African European Maker Innovation Ecosystem

Deliverable 4.1

Skills – Mutual Recognition Standard

Due date of deliverable: 31/01/2023

Actual submission date: 29/06/2023

Start date of project: 01/02/2022 Duration (36 Months)

Dissemination Level: Public ✓

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101016858.

DELIVERABLE

Work Package	WP4 Distributed Manufacturing Network
Deliverable	D4.1 Skills - Mutual Recognition Standard
Document Name	D4.1 Data standard for DIH users' skills published with promotional material for adoption
Due Date	M12: 31. January 2023
Submission Date	M17: 29. June 2023
Dissemination Level	[X] P – Public [ ] CO – Confidential
Deliverable Lead	IOP
Author(s)	Sarah Hutton (sarah.hutton@internetofproduction.org)
Point of Contact	Barbara Kieslinger (kieslinger@zsi.at)
Reviewers	Anna Sera Lowe (anna@manufacturingchange.org), Daniel Ewusi-Essel (daniel@africamakerspace.net)
Status	[ ] Plan [ ] Draft [ ] Working [X] Final [ ] Approved
Abstract (for public dissemination only)	This document describes the development of a mutual recognition standard in order to issue digital "Maker Passports" that show skills and experience levels of makers.
Keywords	Research, Skills, Data standard, processes

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Document History

Version	Date	Comment
01	16 01 2023	First structure and outline
01	16 01 2023	Main content added to all sections
1.0	12 04 2023	Peer review and detailed feedback on overall structure and specific content
1.0	30 05 2023	Integration of peer review comments
2.0	29 06 2023	Final editing

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List of Abbreviations/ Acronyms

CA	**Consortium Agreement**
CO	**Confidential**
DIH	**Digital Innovation Hub**
DI	**Digital Innovation**
DMP	**Data Management Plan**
DoA	**Description of Action**
DOI	**Digital Object Identifier**
DSI	**Digital Social Innovation**
EC	**European Commission**
EGE	**The European Group on Ethics in Science and New Technologies**
GA	**Grant Agreement**
GDPR	**General Data Protection Regulations**
H2020	**Horizon 2020 program of the European Union**
IOP	**Internet Of Production**
IPR	**Intellectual Property Rights**
MAB	**mAkE Advisory Board**
ORDP	**Open Research Data Pilot**

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OKH	**Open Know-How**
OKW	**Open Know-Where**
PMB	**Project Management Board**
PU	**Public**
PSS	**People and Skills Specification**
RE	**Restricted**
R&I	**Research & Innovation**
STEM	**Science, Technology, Engineering, and Mathematics**
SWOT	**Strengths, Weaknesses, Opportunities, Threats**
WP	**Work Package**

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Executive Summary

The goal of this deliverable is to create an open data specification for the mutual recognition of skills and experiences held by makers, by establishing an understanding of vocabulary and a shared taxonomy of skills and experiences, as well as a framework for the verification of this knowledge.

By analysing existing credential verification and learning data systems in digital fabrication and educational settings and gathering data from makerspace leaders around the world, we were able to create a preliminary data standard which can be used as part of a Knowledge Verification Framework for the recognition of an individual maker's identity and credentials.

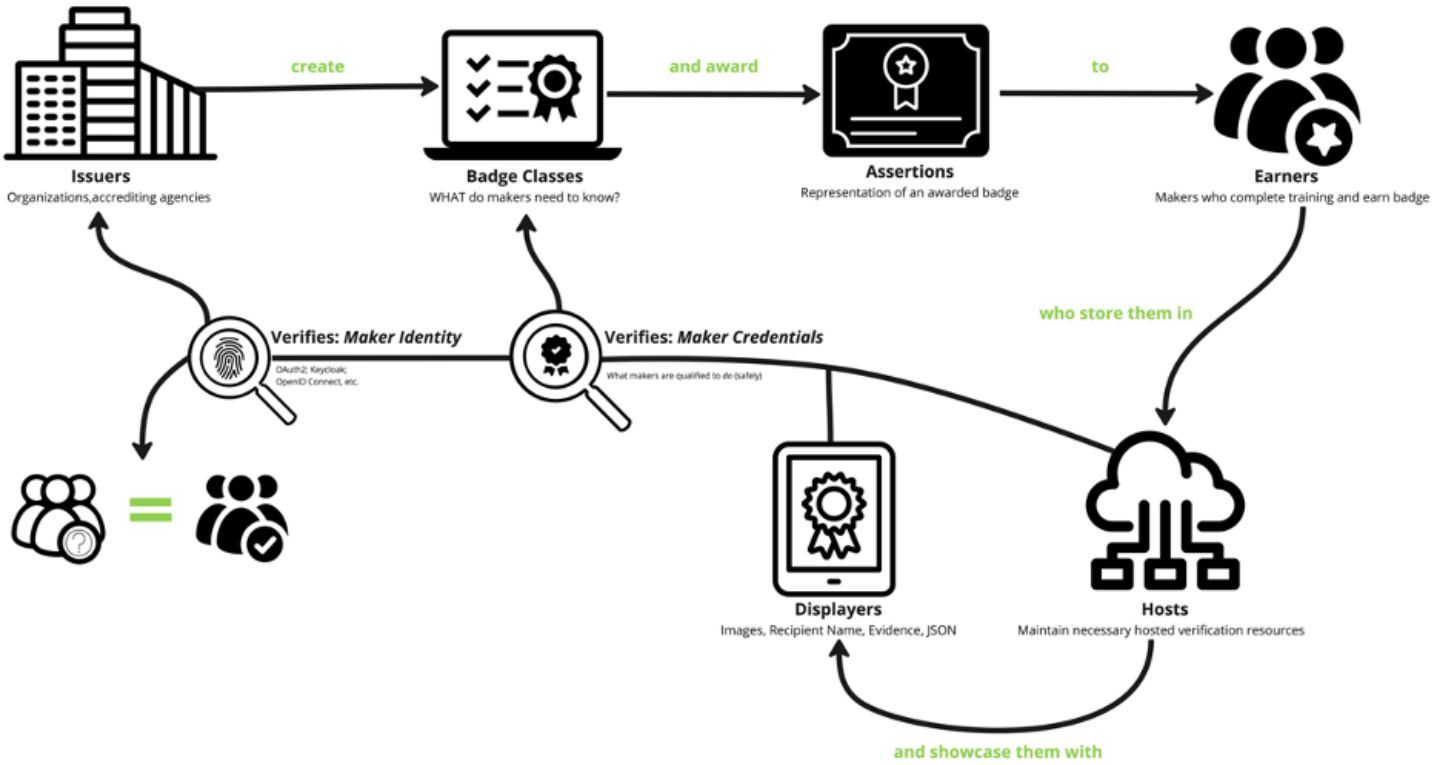

Figure 1: Knowledge Verification Framework, Maker Skills and Experiences[1]

The People and Skills Specification (PSS) provides a structure for verifying the skills and experiences that are needed to make a specific thing, and, when used in conjunction with a Knowledge Verification Framework, the PSS gives individual makers the capability to **signal their experiences and skills to potential employers, collaborators, and policy makers around the world**.

[1] *1EdTech Derivative* / *OBV2.0 IMSGLC*

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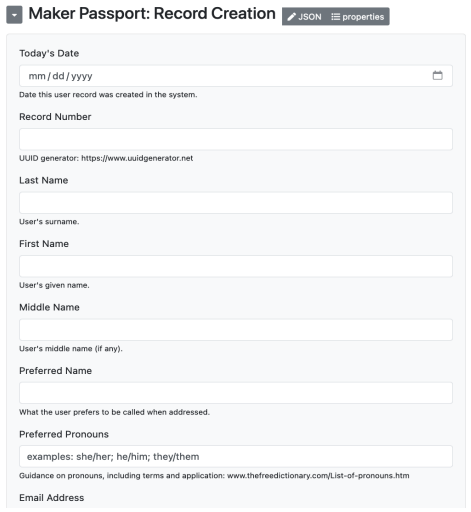
Sections 1-4 provide an introduction to the deliverable, with a focus on the goals, objectives, activities, and outcomes related to the research and development phase. Research methodology, use cases, and data analyses paint the landscape for the People and Skills Specification to emerge in the next section.

Sections 5-7 take a deeper dive into exploring the People and Skills Specification (PSS) as a shared understanding of the explicit, implicit, tacit, and procedural knowledge necessary for production in distributed manufacturing and makerspaces. We specify a mechanism for the verification of passport holders (makers) by authorised issuers.

Methods for information exchange, file and display outputs, and certification properties are included.

PSS JSON Schema
WebUI for easy data entry



We close the report in section 8 with recommendations on how to use PSS at the local level including tooling for WebUI, including a governance framework to support the continued development of the specification in the open source community.

All deliverable assets and outputs are included in the listing of peripherals and accompanying appendices.

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1. Introduction

1.1 How to Read This Report

If you are looking for depth beyond the Executive Summary, here are the recommended areas to target for a quick review:

- Introduction (1-1.4.5): includes background to contextualise the People and Skills Specification (PSS) as one of the 5 infrastructure families, introduces the PSS including a problem statement, and provides use cases that further help to explain the "why" of this project and the imperative for doing the work.
- Discussion of Research Results (4-4xx)
- PSS itself:
- What is needed for you to use the PSS: tools, restful API, web interface, etc
- Next steps: how to get involved

1.2 Process Overview

The goal of this deliverable is to create an open data standard for the mutual recognition of skills and experiences held by makers; with this standard, maker capabilities could easily be verified between learning data model systems, potentially via the use of a "digital maker passport." The aim is to develop a shared understanding of the explicit, implicit, tacit, and procedural knowledge necessary for production in distributed manufacturing and makerspaces, enabling individual makers and makerspaces the ability to communicate expertise, competencies, and transferable skills to potential employers, collaborators, and other organizations all over the world.

By analysing existing credential verification and learning data systems in digital fabrication and educational settings and gathering data from makerspace leaders around the world, we were able to create a preliminary data standard which can be used as a framework for the verification of an individual maker's identity and credentials. Using this standard to connect the competency credentialling process to an individual, as opposed to an academic or university program in a closed credentialing system, an individual maker may then achieve full data sovereignty and mobility.

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Our process is framed by the following 5 steps:

Figure 2: 5-Step Research and Development Process for Establishing the People & Skills Specification

We develop a strategy for establishing a People & Skills Specification, using the themes that emerge from data gathered during desk research and user interviews. This strategy is then used to develop a BETA release of the People and Skills Standard (PSS) for review by a PSS Working Group. We finish with a recommended strategy for application of the standard, including recommended methods and tooling for immediate implementation and pilot testing.

1.3 Context and Background

This section provides background to contextualise the People and Skills Specification (PSS) as one of the 5 infrastructure families. The PSS in introduced with an accompanying problem statement, identified target audiences, and use cases that further help to explain the "why" of this project and the imperative for doing the work.

1.3.1 Open Digital Infrastructure Families

Emerging technology is already transforming the way we produce goods, services, and experiences, allowing more people to join in the design and fabrication process. To build a sustainable system that is globally networked and locally executed, a combination of open infrastructure, information, processes, and data specifications needs to be developed and shared openly with the global community. Providing makers, makerspaces, small to medium enterprises (SMEs) and start-ups with resources and access to networks and open standards and tools, makes rapid collaboration, new revenue streams, and sustainable business models more achievable for entrepreneurial stakeholders in a global manufacturing ecosystem.

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The Internet of Production (IOP) is working to establish five families of open infrastructure that enable anyone, everywhere, to participate in production.

Currently, this work is centered around five families of digital infrastructure which cover the essential ingredients needed to make anything:

1. Designs & Documentation (Open Know-How/OKH)
2. Machines & Tools (Open Know-Where/OKW)
3. **People & Skills** - *currently under development; BETA released*
4. Materials & Components - *research and scoping underway*
5. Contracts & Business Models - *research and scoping underway*

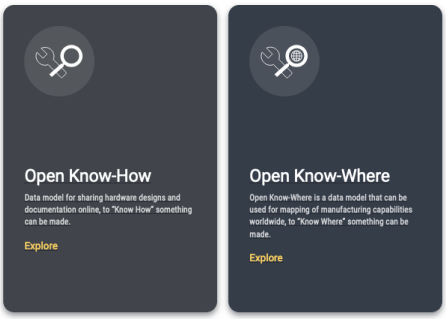

Figure 3: OKH and OKW Data Specifications

Initiatives emerge and are driven by collective community interest in the exploration of common focus areas, either within one or across multiple infrastructure families. The IOP is currently working with community stakeholders on continued development of the first two of the five families listed above.

1.3.2 Introducing the "Who" of Making Things: People & Skills

The central focus of the **People & Skills Specification (PSS)** is to create a shared understanding of the explicit, implicit, tacit, and procedural knowledge necessary for individuals to make things. This specification is also intentionally designed to provide a framework for sharing, fellow makers, and educational institutions via the Open Badge System Framework [3]; this specification can also be used as a stand-alone, should an open badging system not be an option.

Building on Open Know-How (OKH) and Open Know-Where (OKW), which address *how* we share knowledge for making things, and *where* things can be made, the PSS addresses the third critical component of knowledge-sharing for the reproducibility of items - *who* can provide the expertise for making things. This is done with a focus on the experience and skills necessary for production, and how those skills and experiences can be shared. By establishing a shared understanding and vocabulary surrounding the production of goods, we have the potential to open up networked conversations between experts in digital and physical fabrication.

PSS provides the potential for broadening a global network of experts, helping place the possibility of product prototyping into the hands of community members, which means increased potential for rapid collaboration, and increased overall quality of the products being produced.

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Increased recognition of expertise and awareness of who has this expertise also means that products being made are manufactured with fresh community knowledge and skill, which means better products for our society**.** The increasingly diverse engineering talent that will now have the potential to recognize local, specialized knowledge, will appeal to industry and larger manufacturing companies, which supports individual makers seeking industry jobs.

1.3 Problem Statement: Why this Work, and Why *Now*

1.3.1 Do We Need a People and Skills Specification?

Openly sharing knowledge for the purpose of producing items at a global scale relies on the shared understanding of *how* to make the thing, *where* to go to make it, and *who* has the expertise and skills needed to make it. With Open Know-How (OKH) and Open Know-Where (OKW) addressing the *how* and the *where* respectively, verifying the *who* comes into focus as the next necessary phase of data specification development.

The People and Skills Specification provides a structure for verifying the skills and experiences that are needed to make a specific thing, by providing a shared taxonomy of skills and experiences, and a framework for the recognition of this knowledge.

This data specification supports not only the ability to locate the expertise and skills needed to make a thing - it also gives individual makers the capability to **signal their experiences and skills to potential employers, collaborators, and policy makers**.

Our aim is not to reinvent the wheel, rather, it is to **connect preexisting schemas and processes** in a framework that will allow for anyone to build that wheel on their own, in a framework that allows for interoperability with other platforms and systems that may already be in use by manufactures, makerspaces, production facilities, and other educational and training settings. With a framework for locating the people with the skills and experience for making things, individual makers will have the capability to signal their experiences and skills to potential employers, collaborators, and policy makers; this means increased opportunities for employment and progressive training and educational programming.

Used in conjunction with the Open Know-Where and Open Know-How data specifications, makerspaces will have the additional cability to signal what facilities and equipment they have to offer for making things, bundled along with the skills and experiences needed to complete the job. The aim is to connect all the information necessary from start to finish, to make most anything. This will offer increased agency,

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economic security, and professional sovereignty in a shifting industry landscape where personalized training programs are drastically impacting opportunities.

1.3.2 Problem We're Trying to Solve for Target Audiences

For our target audiences such as Makers, Designers, Engineers, and Artists, what is the expanded problem statement? This is how we have frames what we are trying to solve, and what is involved:

Figure 4: People and Skills Problem Statement: Problem We're Trying to Solve for Target Audiences

1.4 Use Cases

Generic use cases from other documents to frame the intro here, and then move into the the immediate application/use cases within mAkE and IMA.

Pull use case in problem scope from page 11 up here, and create a visual with additional use cases

1.4.1 Digital Maker Passport, mAkE

To establish a Mutual Recognition and Data Standard for Digital Innovation Hubs (DIH) Users' Skills Using Maker Passports, in alignment with the remit of D4.1 SKILLS - Mutual Recognition Standard, which is funded by the European Union's Horizon 2020 programme under grant agreement No. 101016858.

A use case for this work will be for its immediate application to the open system infrastructure developed as part of the pan-African mAKe project. Participating makers who are issued a digital 'Maker Passport' will have a way to communicate experience and skill levels automatically for ease of navigation through the ecosystem (estimate of 500+ instances) of Digital Innovation Hubs (DIHs).

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Immediate Use Case: Navigating a Pan-African Ecosystem

By design, the PSS could be adopted and adapted by anyone who wishes to have a credentialing system which enables nomadic makers to travel between makerspaces, such as that being developed as a part of the mAkE project. This navigation will be enabled by using a digital 'maker passport,' the preliminary criteria for which has been defined by maker community members during the research process preceding the PSS BETA release. You can read more about this project, sponsored by the European Horizon 2020 Programme here: https://makeafricaeu.org/about.

2. Deliverable Structure Overview

This section provides an overview of the goals and aims of D4.1 and how the work was undertaken to create the BETA release of the People & Skills Specification as a 5-step process.

2.1 Scoping, Phases of Work, and Outputs

In alignment with project outcomes defined by the Alfred P. Sloan Foundation, there are 4 main categories of work outlined in the People and Skills Standard project:

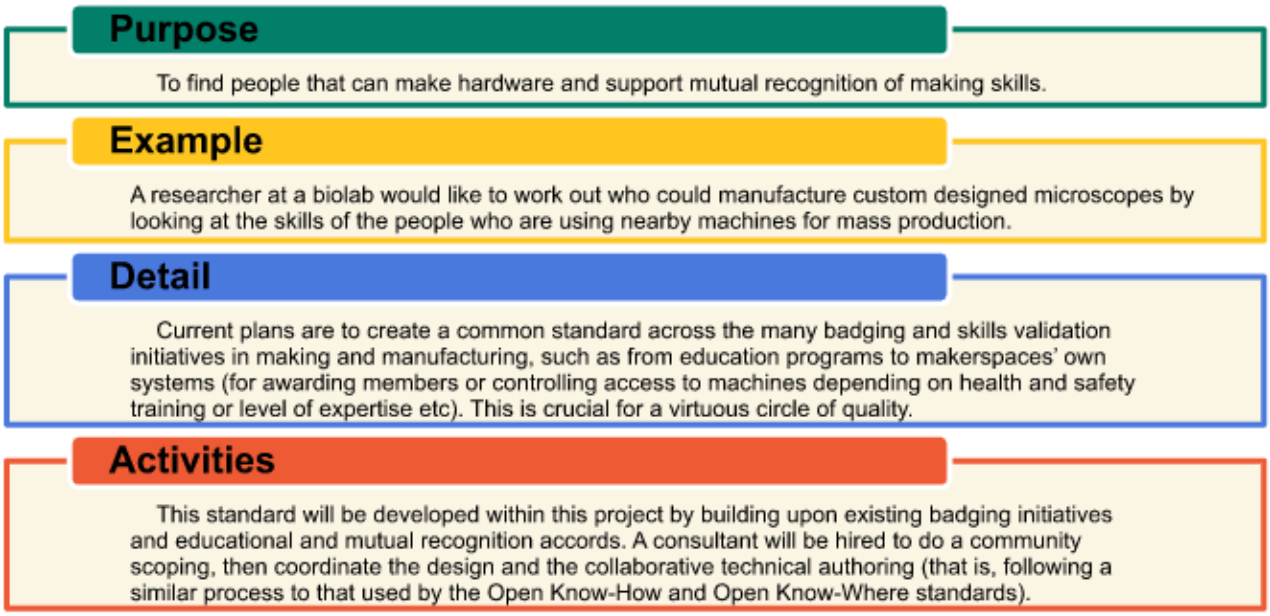

Figure 5: People & Skills Project: Categories of Work

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In alignment with [project outcomes defined by the Alfred P. Sloan Foundation](), there are 4 phases of work activity identified in the People and Skills Standard project:

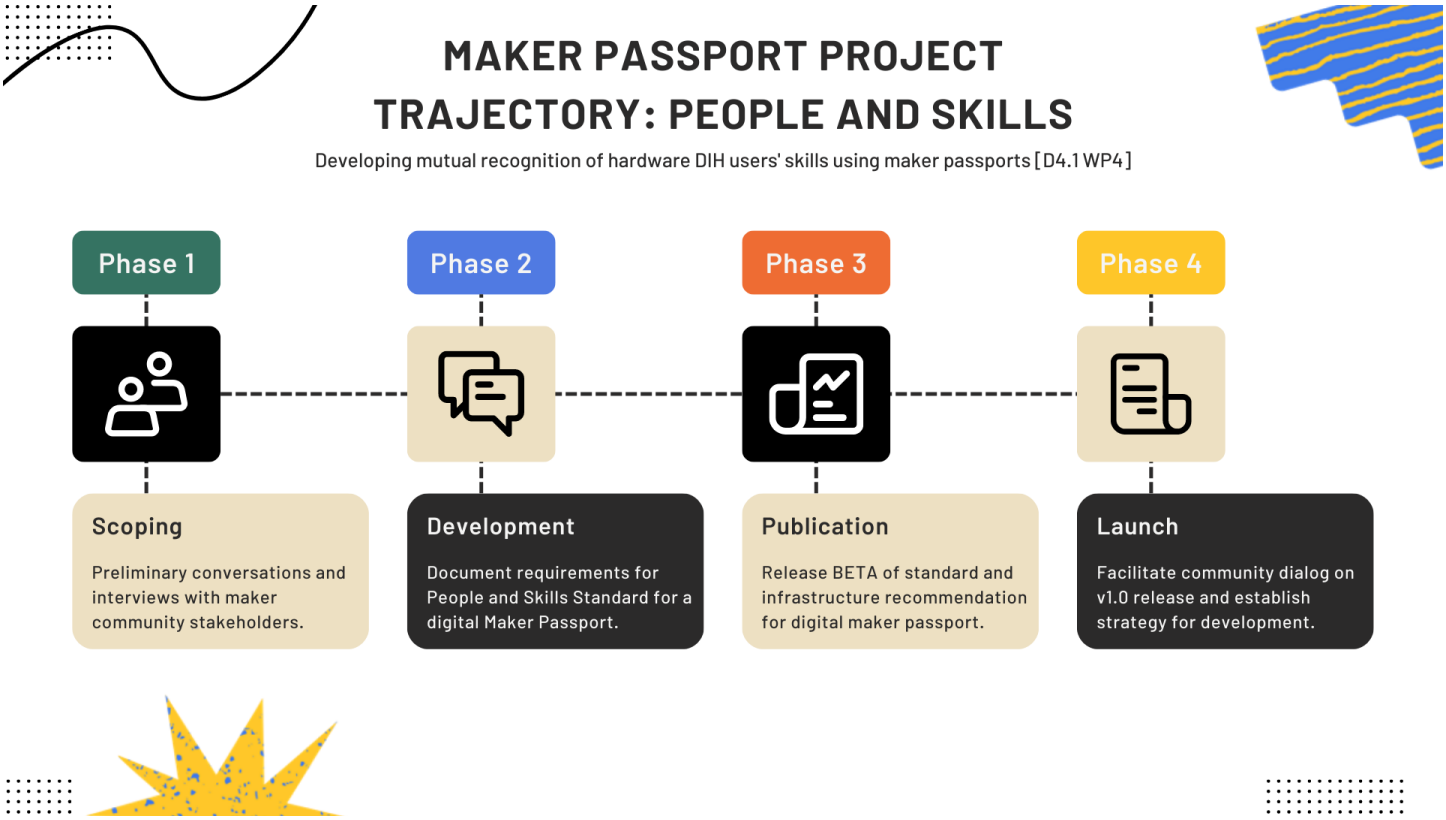

Figure 6: People and Skills project phases defined by the Sloan Foundation

The fifth phase, *Adoption*, falls outside the scope of this project, and is reflected as such in Table 1, which provides a grid overview of the 5 infrastructure families as outlined by the Sloan Foundation.

Standard	Scoping	Development	Publishing	Launch	Adoption
Open Know-How: Discoverability	Done	Done	Done	Done	Project
Open Know-Where	Done	Done	Done	Done	Project
Open Know-How: Portability	Project	Project	Project	Project	Project
Open Know-How: Interactivity	Project	Project	Project	Project	Project
Materials & Components	Project	Project	Project	Project	Beyond
People & Skills	Project	Project	Project	Project	Beyond
Contracts & Business Models	Project	Beyond	Beyond	Beyond	Beyond

Table 1: Summary of standardization work in relation to the scope of this project and broader Sloan project grid

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Figure 7: Where the People and Skills Standard Intersects with the mAkE Project

This work package aims to foster distributed manufacturing across the mAkE network by developing and providing the infrastructures that help sharing 1) skills, 2) machinery and 3) contracts between DIHs and makerspaces.

2.2 Stakeholders and Primary Audiences

The main stakeholders of this work package are DIHs and makerspaces as beneficiaries of the developed infrastructure, who will not only participate in testing and refining the developments but also showing first proofs of concept by using the maker passports, the mapping of machinery and the contracting systems. Additionally, we aim to reach out to other initiatives, such as Fablabs.io and Hackaday, for the creation of the infrastructure as well as the dissemination of the outputs of this work package. The main activities of this work package, together with the expected outputs and outcomes, as well as potential means of data gathering for the evaluation purpose can be seen in the following table.

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Drawing from the communities of practice identified in D6.1 Community Activation and Engagement Strategy, the mAkE community is identified as follows:

Figure 8: mAkE Communities Identified in D6.1

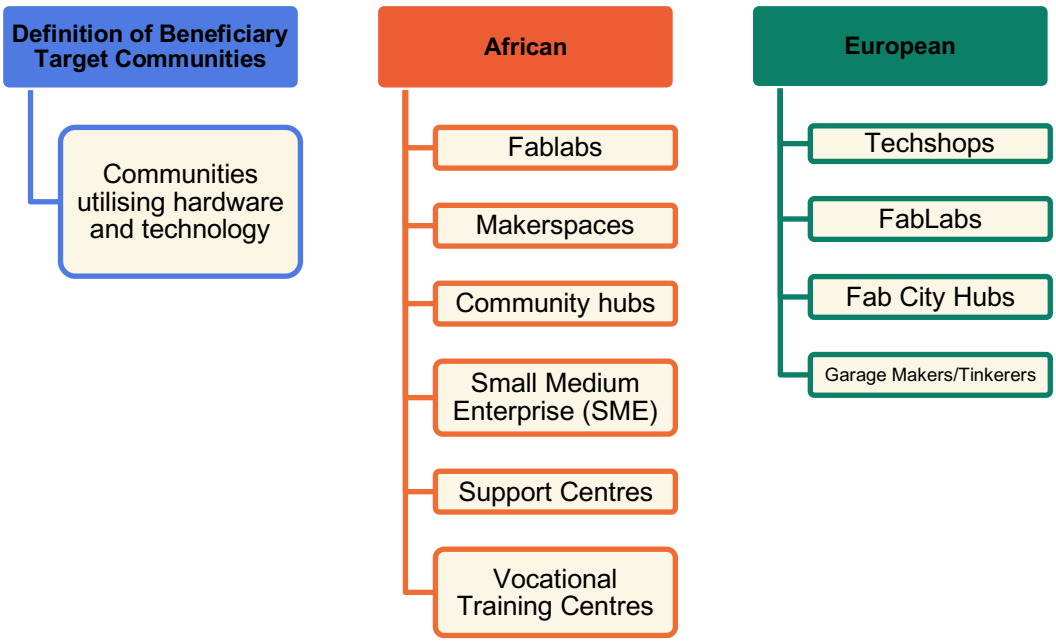

Figure 9: Co-design mapping the African and European community target audiences identified in D6.1

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2.3 Output Matrix and Risk Assessment

Planned activities	Expected output and outcome	Potential means of data gathering
Developing Maker Passports for the mutual recognition of makers' skills Conduct desktop research and interviews Create a working group Co-create an initial open standard for beta testing Implement a Maker Passport prototype system for proof of concept Promote the open standard and Maker Passport internally and externally	**Output:** • Beta version of an initial open standard for mutual recognition of maker skills (M12) • Prototype of a Maker Passport system (M18) • Revised Skills - Maker Passports & Prototype (M34) • 500 references to Open Standards (request or access) • 50 Open Standards adopted, means 50 organisations/ makerspaces, who are willing to use the passport system • Around 150 people using the new open data standard for maker skills (Maker Passport) • Perceived usefulness and applicability of the maker passport to makers and members of DIHs **Outcome:** • Improved demonstration of skills and experience levels of participating makers • Facilitated search for peers to scale up production and fill skill gaps • Facilitated search for mentors • Lessons learned on how to share makers' skills and support digital fabrication processes	• Internal reports and documentation by consortium partners involved in the task • Access and social media statistics • Pre-testing of the initial open standard • Focus groups with makers and DIHs who used the Maker Passport to learn about the applicability and usage in the different contexts and the benefits of usage • Interview or focus group discussions with makerspaces who did not follow up using the maker passport to learn from their experiences

Table 2: People and Skills Expected outputs, outcomes, and activities.

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Risks identified by mAkE associated with this work package:

Identified Risk	Actions Taken to Prevent Negative Impact
01 It might be difficult to find interested experts who are willing to participate in the working group to develop the Open Standard for skill recognition.	Established robust strategy for recruitment of working group members, including outreach via global survey and in-person outreach conducted at the Future of Making, Open Toolchain Foundation, and OSHWA events.
02 High enough number of makers involved in testing the maker passports are not received.	The maker passport can be tested by organization members of the Innovative Manufacturing in Africa (IMA) Project cohort, which is a part of the Research and Innovation Systems for Africa (RISA) and funded by the UKaid through the Foreign, Commonwealth and Development Office. The IMA is a one-year project that will support research and innovation capabilities in the hardware maker innovation ecosystem in Kenya, Ghana and South Africa. During this project, the awardees will engage in research capacity to show their impacts, participate into a distributed production, develop common indicators and participate in Business Models activities.
03 Difficulty finding makerspaces and DIHs who are ready to document their machinery and test the mapping of machinery and the digital contracting system.	*See mitigation activities for identified risk #2.*
04 Challenge in identifying "real" use cases or orders for the testing of the digital contracting system (such as a Kickstarter campaign, a simple donation or a ministry placing an order).	*See mitigation activities for identified risk #2.*

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Table 3: Risks identified by mAkE associated with WP and actions taken to mitigate negative impact

2.4 Project Timeline and Milestones

Project Timeline: Activities and Outputs by Month

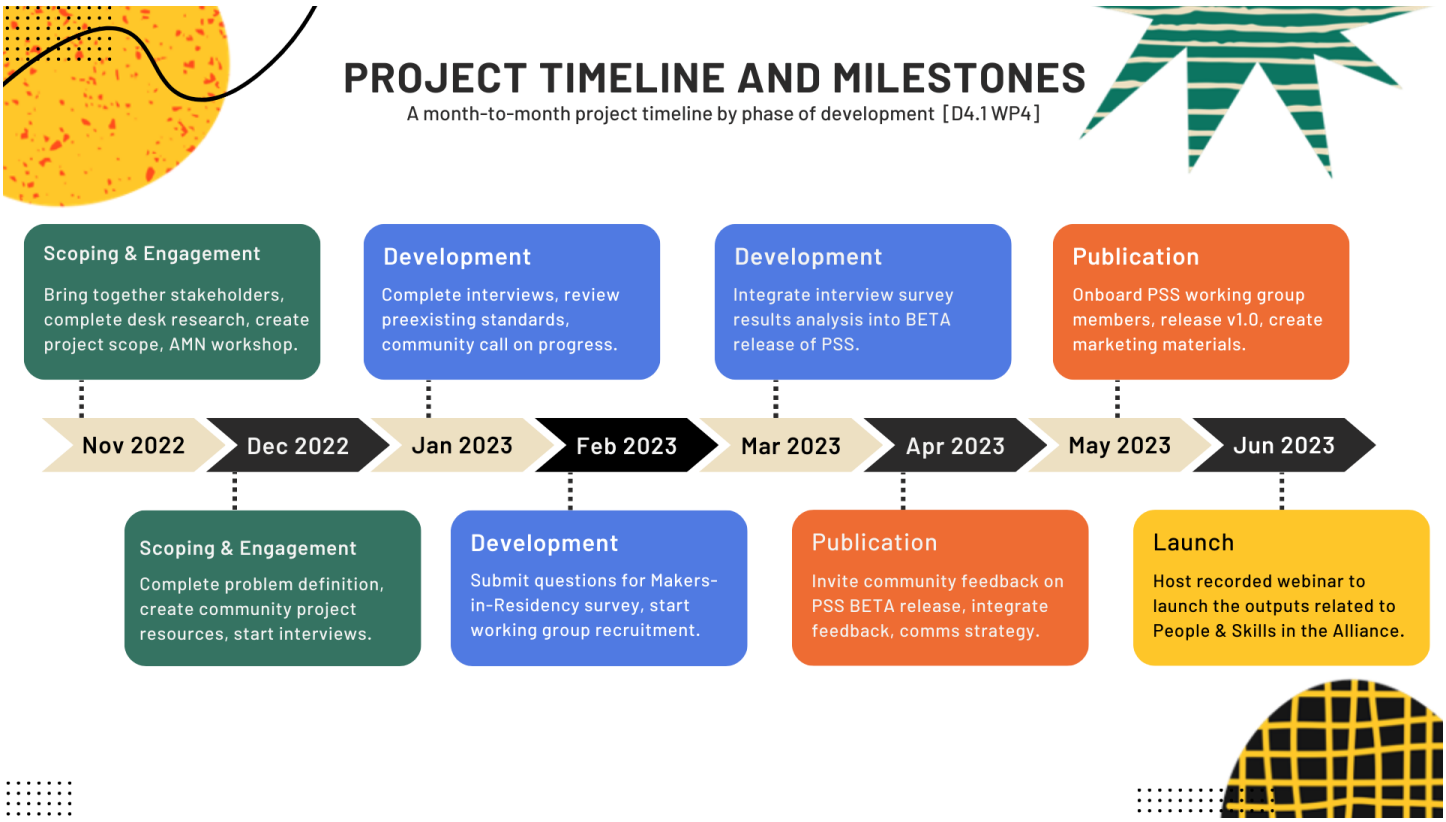

Figure 10: People and Skills Project Timeline Visualization

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2.6 Project Activities Detailed Overview

Activity	Outputs	Means of Gathering Data
T.4.1.1 desk research to identify existing initiatives, skills taxonomies and training programmes that cover maker skills **T.4.1.2** conduct interviews of leaders in this field **T.4.1.3** analyse results and synthesise an initial standard for mutual recognition of skills **T.4.1.4** convene a voluntary **working group** for a maker skills data standard (based on learning from the Open Know-How and Open Know-Where data standard processes **T.4.1.5** agree on a beta version of the standard for testing	• 500 references to Open Standards (request or access) - for ex. put a sign in button on the website to get numbers of subscribers/ interests in maker passports • 50 Open standards adopted, means 50 organizations/makerspaces, who are willing to use the passport system • Around 150 people using the new open standard for maker skills	• Document analysis • Semi-structured interviews • Survey research • Access and social media statistics • Pre-testing initial standard • Focus groups with makers and makerspaces who have tested/used the passport • ITWs or focus group discussions who did not follow up using the maker passport to learn from their experiences
T.4.1.6 implement a simple Maker Passport prototype system for partners within the project to use as a proof of concept	***Deliverables addressed by subsequent work packages (WPs)***	
T.4.1.6 implement a simple Maker Passport prototype system for partners within the project to use as a proof of concept	***Deliverables addressed by subsequent work packages (WPs)***	
T.4.1.7 confirm the data standard with the voluntary working group	***Deliverables addressed by subsequent work packages (WPs)***	
T.4.1.8 support adoption of the standard into the systems of the partners within the project	***Deliverables addressed by subsequent work packages (WPs)***	

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Activity	Outputs	Means of Gathering Data
T.4.1.9 promote the standard externally	***Deliverables addressed by subsequent work packages (WPs)***	
T.4.1.10 hand over the standard to the IOP to maintain and support beyond this project.	***Deliverables addressed by subsequent work packages (WPs)***	

Table 4: Project Activities Detailed Overview

3. Research Methodology

3.1 Purpose and Scope

The primary purpose of this project is to conduct research toward developing a standard for People and Skills, to lend support to establishing a shared understanding of the explicit, implicit, tacit, and procedural knowledge necessary for individual makers to participate in and easily navigate a distributed manufacturing ecosystem, such as that being developed as a part of the mAkE project; this navigation will be enabled by using a digital 'maker passport,' the criteria for which will be defined by maker community members during the research process and/or in the People and Skills Community.

The experiences and feedback of makerspace leaders and stakeholders were captured via semi-structured interviews to help move to identify emergent thematic categories for the development of a survey to gather larger datasets from the maker community. Document analysis across open community platforms, unpublished/grey literature, white papers and open publications related to makerspace passport programs, microcredentialing, and digital badging programs was additionally conducted to inform the research.

Grounded theory and constant comparative analysis were chosen for preliminary data analysis because it is inductive and provides an approach to understanding, particularly in studies regarding software engineering and development (Adolph & Hall, 2011; Hoda, 2021; Shannak & Aldhmour, 2009; Stol, Ralph, & Fitzgerald, 2016).

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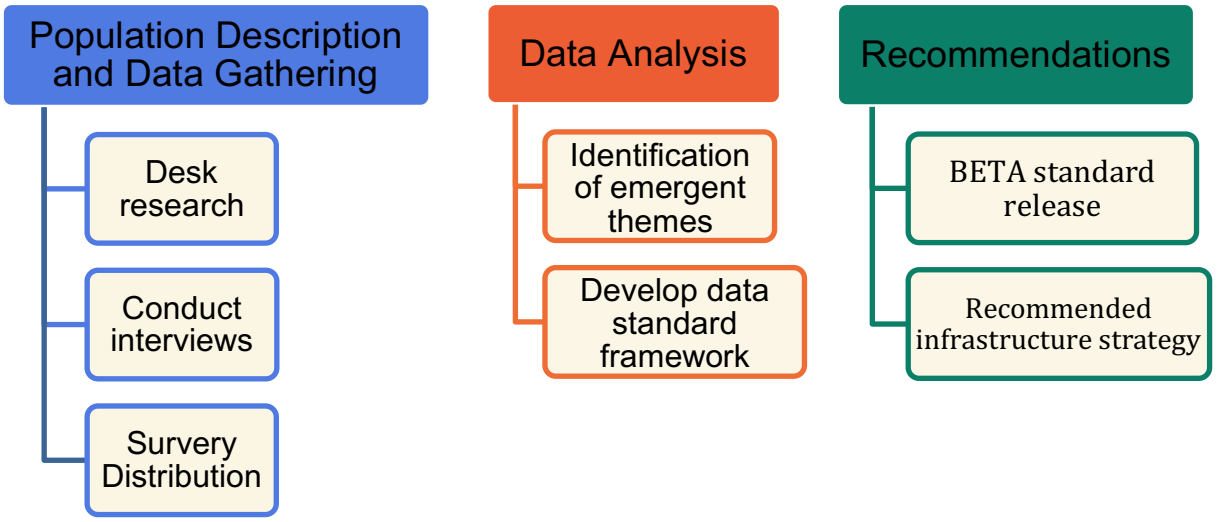

Figure 11: Deliverable research methodology

3.2 Population Description and Characteristics

Study Participants were purposefully selected on the basis of intersection with one or more of the three primary stakeholder categories:

1. Makerspace leaders: space or organisation director, coordinator, head, chair, consortium lead, etc.
2. Makerspace employees/volunteers
3. Makerspace digital passport architects, developers of digital project passport systems

Study participants were selected from a broad range of organisations identified as stakeholders in open hardware and manufacturing, including private and publicly held organisations, for profit, NGO/NFP, academic and research organisations, and community research forums and associations.

3.3 Evaluation Instruments

<u>25 Semi-Structured Interviews</u>

The experiences and feedback of makerspace leaders and stakeholders were captured via semi-structured interviews to help move to identify emergent thematic categories for the development of a survey to gather larger datasets from the maker community.

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Workshops/Focus Group Facilitation

Workshop materials were developed to enable focus group facilitation at stakeholder events. The focus of the workshop content, *Building a Makerspace Passport: What training and skills do people need?*, includes multiple active learning exercises, with the following session goals:

- Communicating the work of D4.1 and making it personally relevant to attendees
- Gathering information relevant to WP D4.1

Surveys

Drawing from preliminary research findings, a survey was distributed in early February, to gather a larger quantitative dataset that is complementary to the qualitative data that has been gathered thus far during interviews. The focus of this survey is framed using the emergent categories of Who, What, Why, and How that have been identified by exploratory research.
Were received 66 responses from individual makers and 31 responses from makerspaces leaders.

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Makers Driving Local Innovation: Join the African and European network of networks and the Makers-in-Residency Program

The form **Makers** Driving Local Innovation: Join the African and European network of networks and the Makers-in-Residency Program is no longer accepting responses. Try contacting the owner of the form if you think this is a mistake.

Resume collecting responses (Only form editors can see this link).

3.3 Interviews

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101016858.

Questions listed in appendix

3.7 Ethics and Data Privacy

The lead researcher in this project is currently (through 2025) CITI certified in the ethical handling of research involving human subjects. In compliance with the CITI Program's standard on research, ethics, compliance and safety training, the following measures are being taken during over the course of the project:

- Risk to participants or others involved with the study are continuously monitored and mitigated appropriately (Creswell & Creswell, 2018).
- Obtained informed consent of all participants and maintained an open and friendly style of communication to foster trust with study participants.
- Confidentiality of all participants was maintained; raw data files are stored on encrypted servers, and any research results are shared in aggregate and deidentified from original participants.
- All data collected was stored on encrypted hard drives, with redundant copies that are password protected.
- Pseudonym identifiers will be used in the final report of findings when/where necessary.

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4. Discussion of Research Results

From this preliminary research and analysis, we determined an emergent framework for structuring the verification and credentialing workflow of a digital maker passport, using the people and skills data standard:

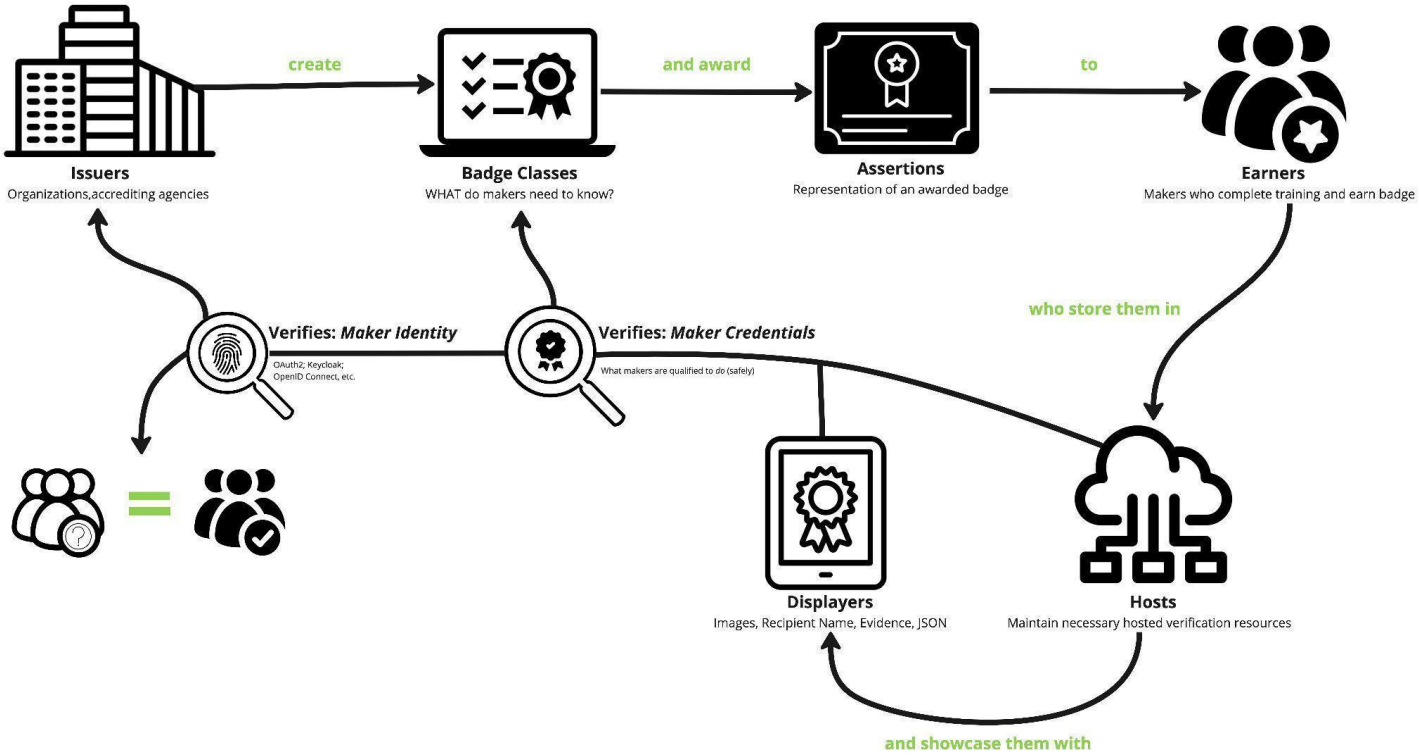

Figure 12: Knowledge Verification Framework, Maker Skills and Experiences[2]

[2] *1EdTech Derivative* / *OBV2.0 IMSGLC*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101016858.

4.1 Verification Categories

This workflow, based on the framework outlined by 1EDTECH's Open Badges, is reliant on two main forms of verification:

1. **Maker Identity:** How an individual confirms they are who they claim to be, using standard authentication protocols such as Oauth 2.0 and OpenID Connect.

2. **Maker Credentials:** What skills and experiences are the most common and necessary for makers, and how these credentials are proven in a mutual recognition system.

Focusing primarily on credentials in this report, the most significant and detailed findings are provided in the Maker Credentials section.

4.1.2 Maker Identity: Mutual Recognition Using Standard Authentication Protocols

Open Authorization for Identity Verification

The identity of makers can be established via organizational affiliations, or preexisting verification processes (OpenID, OAuth2, etc.). The primary focus of the preliminary research findings shareout will be on the second form of verification, which is *credentials* - essentially, what does a maker need to prove that they know and what experiences do they need to provide proof of prior to being allowed entree into a makerspace within the ecosystem?

4.1.3 Open Badging for Verification of Credentials by Identity Qualifier

Open Badges is recommended for the identity and credential verification process. The Open Badges 2.0 Implementation Guide provides and overview of recommended practices as well as several use cases, including the creation of a BadgeClass, issuing badge assertions to recipients, displaying, and importing Open Badges.

Open Badges are visual symbols of accomplishments packed with verifiable metadata according to the Open Badges specification. The Open Badges 2.0 specification [OB-20] defines the properties necessary to define an achievement and award it to a recipient, as well as procedures for verifying badge authenticity and "baking" badge information into portable image files. It includes term definitions for representations of data in Open Badges.

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The Open Badges 2.1 specification [OB-21] defines an API for exchanging badge information, which specify these the following term definitions.

Assertion	A representation of an awarded badge, used to share information about a badge belonging to one recipient.
Backpack	A term originally used to describe Open Badges services that provide importing, aggregation, and hosting features for recipients. These services match most closely with the role we now define as an Open Badge "Host" application. May also refer to the Mozilla Backpack.
BadgeClass	A collection of information about the accomplishment recognized by the Open Badge. Many assertions may be created corresponding to one BadgeClass.
Badge Issuer	A service that allows for the creation of BadgeClasses and the subsequent issuing of Assertions to recipients that conform to the Open Badges specification. Beginning with Open Badges 2.0, the candidate platform must issue a valid baked badge and demonstrate how the badge is retrieved by the recipient.
Badge Displayer	An application that displays verified badges to viewers. Beginning with Open Badges 2.0, the candidate platform must display a minimum set of badge metadata and support viewer-initiated verification of a badge.Badge Host: An application that can import, aggregate, and publicly host Assertions for recipients. It also supports export of badges at user request. Beginning with Open Badges 2.0, the candidate platform must be able to import all formats of Open Badges as well as prove that badge metadata is not lost upon export of the badge.
Baked badge	Badge Assertions may be "baked" into image files as portable credentials.
Candidate platform	A platform implementing the Open Badges specification with the intent to obtain certification from IMS. They may be in the process to obtain certification.
Criteria	Detailed information about what must be done in order to be recognized with an assertion of a particular BadgeClass. Potential recipients may use criteria to understand what they must do; consumers may use criteria to understand what recipients did in order to earn the badge.
Evidence	Links to and descriptions of evidence related to the issuance of an Assertion, such as portfolio items or narratives that describe a badge recipient's work.
Extensions	Extensions are a means for issuers to add additional functionality through the use of metadata on Badge Objects beyond what the standard specifies itself.
Validation and verification	Data validation is a procedure that ensures a cluster of data objects that form an Open Badge are appropriately formatted, published, and linked and that each data object conforms to requirements for its class. Validation of all data class instances

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(of badge assertions)	used in an Open Badge is a part of badge verification. Verification is the process of ensuring the data that makes up an Open Badge is correct. It includes a number of data validation checks as well as procedures to ensure the badge is trustworthy. Verification is distinct from compliance certification for applications and services that implement the specification, though verification is typically a component of certification programs. See Verification in the current specification.

Table 5: Open badges specification

4.1.4 Micro-credentialing and Social Mobility

In skills-based training and education policy around the world, micro-credentialing is a growing proposition for solving a wide range of labor market, economic, and social challenges. Micro-credentials, broadly defined, are stackable, industry-aligned education units designed to help individuals obtain specific skills, and then in turn signal those skills to potential employers. Micro-credentials have been designed to provide affordable and flexible opportunities for learners to upskill, reskill, and stay current with competencies required in their career and industry.

Micro-credentials also provide the ability to verify the competence of a very specific skill or suite of skills; according to Janchenko and Rodi (2019), this ability to target specific skill sets is one of the central reasons that micro-credentials "play a key role in displaying specific marketable skill sets to employers" (p.22). Ngoc et. al. (2022) additionally pose micro-credentials as means to increase education and training responsiveness in labor markets, and support increased social inclusion and access to education.

With the capability to target specific skills with the option to reskill or upskill to meet industry demand, it is no surprise that the use of micro-credentials in education are on the rise, particularly for establishing learning pathways in making and maker education. Figure 2 shows UTeach, a micro-credentialing program that supports students interested in bringing innovative maker-centered practices and skills into STEM curriculum. Upon successful completion of the program, each cohort member, in addition to receiving a certificate from the UTeach Maker Advisory Group and a letter of recommendation from the program director, also receives a branding package for their digital portfolio and a micro-credential that qualifies individuals to serve as future mentors and program advisors.

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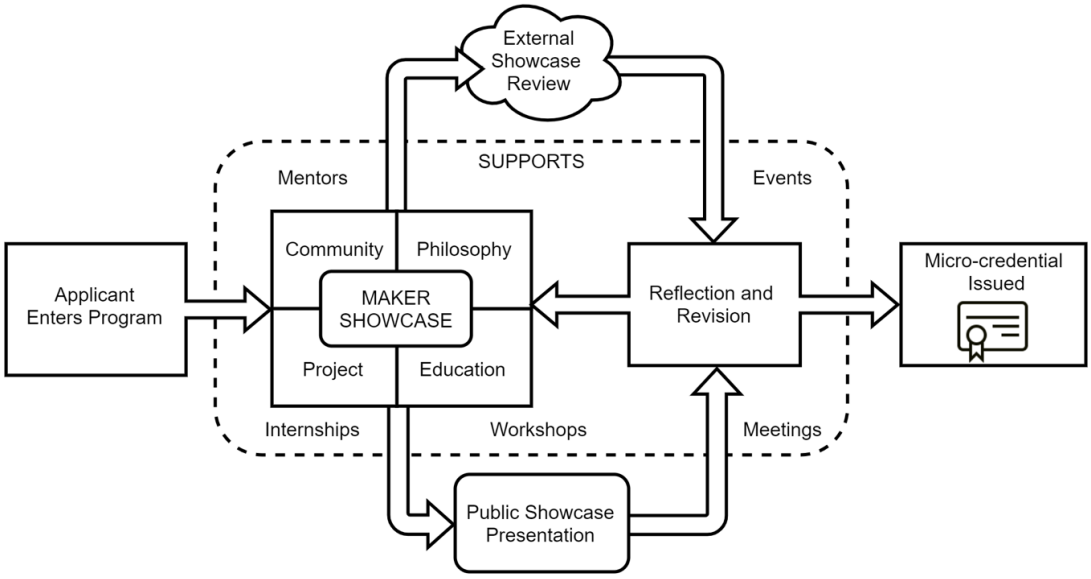

Figure 13: The UTeach Maker Micro-credentialing pathway

While micro-credentials are becoming more prevalent in skills signaling, recognition of micro-credentials by employers and policy makers are immured due to the lack of a universally shared definition of what is being proven. With limited regulation or quality benchmarking, the skills recognition can be a difficult market to navigate and could lead to hidden stratification within the education and training landscape (Robson, J, 2021). With ongoing research identifying the challenges that impede qualification and the overall efficacy of micro-credentialed skills-based training UNESCO study, the work that remains is establishing a shared understanding of the explicit, implicit, tacit, and procedural knowledge necessary to make things.

Whether a micro-credentialing or open badging system is used for the verification of the skills identified in the People and Skills data standard is irrelevant; the primary purpose of the standard is to provide the framework for locating people with the skills and experience for making things, with the potential for creating a digital maker passport being just *one* of the many use cases.

For the purpose of this document and WP deliverable, the focus will primarily be on the aforementioned immediate use case of the standard for use in the piloting of a digital maker passport.

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4.2.1 **Maker Credentials:** What do makers need to prove as part of the digital passport?

What are the qualities indicating specific skill levels and experience?

When a maker is granted authorization to access a makerspace, what is this authorization claiming they are you qualified to do? And, according to whom? You figured out who this person is, and they've gone to multiple nodes to prove which machines they know how to use: and you get a "stamp." Whatever institution is being worked with, they need to agree to the standard that is being used to gain a stamp. This is the way that a makerspace can determine: "you're safe with this CNC device."

Categorically, makers interviewed identified two main areas of skills qualifiers:

1. General Orientation and Safety Training
2. Specialized Equipment and *Types* of Making

These skills qualifier categories are outlined in greater detail below.

4.3 Skills Taxonomies

Skills Qualifiers - General Orientation and Safety Training

WHAT do makers need to prove as part of the digital passport?

These categories are derived from text analysis, literature review, and interviews with makers and makerspace leaders across the U.S., Europe, with a focus on Africa as the immediate use case for the People and Skills Standard for development of a digital maker passport as part of the mAkE project.

Skills and Knowledge Related to General Orientation and Safety - Overview

The General Orientation and Safety category, broken down into the subcategories **General Orientation** and **Safety Training** represent research results in aggregate for the baseline for entry into the makerspace.

Every space interviewed has a baseline orientation/operations training - whether in person, online (as a class), or documentation that is required for users to complete before using the space, whether a part of a membership program/package, or for day use.

Specificity for type of machinery or category of making : XXXX card; specificity for type of membership is covered in the XXXX card.

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General Orientation - *organization-specific knowledge*

1. Overview of space, online resources, equipment inventory, and zones of production
2. Hours of operation, protocol for use, including space use protocol/reservation system if available
3. Code of conduct
4. Directory of support staff/volunteers to support operations on site
5. Directory of support networks/online communities of support
6. Frequently includes safety documentation, guidelines, and training; safety training may be a separate component/separately certified/recognized
7. Membership fees/contracting for production services fee structures if available
8. Safety training may or may not be included/considered as part of the general orientation; see subcategory "Safety" for additional information. Liability signatory more typically a component of a separate safety training program.

Safety Training - *organisation specific, or transferable skills and knowledge*

1. General First Aid
    1. Is it required, and if yes, for whom
        1. Staff most common
        2. Users are not typically required to be certified; safety training/verification of completion of local course/review of documentation more common
    2. For certification - Global/National/Local - what is most commonly used?
        1. Example: American Red Cross Digital Certification (2 yrs)

2. Tiered membership [link to membership card] can indicate level of training needed/level of trust by tier of equipment (https://www.framinghammakerspace.org/equipment/)
    1. What is pro tier vs common equipment? Common denominator? Can be determined by safety certification required by manufacturer, or local expertise/recommendation.

3. Safety orientation and training per machine - varies by location, and can be tiered, with or without membership/fee structure. Common breakdown:
    1. Online safety training/course for certification; microcredentialing, digital badging (provide examples) - MAP or other educational training programs
    2. Online training and workshops - confirmation of attendance by fee or registration (MaCO/baltimoreopenworks)
    3. Online safety instructions
    4. Printed instructions near machines
    5. Safety training certification per machine, either by recommendation by equipment manufacturer or local expertise

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Skills Qualifiers - Specialized Equipment and Types of Making/Production

WHAT do makers need to prove as part of the digital passport?

These categories are derived from text analysis, literature review, and interviews with makers and makerspace leaders across the U.S., Europe, with a focus on Africa as the immediate use case for the People and Skills Standard for development of a digital maker passport as part of the mAkE project.

Skills and Knowledge Related to Specific Machinery/Type of Making* - Overview

The Specific Machinery/Type of Making, are listed in order of most to least common/present in spaces researched, in aggregate. Product, machinery, and materials examples are derived from inventory lists shared, available online, discussed during interviews, or provided in survey results.

General Orientation and Safety Training : XXXX card; specificity for type of membership is covered in the XXXX card.

🧭 - indicates general orientation/training required, no certification necessary prior to use

🎖️ - indicates training with confirmation of certification (by registration, fee, or microcredentialing/badging) is required prior to use

⚠️ - indicates training for safety-related purposes with confirmation of certification (by registration, fee, or microcredentialing/badging) is required prior to use

Workshop 🧭🎖️⚠️

1. Product examples:
2. Machinery examples:
3. Materials examples:

Woodworking 🧭🎖️⚠️

4. Product examples:
5. Machinery examples:
6. Materials examples:

Electronics 🧭

7. Product examples:
8. Machinery examples:
9. Materials examples:

Crafting 🧭

10. Product examples:
11. Machinery examples:

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12. Materials examples:

Laser Systems/Cutting 🧭

13. Product examples:
14. Machinery examples:
15. Materials examples:

3D Modeling/Printing 🧭🎖️

16. Product examples:
17. Machinery examples:
18. Materials examples:

Sewing/Leatherwork** 🧭🎖️

19. Product examples:
20. Machinery examples:
21. Materials examples:

* See emergent themes card for additional categories to consider for education/training - whether or not they are included for certification/part of the digital passport is up for discussion within the mAkE consortium

** Parameters need to be defined; what is the overlap with textiles (fabric dying, wax fabric print, wool, mass production of clothing, etc

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5. People and Skills Specification and Peripherals

5.1 PSS BETA Release

The People and Skills Specification was first released in BETA on March 27, 2023 on the PubPub open publishing platform. The current release, (3), is currently under review by the People and Skills Working Group in preparation of a v1.0 release.

This section provides a brief overview of the BETA release, including recommendations for output file type and display; the full People and Skills Specification is included in Appendix B.

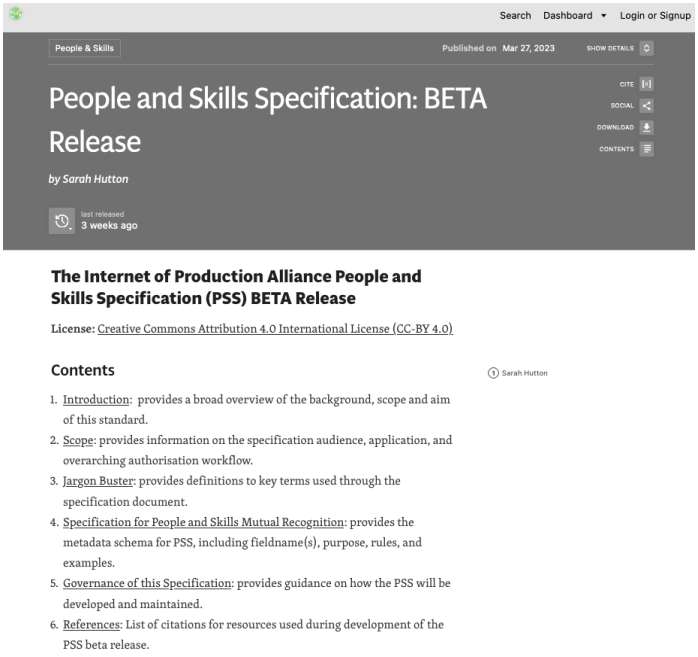

Figure 14: People and Skills BETA release(3)

Contents of the PSS BETA Release

1. Introduction: provides a broad overview of the background, scope and aim of this standard.
2. Scope: provides information on the specification audience, application, and overarching authorisation workflow.
3. Jargon Buster: provides definitions to key terms used through the specification document.
4. Specification for People and Skills Mutual Recognition: provides the metadata schema for PSS, including fieldname(s), purpose, rules, and examples.
5. Governance of this Specification: provides guidance on how the PSS will be developed and maintained.
6. References: List of citations for resources used during development of the PSS beta release.

This specification provides a mechanism for verification within mutual recognition and microcredentialing systems for purposes of:

1. **Identifying WHAT expertise is needed**
2. **Confirming WHO has the expertise**
3. **HOW this expertise is communicated**

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While the PSS provides potential for some of the capabilities listed below *now*, the broader PSS Initiative provides the infrastructure for reaching some of the farther-reaching goals listed below:

1. **Identifying WHAT expertise is needed:** this specification provides standardised, yet flexible, categories of skills and experience which can be mapped to specific types of making and project work, allowing for a shared understanding of what a certain type of training or experience *means* across organisations, consortia, or other larger networks. For example, production spaces have varying rules for providing access to use their spaces for production, based on what machinery, materials, or chemicals are in the space. With this specification, an organisation can customise requirements for different levels of access.

2. **Confirming WHO has the expertise:** this specification supports the creation of a user record for the individual maker, that can easily be integrated into pre-existing systems that catalogue or track organisation membership rosters, whether connected to a public, private, or academic institution. The structure of this user record is also designed with data sovereignty in mind; an individual maker will be able to take their user record, download it, and take it with them - *it does not have to be attached to any organisation that "owns" it.*

3. **HOW this expertise is communicated:** this specification is created with the flexibility to serve as a stand-alone form or, using the provided tooling, could be used to fill out an online form that exports a JSON file that can be integrated into an open badging system. This allows for:

    1. **A makerspace** to create a form tailored to their organisational needs to keep local records of users who have been credentialed to access certain spaces and/or specialised equipment;
    2. **An educational institution** to establish a micro credentialing (using open badges) system to communicate which workshops, classes, or other skills-based training has successfully been completed by an individual;
    3. **An individual** to have the capability to communicate their credentials to a potential employer, via professional or social media platforms, or as a stand-alone file export.

While this specification is designed to be interoperable with common open badging standard protocols, it can also be used without internet connectivity to maintain paper records in-house using the provided template in section 4.10, for makerspaces that either do not have the infrastructure to support an open badging system, or require manual record load for maintaining local records.

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Building on foundational schemas in open badge system frameworks, this specification provides the conceptual framework for mutual recognition within a functional badging system; it does not provide a schema for the functional badging system itself, though multiple open badging systems are referenced throughout.

The beta release of the People and Skills Specification (PSS) is published on the PubPub platform, to support easy collaboration between working group members, and allow for open dialog between community members, while maintaining version control in the specification document.

5.1 Method for Information Exchange: The PSS User Record

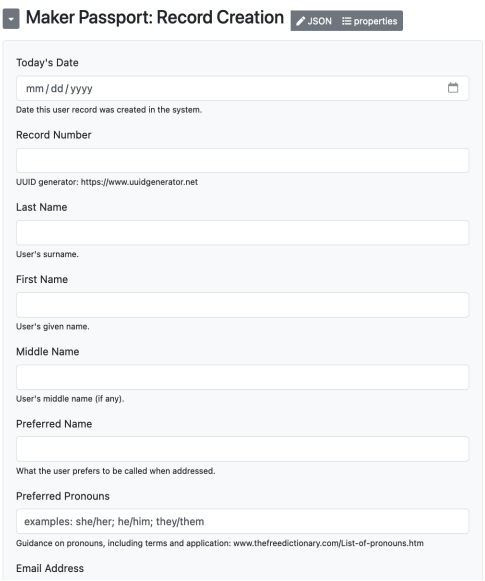
The PSS User Record accompanies the officially and unofficially credentialed skills and experiences that are documented in structured or unstructured formats. The purpose is to allow automated indexings of key properties about the user and to identify and link to the associated issuing clients. The user record shall be used to define user record changes over time. The user record should be updated when any credential status or user descriptor data changes.	

Figure 15: JSON Output Displayed as WebUI Endpoint/Online Form

5.2 Structure of PSS Output as a File: JSON as Predominant Format

Where the user record is contained in a file, it will be JSON [4].

Note: JSON is selected because not only is it a structured data format, but it can also be used directly in client-side coding. It is for this reason that JSON is the predominant format for digital badging systems.

JSON requires Unicode [5]; while UTF-16 may also be used for character encoding, the UTF-8 [6] default is recommended [7].

JSON format is the predominant format used to store data in a structured way. JSON data can easily be displayed in an HTML page using JavaScript in the form of tables and lists [8].

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Example: HTML Table with data retrieved as JSON

```
const dbParam = JSON.stringify({table:"customers",limit:20});
const xmlhttp = new XMLHttpRequest();
xmlhttp.onload = function() {
   myObj = JSON.parse(this.responseText);
   let text = "<table border='1'>"
   for (let x in myObj) {
     text += "<tr><td>" + myObj[x].name + "</td></tr>";
   }
   text += "</table>"
   document.getElementById("demo").innerHTML = text;
}
xmlhttp.open("POST", "json_demo_html_table.php");
xmlhttp.setRequestHeader("Content-type", "application/x-www-form-
urlencoded");
xmlhttp.send("x=" + dbParam);
```

Figure 16: Displaying Output Information on a Web Page; Section 4.4, PSS BETA Release3

5.1 Adoption and Project Constellation

How does this standard relate to the others (v2 pg 14)

5.2 Working Group

Working Group Members and BETA Release Contributors

Name	**Affiliation**
Andrew Lamb	Internet of Production; Massive Small Manufacturing; FabLab Winam; Helpful Engineering
Anna Sera Lowe	Manufacturing Change; Internet of Production
Barbara Schack	Internet of Production
Kai Kriegel	Ostfalia University of Applied Sciences
Lawrence Kincheloe	Public Invention; SPEC; Juniper Garden LLC; CoLaboratory
Nadja von Reitzenstein Čerpnjak	FabAccess
Nathan Parker	Internet of Production

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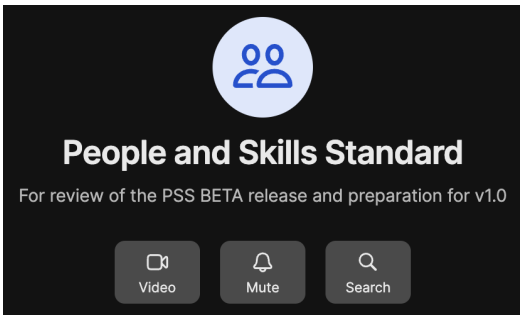
Sigrid Peuker	Berlin University of Applied Sciences
Sarah Hutton	Internet of Production; University of Massachusetts Amherst
Sarah Abowitz	Tufts University; Helpful Engineering
Tasso Mulzer	FabAccess; Berlin Hochschule für Technik
Will Holman	Open Works

Table 6: Working group members and beta release contributors.

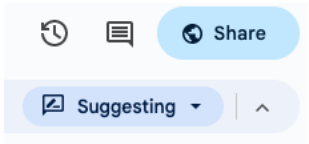
PSS Working Group Onboarding



D4.1 Skills - Mutual Recognition Standard (People & Skills Specification / PSS)
INTRODUCTION for review by PSS WG

REVIEW PROCESS

1. Read through the document, evaluating for the following:
    a. General comprehension of concepts
    b. Copyediting/grammar/spelling
    c. Figure/Table quality
2. Make suggestions for improvement using one or both of the following:
    a. Inserting suggestions as comments
    b. Make changes to content directly while in "Suggesting" mode



If you have any questions, reach out to @Sarah (Hutton) via Signal.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101016858.

5.3 Communications Strategy and Promotional Materials

In progress:

- community calls
- discourse forum
- template for initiatives page
- form for testing
- social media

Figure 17: Social media post example

5.5 Continued Development and Sustainability

Continued collaborative technical authoring to continue with a v1.0.

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6. Project Resources

6.1 Glossary

1. Controlled Vocabularies: General purpose:
    1. ISO 639-2 Codes for Representation of Names of Languages
    2. Library of Congress Subject Headings (LCSH)
    3. Library of Congress Name Authority File (LCNAF)
    4. Virtual International Authority File (VIAF)
2. Cross-Certification: A process whereby two CAs establish a trust relationship between them by each CA signing a certificate containing the public key of the other CA. Reference: NIST SP 800-57 Part 2 Rev.1
3. NCCER Terms of the Industry (words of choice): Career and Technical Education; Craft; Craft professional/skilled professional; High Skills or Highly Skilled; Options
4. Open Source Hardware, Defined: Open Source Hardware (OSHW) is a term for tangible artifacts — machines, devices, or other physical things — whose design has been released to the public in such a way that anyone can make, modify, distribute, and use those things. This definition is intended to help provide guidelines for the development and evaluation of licenses for Open Source Hardware. Hardware is different from software.. [more/OSHWA]
5. Public Key Infrastructure (PKI):
6. schema.org: Schema.org vocabulary can be used with many different encodings, including RDFa, Microdata and JSON-LD. These vocabularies cover entities, relationships between entities and actions, and can easily be extended through a well-documented extension model. Over 10 million sites useSchema.org to markup web pages and email messages.
7. W3C Web Standards Tooling

6.2 References

Reconciliation Needed

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[4] JSON Data Interchange Syntax Standard, ECMA International, https://www.ecma-international.org/publications-and-standards/standards/ecma-404/

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Overview of UTeach Maker Micro-credential

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Stol, K-J; Ralph, P. & Fitzgerald, B. (2016). Grounded Theory in Software Engineering Research: A Critical Review and Guidelines, Presented at the 2016 IEEE/ACM 38th IEEE International Conference on Software Engineering.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101016858.

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6.3 Project Toolkit and Community Resources

Project Management: Trello

People and Skills

IoPA Community Support Manager
mAkE
IMA

Assessment

Limesurvey
Google Forms

Notetaking and Publishing

PubPub
Framapad
CryptDrive

Community Resources

People and Skills Discussion Channel
Resources wiki

mAke Consortium Project Materials

WP4 Distributed Manufacturing Network: D4.1 Skills - Mutual Recognition Standard (Google Drive)

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7. Appendices and Attachments

Appendix A: Research Methods

Semi-Structured Interview Questions

Introduction – Tell me about your space and organization

1. What is the name of your organization?
2. In which geographic area do you operate and for how long?
3. Tell me about the purpose/reason you established your organization.
4. [For an individual hub] What does your organization seek to achieve, for local community members, in your geographic area of operation?
5. [For a hub network] What does your organization seek to achieve for digital innovation hubs (DIHs)/makerspaces and or local communities in your geographic area of operation?

Community Needs Assessment

1. How do you determine the most pressing needs for your community?
2. Do you keep any information/data on *how* your space is used and by whom?
    a. What does that data collection workflow look like? What do you use that data for (example: to determine gaps in programming, new equipment purchases, advocating for funding/applying for grants, general reporting to an advisory board, etc)?

Questions: Space and Equipment

1. Is your space private, open to the public, or accessible by certain user only (academic, membership)?
2. What equipment, tools, and/or materials do you have in the space? Do you have an inventory list you could share?
3. What types of work are done in your space most frequently, categorically – what do your users come in the most often to *do* in the space (example: cutting materials, using the space to store a project in progress, use a specific type/piece of equipment, electronics repair, etc)?
4. Do makers using your space have to pay a membership or materials fee? Please describe how that works and what systems you may use.

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5. What does that process look like/what tools do you use (do they sign in using a form, or automated system, or are they recognized by scanning an affiliate card either for that space or another community network to which the space belongs)?
6. Are makers able to reserve specific space or equipment? What system or workflow do you use?

Skills, Training, and Experience

1. Do you have any trainings or certifications that users are required to complete before they are allowed to use your space? If yes, please describe.
2. Do you have any orientation or training materials for your space/equipment? If yes, please describe.
3. Do you have standard "shop rules" or "safety guidelines" or a code of conduct in your space? How are users able to access that information?
4. Do you have staff or volunteers physically located in the space to provide support for your users? How often are they in the space (part time, full time, only occasionally, or other)?

Gathering Additional Content for Document Analysis (When Possible)

1. Any pertinent website/data links
2. Training or orientation materials
3. Liability waivers, insurance policies/forms
4. Any 'shop rules' or safety guidelines
5. Any other internal workflow processing documentation – contact lists, materials inventory, etc.

Each interview was scheduled for 45 minutes, though many conversations stretched beyond that time marker.

<u>Maker and Makerspace Leader Survey Questions</u>

Maker Survey Questions

1. Where are you located? *City/Town, Country
2. Which makerspace (Digital Innovation Hub, FabLab, etc.) are you affiliated with?
3. Please share a link to your makerspace's website or online community platform/s if you have one.
4. What community networks are you a member of? (GIG, AMN, AOSH, None, other)
5. What sectors do you focus on, if any?
    - Health and Sanitation
    - Climate Technologies (renewables)
    - Education
    - Infrastructure (connectivity, logistics)

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- Agriculture
- Other

6. What type of projects are you typically/ most frequently working on?
7. Which machinery do you use frequently, are you trained on, do you have certification for?
8. If you indicated "other" in the previous question, please list additional machinery that you use frequently, are you trained on, or have certification for:
9. What business services do you as a maker think are most valuable to be trained on?
    - Startup pitching
    - Business models
    - Financials (costing, pricing, projections etc)
    - Marketing
    - Branding
    - Not valuable
    - Other
10. When thinking about how a maker passport could be useful, please rank the following challenges your may experience in you project work/making: (Multiple choice grid: least to most challenging)
    - Equipment I need isn't in my space
    - Support I need isn't in my local space
    - My local space isn't open when I need it
    - I have difficulty travelling to my space
    - The cost of materials/space is too high
11. When thinking about how a maker passport could be useful, please rank the following challenges you may experience in travelling to another makerspace to do your work:(Multiple choice grid: least to most challenging)
    - I don't know what other makerspaces have what I need
    - I'm not sure who has the expertise I need
    - I don't have the credentials/membership(s) to use other spaces
    - I do not have the personal means to travel (funding, transportation)
    - To get to the makerspaces I need, visa/passport/other travel documentation is needed
12. I am interested in learning more about and potentially participating further in the ongoing research on the maker passport, and would like to be contacted for follow-up. (yes/no)

Makerspace Leader Survey Questions

1. What is the name of your makerspace (Digital Innovation Hub, Fablab etc.)
2. Please share a link to your website or online community platform/s if you have one (if you don't have one, please enter "not available"):
3. What community networks are you a member of? (GIG, AMN, AOSH, None, other)
4. What machinery and equipment does your makerspace have?

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- 3D Printer
- 3D Scanner
- CNC Router
- Moulding & Casting
- Sewing and/or Embroidery Machine
- Vacuum Forming
- Laser cutter/Engraver
- Vinyl Cutter/Printer
- Oscillating knife tool
- 2D and/or 3D Milling
- Crafting
- Woodworking
- Metal workshop
- Robotics
- Electronics station
- Other

5. Would you share your inventory of machines, equipment and tools to be part of the map of machinery and potentially get some business opportunities? (Yes/No)
6. What maker services does your makerspace provide? (Tick box grid)

- Training / Certification / Production / Prototyping / Consulting

➔ 3D Printer
➔ 3D Scanner
➔ CNC Router
➔ Moulding & Casting
➔ Sewing and/or Embroidery Machine
➔ Vacuum Forming
➔ Laser cutter/Engraver
➔ Vinyl Cutter/Printer
➔ Oscillating knife tool
➔ 2D and/or 3D Milling
➔ Crafting
➔ Woodworking
➔ Metal workshop
➔ Robotics
➔ Electronics station
➔ Other

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7. If you responded "Other" in the previous question, please list any additional machinery your makerspace provides that were not listed:
8. What business services does your makerspace provide? (Tick box grid)
    - Training / Bootcamps / Mentoring / Funding

➔ Startup pitching
➔ Business models
➔ Financials (costing, pricing, projections etc)
➔ Marketing
➔ Branding
➔ Not valuable
➔ Other

9. If you responded "Other" in the previous question, please list any additional business services your makerspace provides that were not listed:
10. In which of the business related topics would you need support in order to provide sufficient support to your startups and founders?
    - Pitching
    - Business models
    - Financials (costing, pricing, projections etc)
    - Marketing
    - Branding
    - None
    - Other
11. Does your makerspace have a membership programme/ structure? (Yes/No)
12. If you have a membership programme could you tell us whether it is fee-based/paid?
13. What is your role in the makerspace?
14. Which platform would you want your skills (certifications, training and products) to show up (on social media platforms, Credly, LinkedIn, etc)?
15. Do people need to be trained prior to using the machine/space? (Tick box grid - Yes/No)
    - 3D printer
    - 3D scanner
    - CNC router
    - CNC miling
    - CNC punching
    - Moulding & Casting
    - Sewing/overlock/embroidery
    - Vacuum Forming
    - Press Brake
    - Laser cutter/Engraver

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- Vinyl Cutter/Printer
- Plasma Cutter
- Oscillating knife tool
- 2D and/or 3D Milling
- Lathe
- Crafting
- Woodworking
- Metal Workshop
- Robotics
- Electronics station
- Other

16. If you responded "other" in the previous question, please provide additional machines/space that require training that you did not see listed above.
17. What type of making can one do in your makerspace? (multiple choice grid: support/training-education/ certification-microcredential)
    i. Workshop (pillar drills, welding, etc)
    ii. Woodworking (circular saw, etc)
    iii. Electronics (breadboard, arduino, etc)
    iv. Crafting (wet embossing, quilling, etc)
    v. Laser Systems/Cutting (CNC, CTR, etc)
    vi. 3D Modelling/Scanning/Printing
    vii. Sewing (embroidery, leather, etc)
    viii. Textiles (dying, wax print, spinning etc)
    ix. General Space/Service Orientation
    x. First Aid/Health and Safety
    xi. Other
18. If you responded "other" in the previous question, please provide additional types of making in your space that you did not see listed above.

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Appendix B: People and Skills Specification - Full Schema

Exported from release3: https://standards.internetofproduction.org/pub/r7g0n9fo/release/3

4. Specification for People and Skills Mutual Recognition

4.1 Introduction

This section specifies a mechanism for the verification of passport holders (makers) by authorised issuers. Building on foundational schemas in open badge system frameworks [3], this specification provides the conceptual framework for mutual recognition within a functional badging system; it does not provide a schema for the functional badging system itself, though multiple open badging systems are referenced.

Any infrastructure designed and developed to support an open digital badging system should support [3, p10]:

4.1.1. *Independent-Source Badge Issue*

Similar to assessment design and execution, badges can be issued by authorities, course organizers, peers, the system or each learner. Within the open badge infrastructure, it is important to allow for badges from many independent sources across the Web and across each learner's experience to ensure that the badge system supports all of their learning.

4.1.2. *Badge Collection*

Badges should be collected in a way that ties them to the learner identity and enables use across websites or experiences. Learners can get badges from many environments or experiences, through many different types of assessments, and store them in a single badge collection as they go. Each badge should carry comprehensive metadata to communicate information about the issuance of the badge, provide a link back to the learner's work as demonstration and justification of the badge and enable authentication back to the issuer. The learner should also have an interface to their badge collection to manage badges and set privacy controls.

4.1.3. *Badge Display*

The value of badges increases further when learners have control over where to display them across audiences and contexts. The learner should be able to control which badges are available for which audience and share subsets of badges with selected audiences, ranging from target groups or networks, to the open web. Further, the infrastructure should allow

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learners to add badges to any external website or environment that supports badge display, including personal websites, such as blogs, and social networking environments such as LinkedIn or Facebook. Finally, these display sites should be able to authenticate the badge to ensure that the badge was issued to this particular user.

This specification provides recommendations for display platforms based on community scoping research; for application of this specification within an open badging infrastructure contextualized for a specific use case, additional user research *must be conducted* to ensure that the selections for badge display are in alignment with user community needs. The power of credentialing resides in not only the authorising entity, but also the interoperability of the issued credential with platforms that are relevant and meaningful to the earner.

Mandatory and recommended provisions are made along with other fields that are defined. A template is provided that can be used to aid in the development of a digital maker passport, or could be used to input data manually, for makers and organisations that are not yet a part of a digital network or digital recognition system.

4.2 Method of Information Exchange: The PSS User Record

The PSS User Record accompanies the officially and unofficially credentialed skills and experiences that are documented in structured or unstructured formats. The purpose is to allow automated indexings of key properties about the user and to identify and link to the associated issuing clients.

The user record shall be used to define user record changes over time.

The user record should be updated when any credential status or user descriptor data changes.

4.3 Structure of the Output as a File

4.3.1. Format

Where the user record is contained in a file, it will be JSON [4].

Note: JSON is selected because not only is it a structured data format, but it can also be used directly in client-side coding. It is for this reason that JSON is the predominant format for digital badging systems.

JSON requires Unicode [5]; while UTF-16 may also be used for character encoding, the UTF-8 [6] default is recommended [7].

4.3.2 Filename

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The file containing the user record shall begin with “pss”.

The file extension shall be “.json”.

Example: “pss.json”

The user’s name may be included in the filename, prefixed with a hyphen.

Example: “pss-user-name.json”

4.4. Displaying Output Information on a Web Page

JSON format is the predominant format used to store data in a structured way. JSON data can easily be displayed in an HTML page using JavaScript in the form of tables and lists [8].

Example: HTML Table with data retrieved as JSON

```
const dbParam = JSON.stringify({table:"customers",limit:20});
const xmlhttp = new XMLHttpRequest();
xmlhttp.onload = function() {
  myObj = JSON.parse(this.responseText);
  let text = "<table border='1'>"
  for (let x in myObj) {
    text += "<tr><td>" + myObj[x].name + "</td></tr>";
  }
  text += "</table>"
  document.getElementById("demo").innerHTML = text;
}
xmlhttp.open("POST", "json_demo_html_table.php");
xmlhttp.setRequestHeader("Content-type", "application/x-www-form-
urlencoded");
xmlhttp.send("x=" + dbParam);
```

4.5. Output Metadata

4.5.1. User Record Unique Identifier

Fieldname: `id`

Purpose: Assignment of a unique identifier will make user records easier to locate, also allowing for easier differentiation between versions.

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Format: UUID [9]

```
"id" : "a3cdb71f-d1c8-4867-90af-d7dd6c6391a8"
```

Rules: Required.

4.5.2. Date User Record Created

Fieldname: `date_created`

Purpose: Identifies date user record was originally created.

Format: YYYY-MM-DD [10]

```
"date_created" : "2022-09-27 18:00:00.000"
```

Rules: Required.

4.5.3. Date User Record Last Updated

Fieldname: `last_updated_date`

Purpose: Identifies date user record was last updated.

Format: YYYY-MM-DD

"last_updated_date" : "2022-09-27 18:00:00.00**Rules:** Required.

4.5.4. Record Issuer

Fieldname: `record_issuer`

Purpose: Identifies the entity issuing the passport.

Format: Object.

Rules: Required.

4.5.4.1. Name of organization issuing maker passport

Fieldname: `name`

Purpose: Identifies the entity issuing the passport.

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Format: Text.

Rules: Required.

4.5.4.2. Primary contact at issuing organization

Fieldname: `primary_contact`

Purpose: Identifies the primary contact at the entity issuing the passport.

Format: Object.

Rules: Recommended.

4.5.4.2.1. Primary contact name

Fieldname: `name`

Purpose: Provide the email of the primary contact at the entity issuing the passport.

Format: Text.

Rules: Subfields required if object is present.

4.5.4.2.2. Primary contact email

Fieldname: `email`

Purpose: Provides the email of the primary contact at the entity issuing the passport.

Format: Text.

Rules: Subfields required if object is present.

Example record_issuer and primary_contact objects

```
"record_issuer" : {
  "name" : "IOPA",
  "primary_contact": {
    "name" : "Sarah Hutton",
    "email" : "sarah@iopa.org"
  }
}
```

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4.6. User Properties

Fieldname: `user`

Purpose: Contains user metadata.

Format: Object.

Rules: Required.

4.6.1. User Name

Fieldname: `name`

Purpose: States the first name (forename) and last name (surname) of the user to which the passport is issued.

Format: Text; last name, first name.

Rules: Required.

4.6.2. User Email

Fieldname: `email`

Purpose: Email address of the passport holder.

Format: Text; username@domain.tld

Rules: Required.

4.6.3. User Authentication

Fieldname: `openid_token`

Purpose: Authentication via OpenID Connect [11] provides a way to prove that an end user controls an Identifier. It does this without the Relying Party needing access to end user credentials such as a password or to other sensitive information such as an email address. OpenID Connect performs similarly to OpenID 2.0 [12], but does so in a way that is API-friendly, and integrates OAuth 2.0 capabilities directly into the protocol.

Format: OpenID Connect Token URL

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`${baseURL}/v1/token`

Rules: Required. Recommended apps for provision of OAuth token: GitHub, Facebook, Twitter, Google.

4.6.4. User Affiliations

To identify related consortia, organizations, guilds, and other networks which can lend to validation of experience and skills held by user.

Fieldname: `affiliations`

Purpose: To identify any consortia, organizations, guilds, and other networks which can lend to validation of experience and skills held by user.

Format: Text.

Rules: Recommended; if affiliations provide a badge issuance token and/or API badge identifier, enter badge tokens in 4.7.1. Certifications.

4.6.5. User Photo

Fieldname: `image`

Purpose: For visual identification of user when entering a space within the maker ecosystem.

Format: URL

Rules: Recommended.

Example of User Properties Object

```
"user" : {
   "name" : "Sarah Hutton"
   "email" : "sarah@iopa.org"
   "openid_token" : "token",
   "affiliations" : [
      {
       "name" : "IOPA"
       "primary_contact" : {
         "name" : "Andrew Lamb"
         "email" : "andrew@iopa.org"
       }
```

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```
      },
      {
        "name" : "OSHWA"
      }
    ],
    "image" : "https://iopa.org/about/sarah.png"
}
```

4.7. Certification Properties

Those with digital badges that are compliant with the Open Badge specification [13] that are authorized/signatory compliant in alignment with

4.7.1. Certifications

Fieldname: `certifications`

Purpose: Serves as a container for all issued certifications, badges, skills training evidence.

Format: Array.

Rules: Required.

4.7.2 Digital Badges

Purpose: Identifies digital badges earned by passport holder.

Format: Object.

Rules: Required *if* entering badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.1. Badge name

Fieldname: `badge_name`

Purpose: Identifies earned digital badge by name.

Format: Text.

Rules: Required *if* entering badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

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4.7.2.2. Badge criteria

Fieldname: `badge_criteria`

Purpose: Typically located in the *description* section of an open badge, this information describes what knowledge has been gained/skills have been proven for earner to receive badge.

Format: Text.

Rules: Required *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.3. Badge URL

Fieldname: `badge_url`

Purpose: Location/hosting site of earned badge.

Format: URL

4.7.2.4. Issue date

Fieldname: `badge_issue_date`

Purpose: Date badge was issued to earner.

Format: YYYY-MM-DD

Rules: Required *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.5. Issuer

Fieldname: `issuer`

Purpose: Location/hosting site of earned badge.

Format: Object

Rules: Required *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.6. Recipient

Fieldname: `badge_recipient`

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Purpose: Identifies the user who earned the badge.

Format: Object; see 4.6 User Properties

Rules: Required *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.


```
"certifications" : [
 {
  "badge_name" : "health and safety badge",
  "badge_criteria" : "health and safety training, badge in first aid",
  "badge_url" : "https://badges/io/hasbadge",
  "badge_issue_date" : "2023-02-14",
  "issuer" : {
   "name" : "OpenBadgeHaus",
   "primary_contact" : {
    "name" : "Bill Badger",
    "email" : "bill@badges.io"
   }
  },
  "badge_recipient" : {
   "name" : "Sarah Hutton",
   "email" : "sarah@iopa.org"
 }}
]
```


4.7.2.7. Alignment (with specific standards/accrediting bodies)

Fieldname: `badge_alignment`

Purpose: Identifies related standards with which alignment is pertinent/meaningful to the passport issuer (need to pick a new work for passport issuer!).

Format: Text.

Rules: Recommended *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.8. Additional information about the Issuer

Fieldname: `issuer_additional_info`

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Purpose: Provides additional information about the organization that issued the badge, such as authorized issuer platform status [28].

Format: Text.

Rules: Recommended *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.9. Expiration Date

Fieldname: `expiration_date`

Purpose: Identifies the expiration date of the badge as identified by issuer.

Format: YYYY-MM-DD

Rules: Recommended *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.10. Badge Evidence

Fieldname: `evidence`

Purpose: In the case that a badge token or URL is not available for proof of issuance, this field is used to gather information that could serve as supporting evidence that the badge has been earned by the user affiliated with it.

Format: Text.

Rules: Required *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.11. Revocation/Revocation Reason

Fieldname: `revocation`

Purpose: Identifies when a badge has been revoked and for what reason.

Format: Text.

Rules: Recommended *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

4.7.2.12. Tags

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Fieldname: `badge_tags`

Purpose:

Format: Array.

Rules: Required *if* entering in badges. If Open Badge-compliant badges have *not* been earned by user, this field is not applicable.

```
"certifications" : [
  {
    "badge_name" : "health and safety badge",
    "badge_criteria" : "health and safety training, badge in first aid",
    "badge_url" : "https://badges/io/hasbadge",
    "badge_issue_date" : "2023-02-14",
    "issuer" : {
      "name" : "OpenBadgeHaus",
      "primary_contact" : {
        "name" : "Bill Badger",
        "email" : "bill@badges.io"
      }
    },
    "badge_recipient" : {
      "name" : "Sarah Hutton",
      "email" : "sarah@iopa.org"
   },
  "badge_alignment" : "https://badges.io/hasbadge/alignment",
  "expiration_date" : "2024-12-31",
  "issuer_additional_info": "Also issues paper certificates",
  "badge_tags": ["health", "safety"]
 }
]
```

4.8 Language and Translation

Language shall be declared as defined in BCP 47 [14], which prescribes the format for identifying languages as the ISO 639 [15] codes for representing languages followed by the ISO 3166 [16] code for the region in which the language is used. Use the Alpha-2 code for each where available.

4.9 User Record Template

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ETA April 2023

%PSS user record 0.1

5. Governance of This Specification

Changes will be discussed with community members and voted on during meetings of the People and Skills Working Group.

Proposers should consult the Working Group prior to proposing changes so that members can contribute to the development of proposals.

All proposed changes will be shared on the community forum for review prior to Working Group meeting discussions. This can increase the likelihood of the group accepting changes to the specification.

6. References

Peripheral and supporting documentation will be placed in the shared Appendices and Attachments folder in the mAkE Google Drive, and will be continuously updated over the course of the project.

Project Scoping

This project scope is based on an understanding derived from the Alfred P. Sloan Foundation Grant Number G-2021-16806 and contract agreement between the Internet of Production Alliance and Research and Community Engagement Lead, Sarah C. Hutton, October, 2022. All proposed activities and expected products are in accordance with Sloan-Grant-Proposal IoP Alliance FULL 30 4 21.

A synopsis of the original grant proposal and how ODS3 fits into the full IOP suite of standards can be found on page 07 for reference.

Consultancy and Terms of Reference: People and Skills Standard

Coordination of stakeholders and technical authoring for the Internet of Production Alliance Standard(s)/recommended specifications around 'People & Skills;' primary items and timelines are derived from the Research and Community Engagement Lead – People & Skills position description.

Proposed Activities and Expected Products - Full Scope

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101016858.

Scoping and development of recommendations for a data standard through extensive, global stakeholder engagement processes. Technical authoring, publishing and launch events for each of the data standards. Adoption support activities, creation of communications materials, an online conference, data mapping workshops and awards, participant in stakeholder networks and assistance in fundraising for open tools based on the standards.

Communication materials and dedicated webpages/website(s) for each standard. Registered 'Internet of Production Alliance' legal entity with 20 new members and related communications material.

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