references that indicate the existence of the affordance, if applicable. Each affordance and how different features allow them is then discussed in detail. In general, these are cognitive affordances that arise from interacting with the platform, they might be put into action by users in a higher education context. The list is not meant to be exhaustive and other affordances can arise from the use of the micro-credential platforms.

Table 5-Affordances of micro-credentials

Affordance	Description of affordance	Associated features	Stakeholders involved	References
Building brand awareness	The extent of which the brand is recognized by the public.	• Designing the display for MCs • Registration for learning offering • Sharing MCs on social media • Sharing MCs to other parties	• Issuers	(Young, et al., 2019)
Stackability of achievements	The ability to use smaller achievements to build larger ones and to	• Visualising and documenting the pathways	• Issuers • Earners	(Hall-Ellis, 2016)

	demonstrate the pathway of the learner's achievements	for micro-credentials • Organizing micro-credentials into collections		
Recognition and portability of skills	The ability to have one's earned skills validated beyond the institution where they earned them	• Skill-related data • Verification technology	• Earners • Recognizers	(MicroHE, 2019)
Increasing Issuing process efficiency	The ability to handling the issuing of micro-credentials in a more efficient manner to resources	• Creating templates for micro-credentials • API integration	• Issuers • Recognizers	N/A

6.1.1 Building brand recognition

Today's higher education environment is complex and highly competitive, as a result, higher education institutions are expanding their brand recognition efforts (Pinar, et al., 2014). These efforts include being flexible to reach their stakeholders through different channels (Jackson, 2017). They also include communicating their brand identity elements such as logo, name, motto as well as value creating elements such as program content, students' educational activities and quality (Argenti, 2000; Pinar, et al., 2011).

One of the potential benefits of micro-credentials is that they can help issuer organizations to build their brand recognition (Young, et al., 2019). This thesis has identified three main features that can help issuers with building their brand recognition: (1) designing the display of micro-credentials, (2) sharing micro-credentials on social media and (3) sharing micro-credentials to other parties. The results of this study show that micro-credential platform providers are aware of these potential benefits as the majority of platforms offer these features for issuers.

- **Designing the display of micro-credentials**

Micro-credential platforms that offer this feature for issuers allow them to modify the visual aspects of the micro-credentials they issue, it also allows them to add their logo,

name and other information that they see relevant. It is important to note that this information is not dependent on the metadata related to the issuer and the activities that lead to earning the micro-credential. Allowing issuers to design the display of micro-credentials gives them control of what kind of information they want attached to them and communicated to stakeholders who will see them later on. As a result, issuer organizations have a new tool for communicating their brand identity and subsequently building their brand recognition.

- **Sharing micro-credentials on social media platforms**

The findings of this thesis show that sharing micro-credentials on social media is a feature that is offered by almost every platform included in this research. This highlights the awareness of micro-credential platform providers on the potential benefits this feature can have for higher education. This feature opens up new channels for issuer organizations to build their brand recognition. It also allows issuer organizations to communicate value creation elements embedded in the metadata of micro-credentials to a broader audience. Sharing micro-credentials that contain metadata related to the learning experience, evidence and other information can help issuers communicate those elements and build their brand recognition.

- **Sharing micro-credentials to other parties**

Similarly to the previous feature, sharing micro-credentials to other parties was offered by most platforms included in this study and allows them to build their brand recognition. The interesting difference would be that when earners share their micro-credentials to specific parties, they are mostly parties who are interested in understanding the activities that led to earning the micro-credential, the quality of learning experience and the skills that the micro-credential recognizes. This leads to a deeper understanding about the issuer organization and its process by these parties.

6.1.2 Stackability of achievements

One of the most discussed aspects of micro-credentials is stackability. Stackability is the ability to use smaller qualifications to build larger ones and to demonstrate the pathway of the learner's achievements. This allows a more flexible learning process for learners according to their objectives, time and resources. Learners can also create their own learning pathway instead of a one size fits all approach . They do not have to pay the tuitions for a complete program but they can only pay for the learning offerings they want and need (Willis, et al., 2016; Hall-Ellis, 2016).

This thesis identifies two main features that are offered by micro-credential platforms that afford stackability for its users: (1) visualising and documenting the pathways of micro-credentials and (2) organizing micro-credentials into collections. The results of this research show that only four out of the ten platforms offer one of these two features which is somewhat surprising since stackability is mentioned multiple times as a potential benefit of micro-credentials in literature. The platforms that offer these features realize those benefits but however, they still do not have a clear understanding of what is the best ways of implementing those features.

- **Visualising and documenting the pathways of micro-credentials**

In order to afford stackability, micro-credential platforms allow issuers to visualise and document the pathways of micro-credentials. The documentation part is mostly included in the metadata of the micro-credential, linking it to other micro-credentials. There remains a lack of understanding to the visualising part. There is no clear or consistent way to visualise the stackability of micro-credentials. That is why more research is necessary to better understand what the best ways are to visualise stackability.

- **Organizing micro-credentials into collections**

This feature is offered to earners as they are allowed to group their earned micro-credentials into categories. The platforms that offer this feature give complete freedom to earners over what to name the groups and what type of micro-credentials are included

into which group. There is no categorization for groups in any way or form. It still remains a unique feature that affords the stackability of micro-credentials when used by earners.

6.1.3 Recognition and portability of skills

According to a report by MicroHE (2019), micro-credentials have the potential to allow earners to take their earned skills beyond the institution where they earned it. However, there are several issues that can arise when earners try to get their skills validated in other organizations: (1) traditional degrees do not include specific skill-related data, (2) the recognizer's perception of the skills might not align with the issuer's perception and (3) there remains a lack of trust in micro-credentials as their implementation in higher education remains fairly new.

This thesis identifies two main features that can tackle those issues and afford the portability of skills for earners. These features are: (1) skill-related data and (2) verification technology.

Skill-related data

The findings of this study show that few micro-credential platforms include skill-related data in their metadata standard and that this might be due to the provider's prioritizing the technical features of their platforms over the academic ones. However, transparency of skill-related data is essential if earners want their skills recognized in different institutions to the ones they got the skills from. Skill-related data can include skill definition, skill type, level of mastery of skills, whether the skill is derived from a particular taxonomy and the skill reusability. All this information can help recognizers to have a better understanding of the earner's skills and what they mean. Making it possible to accept them.

Verification technology

An overwhelming majority of the micro-credential platforms included in this study prioritize verification technology to instil trust and confidence to the micro-credentials issued. These technologies allow all stakeholder to make sure that the micro-credentials and the

organization that issued them are authentic. This can give recognizers a sense of trust in the micro-credentials and the information they entail. It also makes sure that micro-credentials are never faked unlike traditional degrees. When recognizers have more trust in micro-credentials, they can be more likely to accept them from another organization, knowing they are authentic.

6.1.4 Issuing process efficiency

Higher education institutions are always looking to maintain their processes in a more efficient manner with respect to their time and financial resources. There remains a lack of understanding from the issuer's point of view regarding the resources needed to issue micro-credentials. Micro-credential platforms offer the affordance to handle these processes in a more efficient manner. There were two main features identified in this thesis that can contribute to help higher education institutions to better handle their resources when issuing micro-credentials: (1) Creating templates of micro-credentials and (2)API integration.

Creating templates of micro-credentials

Allowing issuers to create templates of micro-credentials can help them with their issuing process efficiency as they do not need to repeat the process every time a new credential is created. They would simply import the created template and edit it. This feature affords the issuing process efficiency but it would be interesting to see to what extent it would be used by issuers in a real-life context when the micro-credential platforms are implemented by higher education institutions.

API integration

Allowing the integration of micro-credential platforms to the higher education institution's existing platforms can save the institutions a lot of resources since they do not need to do double the work on multiple platforms. For example, teachers do not need to handle the grading on multiple platforms and administrators do not need to move their students'

data from platform to another if this process is streamlined using APIs. API integration might hold other affordances to higher education but it is difficult to state them without actual implementation.

6.2 Theoretical contribution

This research provides insights to micro-credential platforms, categorizes their features and analyses how different platforms compare to each other. It also helps establish an understanding regarding the affordances of micro-credentials to higher education and how the features of micro-credential platforms contribute to these affordances.

The findings of this study can be significant to the relevant literature at this early stage of micro-credential adoption in higher education. As mentioned earlier, the research around micro-credentials remain scarce (Young, et al., 2019), especially from the point of view micro-credential platforms and their affordances. Relevant literature often discusses the challenges and potential benefits of micro-credential implementation in higher education (Clayton, et al., 2014; Halavais, 2018; Barnett, 2017).

Different studies discuss micro-credentials from different perspectives in higher education, for example some studies discuss the issuer perspective, others discuss earners perspectives. However the perspective of micro-credential platforms and the features they offer is often left out of the conversation and to the best of our knowledge, the concept of affordances of micro-credentials is not discussed in literature until this point. This study contributed to fill this research gap by two key theoretical contributions. First, categorizing the features of micro-credential platforms and goes further into understanding why different platforms offer different sets of features. Second, the study also uses the affordance theory to draw out the affordances of micro-credentials for higher education and analyses how different features make these affordances possible.

6.3 Practical contribution

The findings of this study can help higher education institutions to have a broad understanding of the micro-credential platforms environment in terms of what features they offer and technologies they support. Based on these findings, higher education institutions can make informed decisions on which platforms to adopt depending on how they align with their vision, operations and stakeholders' perspective.

Regarding the case organization, this study lays out the foundation for achieving its objectives for adopting a micro-credential platform that fits with its vision. This study helps communicate an understanding of how different features can contribute to different affordances and also explicitly identifies the potential affordance for higher education. Based on this study, five platforms were chosen for a more extensive piloting process that involves the case organization's stakeholders in order to develop the initial understanding into more concrete knowledge.

This study can also help micro-credential platforms to assess their own offerings and solutions based on the needs of higher education institutions.

6.4 Research limitations and future research topics

Lincoln & Guba compiled four main criteria to evaluate the trustworthiness of qualitative research: (1) credibility, (2) transferability, (3) dependability and (4) confirmability. According to (Shenton, 2004) and (Korstjens & Albine, 2018), the criteria compiled by (Lincoln & Guba, 1985) are the best-known criteria for evaluating qualitative research.

Credibility describes the reliability of the research results (Korstjens & Albine, 2018), the rigour of the research process and how the actions taken were communicated. Credibility of a qualitative study can be measured by data triangulation and the secondary sources of data used to validate the primary results, the involvement of all authors to collect and analyse the data and the confirmation of the analysis results by other actors for further

checking. During this study, a rigorous research process was undertaken and communicated. The findings were also based on the primary data from the semi-structured interviews and group discussions as well as using the platforms to carve out the affordances based on indirect experimentation. The credibility of the research process could have been increased if other data collection processes were used. During the interviews, it was challenging to have the same line of questions for every interview since different platforms offer different features as well. It was the reasonable approach but it might affect the study's credibility.

Transferability is how the research results can be generalized and adapted to other settings (Shenton, 2004). Transferability can be measured by using quotes to communicate the data and the analysis methods taken. The findings of this thesis can be adapted to other settings in higher education. However it is difficult to say that the affordances identified in this study can also be applied to other settings like professional environments for example. Quotes were used to communicate the data to ensure the transferability of the study.

Dependability describes the accuracy, relevance and meaning of the study. It can be measured by external auditing and experts to review the data (Shenton, 2004). This study was not subject to external auditing, only the supervisor was involved in ensuring the dependability of the study.

Confirmability is how well the findings are connected to the data results in way that is helpful to the reader (Shenton, 2004; Korstjens & Albine, 2018). It can be measured by following a rigorous analysis method and discussions between the researchers conducting the research and other senior scholars who are not included in the research process regarding the preconceptions. The theoretical framework used during this study clearly communicates the link between the research results and the findings. The discussion section of this research further analyses those findings.

There are plenty of future research topics that can follow this study. Analysing how different stakeholders in higher education interact and perceive micro-credentials would be of high value at this stage of micro-credential adoption. Applying the same study to other settings like professional environments or non-profit environments can also uncover new knowledge concerning micro-credentials. In order to make the most out of the implementation of micro-credentials in higher education, understanding the convenience of micro-credentials for recognizing different types of skills is essential. For example, if micro-credentials are more suitable for recognizing soft skills or technical skills better.

On a more practical level, the confusion around micro-credentials and lack of understanding remains the top challenge for implementation. Hence, awareness building activities and micro-credential initiatives would highly benefit the micro-credential movement.

CONCLUSIONS

Micro-credentials are a relatively new concept that lacks common understanding in literature and when implemented in higher education. However, they have the potential to benefit higher education institutions and stakeholders as a solution to unbundle higher education, counter the decrease of traditional degrees' popularity and more. At this stage, the adoption of micro-credentials in higher education remains at its beginning stages. There are already challenges and opportunities that are shaping up from the early adoption initiatives. One aspect that has been often overlooked is the technological aspect and the micro-credential platforms accompanying the adoption process.

The objective of this thesis was to identify the features and affordances of micro-credentials to higher education. An initial set of interviews with micro-credentials experts took place to familiarize with the topic and identify relevant micro-credential platforms. During this study, ten micro-credential platforms were identified and the platform providers were interviewed to get a broad understanding of their different features. A comparison was drawn between the platforms that were included in this study and their features. Based on the results of the interviews and the affordance theory (Pozzi, et al., 2014), four main affordances of micro-credentials for higher education were identified: building brand recognition, stackability of achievements, recognition and portability of skills and issuing process efficiency.

The affordances identified in this study fall into the cognition process of the affordance theoretical framework. In order to have a better understanding of how these affordances are perceived and how can they affect higher education organizations, more studies that include actual implementation of micro-credential platforms are required. Once the initial challenges of micro-credentials in higher education are tackled, the technological challenges will rise, therefore it is essential at this stage of micro-credential adoption to start

looking into these aspects in order to make the most out of the micro-credential movement in higher education.

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APPENDIX A: MICRO-CREDENTIAL EXPERTS INITIAL INTERVIEWS

The interviews were carried out in the same format. Each interview begins with the respondent providing an overview of their experience followed by a semi-structured interview using the questions below.

Interview questions:

a) What opportunities would digital badges offer for universities/students/employers? / What challenges can micro-credentials solve in Higher Education?

b) What are the skills (soft skills-core competencies-technical competencies) that the competence passport should include?

c) Can core competencies like critical thinking, decision making, and teamwork be assessed and certified by universities?

d) How will the concept of digital badging be communicated to students and employers to make the most out of it?

e) What will be the standards required from students to earn a badge? (The completion of an exam? The successful part-taking in a challenge?)

f) What kind of information should be on the competency passport? (Picture-Name-Badges-Challenges-Languages)

g) How can the digital badges be searchable from an employer perspective?

h) If a student has already a certain skill or a competence, will that skill be verified by the university and will the student be awarded a digital badge for their passport or will the student have to take the course all over again from the issuing university?

i) Will badges have different levels of achievements for each competence depending on the student's mastery of that competence? (Novice-Intermediate-Advanced-Expert/Bronze-Silver-Gold-Platinum)

j) If an ECIU student takes courses elsewhere (another university-MOOC) will their skill acquired be recognized or even considered to be measured? If yes, how?

k) What are the main challenges for implementing a competence-based digital badging system?

l) What security/privacy concerns should be addressed?

m) Are there benefits to a System-wide approach? Is a System-wide approach financially feasible and sustainable?

APPENDIX B: MICRO-CREDENTIAL PLATFORMS INTERVIEWS

The interviews were carried out in the same format. Each interview begins with the respondent providing an overview of their experience, role and their platform followed by a semi-structured interview using the questions below. Since each platform provides different features, these questions were adapted accordingly during each interview.

Interview questions:

a) How micro-credentials are issued in the proposed solution?

b) Who handles the micro-credentials issuing?

c) What metadata is captured by the micro-credential issuer about the learning activity or the stakeholders involved, is the information manually entered or automatically retrieved (e.g., via APIs)?

d) Who are the users of the proposed system and how the use of the system differs based on the different user types?

e) Does the solution enable profiles for the learners?

f) How the solution displays the earned micro-credentials?

g) What features are offered for each user group of the system?

h) Does the solution capture the skills and competences the learner has achieved, if yes, how?

i) Is the solution proprietary or free to use by ECIU University?

j) Is the solution GDPR compliant?

k) Does the solution support the import of credentials from other platforms such as LinkedIN or MOOCs?

l) How is information shared between the solution provider and the ECIU University?

m) What is the degree of transparency regarding information exchange?

n) Can the solution be customized for ECIU University, and if yes, to which extent and by who?

o) How is the solution developed further in the near future, is there a chance to join the piloting of the solution if it is a good fit to ECIU University vision of a Learner's Wallet?