OPEN BADGES PASSPORT (PR4)

Leading organization:

Consorzio Scuola Comunità Impresa (CSCI), Italy

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Online Passport platform for storing and sharing digital open badges related to EcoPedagogical activities and GreenComp

Disclaimer

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Information

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1. INTRODUCTION

The OpenPass4Climate project developed a system of digital open badges focused on climate action, enabling the recognition of eco-pedagogical activities and the assessment of knowledge through quizzes aligned with the European GreenComp framework. This initiative is made possible through the OpenPass4Climate platform (https://openpass4climate.csciformazione.eu/), designed and implemented within the third work package of the project (WP3).

To ensure interoperability and long-term usability, the project adopts the Open Badge v2.1 open standard established by IMS Global, which defines the roles and specifications of Open Badge hosts and displayer (https://www.imsglobal.org/spec/ob/v2p1) .

> *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.*

The objective of Work Package 4 (WP4) was to create an open online host and displayer to store and showcase the Open Badges developed by the project consortium and issued through the platform.

Importantly, the ambition extends beyond the project's own badges. The ultimate goal was to develop a digital passport (https://op4c-passport.csciformazione.eu/) that enables users to collect and manage all badges related to climate, environmental, and sustainability themes, thereby creating a comprehensive and transferable record of their achievements.

1.1. General requirements

It is required to create an open source, free-to-use Open Badge v2.1 host and displayer that enables the storage and visualization of Open Badges compliant with the IMS Global Open Badge v2.1 standard. The system must specifically support badges related to climate, environmental, and sustainability matters.

Conformance with these thematic requirements must be explicitly identifiable through the badge description in the associated metadata. In line with the choice adopted for all project technical outputs (the online platform, digital open badges, and the digital passport), the language of uploaded badges must be English.

Although the Open Badge v2.1 standard includes both PNG and SVG formats, the decision was made to focus on PNG badges for the current development stage, leaving the support of SVG badges for future extensions.

The system must also account for the possibility that a single individual may possess multiple badges obtained through different accounts or from diverse sources. Every user must be able to upload all their badges, including those linked to different email addresses. For this reason, the system must support the verification of multiple email addresses for each user and accept only badges associated with verified addresses.

Furthermore, the platform must provide secure export and reliable display of stored Open Badges while implementing safeguards against misuse. Finally, the system must comply with the requirements of the General Data Protection Regulation (GDPR).

1.2. Roles and functionalities

The system must support three types of roles: guests, registered users, and administrators.

Guest users must be able to view badges and verifications uploaded, stored, and shared by registered users and all the following information: badge title, description, issuer, issue date, validity of the badge and if the badge is related to climate, environment and sustainability, without accessing sensitive information or the original version of the badges. The original badge files should remain private and be personally shared by users at their discretion. Guests should also be able to share public profiles and badges of registered users.

Administrators must be able to oversee and control the entire system. Their responsibilities include resolving validation issues in cases where algorithmic verification fails and performing all necessary operations to ensure compliance with GDPR. This includes, for example, retrieving all information related to a specific user upon request or deleting all user-related data when required.

Registered users must be able to sign up with a verified email address, register multiple email addresses, and upload their badges. They must also be able to view, organize, and filter their own badges. Each badge can be set as public or private, with the option to change its visibility

status. Users must be able to share their profile displaying only public badges, download their badges without any loss of metadata, and share individual badges, provided they are public. They must also be able to delete their own badges.

Registered users cannot search for other users within the system. However, they must be allowed to upload badges unrelated to climate, environmental, or sustainability matters. Such badges must be clearly marked as not compliant with the system's thematic standard. Additionally, users must have the ability to reset or recover their password if lost.

2. System Design

2.1. Project constraints

The hosting of the system must be provided at a reasonable cost, consistent with the project budget so to guarantee also 5 years of functioning as required for Erasmus project sustainability.

Administrative operations should minimize the need for manual coding, relying instead on a dedicated graphical interface whenever possible.

2.2. Design and architectural choices

Given all requirements and constraints the choice has been to implement the whole system as a python application implemented through the Django framework (Official documentation: https://djangoproject.com/; Django documentation: https://docs.djangoproject.com/en/5.2/).

Django helps a lot with the safety of application and the response time, and moreover speed up the development time a lot, being already refurbished of main user management operation.

Moreover, Django brings an Administration panel that interacts directly with the database, helping a long with our needs.

However, the choice of Django and Python is also due to an important factor: the IMS Global on its open source repository of Github offers a library for verifying digital open badges.

To ensure maximum security, support and system lifetime, we decided to use the latter version of Django, version 5.2 which is a LTS version (Long-Term support), and the support is granted up to the first trimester of 2028. The python version used is Python 3.12.4.

However, the stability and the security that has been prioritized had come with incompatibilities

with the OpenBadge v2.1 verification library by IMS Global.

Thus, part of the work has been also on fixing and updating such library in order to verify the open badges with updated and python version

2.3. UI and UX Choices

2.3.1. Passport Structure

Given the project requirements, the passport was designed with a dual objective: to address the needs of a diverse user base while ensuring that the interface remains simple and intuitive. At the same time, the structure follows modern design conventions so that the platform appears both current and professional.

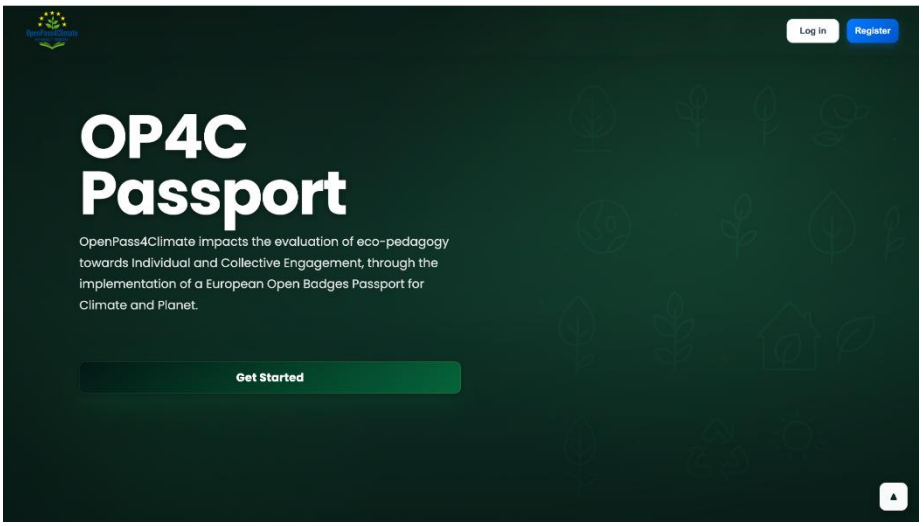
The passport is organized into three core sections. The Homepage introduces the concept of the passport and outlines its purpose in a concise and accessible manner, while also providing direct entry to the user's account. The Dashboard functions as the central hub, enabling users to manage their activity, track progress, and interact with earned badges. The Single Badge Pages provide detailed information about each badge, clarifying the meaning of the achievement and its associated value.

In addition to these core sections, the passport includes dedicated sharing features. Users can either share an individual badge page, highlighting a specific accomplishment, or a profile page, which consolidates and displays the complete set of earned badges.

This structural organization was chosen to guarantee clarity for first-time visitors, efficient navigation for returning users, and straightforward integration of sharing mechanisms that promote visibility outside the platform.

2.3.2. Design Principles

The interface design was guided by contemporary best practices, taking direct inspiration from leading technology companies. Particular emphasis was placed on transparency and light-based effects in interactive elements, which contribute to a modern and responsive user experience.



The background employs a linear gradient, selected to achieve a balance between minimalism and visual appeal. This choice supports a clean presentation while ensuring that the interface aligns with current design trends.

Consistency was addressed through the use of icons in combination with text labels. This approach improves recognition of actions, reduces the dependency on extended reading, and enhances accessibility across different user groups.

2.3.3. Button Design

Buttons received particular attention during the design process, as they represent the most critical interaction points within the platform. The primary objective was to ensure immediate recognizability of their purpose and to minimize ambiguity during use.

A three-color coding system was implemented, with each color mapped to a distinct functional category:

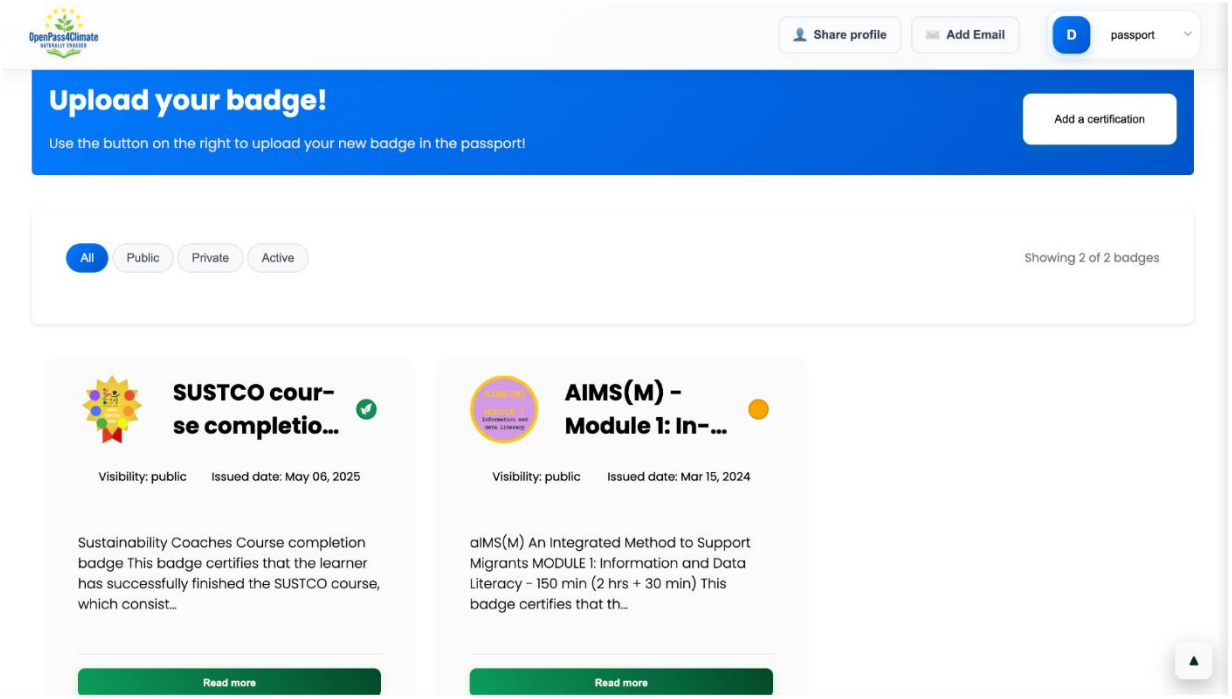
- **Green buttons** – reserved for navigation and redirection, such as accessing the dashboard.
- **Blue buttons** – associated with user-initiated actions, for example downloading badge information.
- **Grey buttons** – used to indicate unavailable or disabled states, such as an attempt to share a private badge.

This color scheme was chosen to provide unambiguous visual feedback, reduce user uncertainty, and improve task completion speed. In addition, the scheme aligns with established usability

guidelines by maintaining consistency across the interface and leveraging widely recognized color associations.

2.3.4. Guided Interactions

Guided interactions were introduced to provide users with immediate feedback about system states and restrictions. Rather than requiring users to interpret unexpected behavior, the platform issues clear alerts that explain the situation and its cause.



Examples include notifying the user when a badge is not yet validated (and therefore not displayed in green) or when an attempt is made to login a profile that is still inactive. These alerts act as contextual explanations, reducing ambiguity and ensuring that users understand why an action cannot be completed.

This approach was selected to lower user frustration, reduce the need for external troubleshooting, and maintain confidence in the reliability of the platform.

3. IMPLEMENTATION

3.1. Recognize Open Badge to be related to environmental matters, sustainability and climate

To determine whether a badge is related to environmental matters, sustainability, or climate, three potential resources were considered: the badge issuer, the badge logo, and the badge description.

The issuer presents a double issue. On the one hand, a known issuer may produce many badges aligned with our standards, but not necessarily all of them. On the other hand, an unknown issuer, or one that generally issues unrelated badges, may still issue a valid badge related to environmental topics.

The logo of the badge can also provide useful hints, but it carries a high risk of both false positives and false negatives. Moreover, proper image recognition requires significant computational resources, which makes it unsuitable for the system's context.

This left us with the option of analyzing the badge description. However, this also poses challenges: descriptions are not always sufficiently explanatory, as their quality depends entirely on the issuer, and they are written in natural human language, which is difficult to analyze automatically.

An initial attempt was made to test whether a Large Language Model (LLM) could meet our needs. During development, however, it became clear that LLMs were too slow, produced highly non-deterministic results, and required computing resources beyond those available. With the resources at hand, results still contained too many false positives and false negatives.

For these reasons, we opted to design a deterministic algorithm.

The first step was to analyze (manually and helped by LLMs) a set of badge descriptions both acceptable and non-acceptable, taken from OpenPass4Climate badges, other CSCI badges, and badges found online. From the analyses, we identified recurring features common to accepted descriptions. In particular, a list of key tokens was observed: "sustain", "green", "eco", "environment", "climate", and "waste". These tokens appeared either as standalone words or as parts of larger words.

We further observed that, in descriptions considered "green", the total frequency of these tokens

relative to the total number of words exceeded 4 percent. To reduce the risk of false negatives, we set the threshold slightly lower, at about 3.3 percent, which allowed all relevant badges to pass the test.

Our approach deliberately prioritizes reducing false negatives. The platform must accept badges genuinely related to sustainability, environment, and climate. Rejecting such a badge would frustrate the user, especially since an external reviewer, such as an employer, would immediately recognize that the badge is not related to climate and disregard it. Conversely, if a false positive occurs, a reviewer focusing on the participant's validated certifications would likely notice the inconsistency and correct for it, since humans are better at spotting such errors in context.

3.2. Update to the IMS Global Open Badge verification library for python 3.12

A significant part of the work behind the platform involved fixing and updating the Python library used to verify Open Badges v2.1. The main issue was that the original library relied on outdated or discontinued Python dependencies, as well as versions with unmaintained or incompatible updates. Our task was to identify all these issues and produce a new, functioning version of the library.

One crucial aspect concerned the RSA signature verification library, which had undergone major updates in recent years. Another important area was the caching system, which in our revised version was reimplemented to operate with modern, supported libraries.

3.3. Database configuration

This section explains how the database is structured internally.
The database is built with a relational system, in order to store the data of the application in a structured way, and for satisfying all the requirements described in section 1.

3.3.1. Overview

To support badge management and user interactions within the platform, the database schema was structured around three core data-models: User, Badge, and UserEmailLink. All the data stored in the database will be structured according to one of these models. Each model addresses a specific requirement of the system and ensures that data is consistently managed across different use cases. All these models combined, allow the application to store all the necessary

data for every possible operation on the platform.

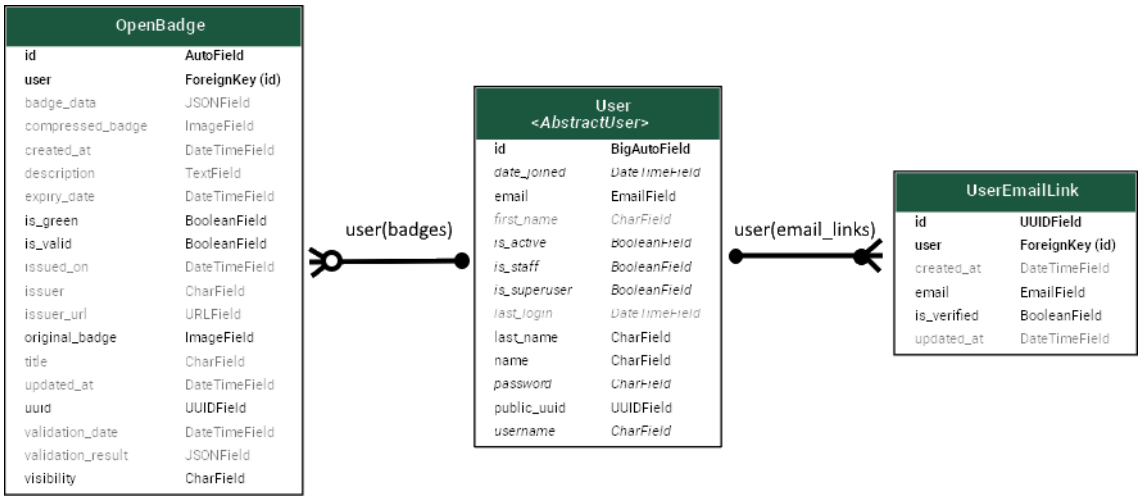
- User – represents data for account-related information and serves as the primary entity linking all user activities within the platform.
- OpenBadge – represents individual OpenBadges, including corresponding images, their metadata, and their validation status. This model is directly associated with one or more users.
- UserEmailLink – provides a mechanism for consolidating multiple email identities under a single user account, ensuring that badges issued to different email addresses owned by the same users remain unified within the same profile.

This configuration was chosen to guarantee efficient data retrieval, reduce redundancy, and provide flexibility for handling common scenarios such as users with multiple email addresses or badges issued from different organizations.

The system uses SQLite as an embedded relational database to store and manage application data efficiently (D. R. Hipp, *SQLite*, Version 3. SQLite Consortium, 2024. [Online]. Available: https://www.sqlite.org/)

3.3.2. Entity-Relationship Diagram

To better understand how the database is structured internally, the following visual representation is provided through what is known as the Entity-Relationship Diagram.



3.3.3. User Model

The User model stores the essential account information required for authentication, personalization, and overall platform operation. It also maintains key status indicators that control account accessibility and administrative roles.

This design ensures secure handling of user data while supporting straightforward management of accounts within the system.

3.3.4. OpenBadge Model

The Badge model represents the digital credentials owned by users. Core fields include:

- title – the official name of the badge.
- description – a textual explanation of the badge's purpose and scope.
- issuer – identifies the organization or entity that awarded the badge.
- visibility – defines whether the badge is private or publicly shareable

By standardizing these attributes, the platform can handle badges consistently, while also supporting future extensions (e.g., additional metadata or new badge formats).

3.3.5. UserEmailLink Model

The UserEmailLink model enables users to consolidate multiple email addresses within a single account. This design choice addresses a common scenario: users often receive badges from different institutions, each tied to different email addresses. By linking emails, the platform ensures that:

- A user's full badge collection is accessible in one profile.
- Users do not need to maintain separate accounts for different email identities.
- Badge ownership is preserved even if a user changes or abandons a particular email.

3.3.6. Benefits of the Model Structure

This three-model configuration balances simplicity with flexibility:

- Simplicity is achieved by maintaining a minimal schema with clear relationships.

- Flexibility is preserved by supporting multiple emails per user and future-proofing badge attributes.

As a result, the database provides a robust foundation for managing digital credentials while keeping the user experience seamless and intuitive.

3.4. Interface and functionalities for the user role

The platform was designed to provide users with complete control over their profile and digital credentials, while ensuring that interactions remain secure, transparent, and straightforward. Core functionalities include registration and login, badge management, email linking, profile sharing, and account maintenance.

3.4.1. Login and Registration

Users can create an account through the registration process or log in to an existing account. Upon authentication, they gain direct access to the dashboard, which serves as the central hub for managing badges, profile information, and account settings.

3.4.2. Adding Certifications

Users are able to upload and manage all badges they have earned. This process is supported by a series of automated checks:

- **Ownership Verification** – the system confirms that the badge truly belongs to the logged-in user, preventing unauthorized claims.
- **Green Badge Validation** – each badge is analyzed to determine whether it is related to sustainability, environmental matters, or climate.
- **Validity Check** – the badge is verified against its expiration date to ensure that only valid certifications are added.

Once processed, the user receives immediate feedback on whether the badge was uploaded successfully or if errors were detected.

3.4.3. Linking Additional Emails

A user may possess badges linked to multiple email accounts (e.g., academic, professional, or personal). To consolidate these credentials, the platform allows linking new email addresses to a single profile. The process requires:

1. Entering the new email address.
2. Receiving and confirming an activation link sent to that email.
3. Once verified, all associated badges are imported into the user's main profile.

This feature ensures that users can maintain a unified badge portfolio without juggling multiple accounts.

3.4.4. Profile Sharing

The system enables users to share their badge portfolio via a dedicated public page. For privacy and security, only badges marked as public are displayed. This ensures that users remain in control of which credentials are visible to external reviewers, employers, or peers.

3.4.5. Password Management

Users can reset their password at any time through a secure recovery flow. This helps prevent unauthorized access and ensures that accounts remain protected even in case of forgotten credentials.

3.4.6. Account Deletion

For full data ownership, the platform offers the option to permanently delete a user account. This process removes all personal information and associated badges from the system.

3.4.7. Badge Information Access

Users can view the complete metadata of each badge, including title, description, issuer, date of issue, expiration, and visibility status. This ensures transparency and clarity regarding the details of their digital credentials.

3.4.8. Badge Management

The platform provides fine-grained controls over each badge:

- Download – users can export badge information for external use.
- Visibility – badge privacy can be toggled between public and private.
- Deletion – unwanted badges can be removed from the account.
- Individual Sharing – selected badges can be shared independently from the full profile.

3.4.9. Benefits of Functional Scope

Together, these features ensure that users can manage their digital identity with flexibility and security. By combining ownership validation, privacy controls, and user autonomy, the platform supports both individual needs (portfolio building, credential verification) and external requirements (sharing with institutions or employers).

3.5. Interface and functionalities for the administrator role

The platform provides administrators with a comprehensive interface for managing users, email links, and open badges. Through this system, administrators can oversee data integrity, enforce policies, and support users when necessary. The administrative view is organized around three main tables: Users, UserEmailLinks, and OpenBadges.

3.5.1. Open Badges Management

The OpenBadges table gives administrators access to all information related to issued badges. For each badge, almost all the data can be reviewed, and in particular:

- Title and description – the official name and explanation of the badge.
- Linked user – the account to which the badge belongs.
- Issuer – the organization or institution responsible for awarding the badge.
- Validity - whether the base is considered valid by this platform or not, and if it is marked as “Green” (environment-related) or not.
- Visibility – whether the badge is public or private.

In addition to viewing badge details, administrators can perform several actions:

- Download – export badge data for verification or record keeping.
- Save – update metadata or re-validate stored information.
- Delete – permanently remove a badge from the system.

This ensures administrators retain full oversight over the lifecycle of badges within the platform.

3.5.2. User Management

The Users table provides administrators with control over individual accounts. For each user, administrators can:

- Activate or deactivate email addresses.
- Grant staff or superuser status for administrative responsibilities.
- Modify account details, including first name, last name, email, and password.
- Adjust permissions, such as active status, staff status, or superuser rights.

Additionally, the admin can review all emails and badges linked to a user. This includes:

- A list of associated email accounts.
- A detailed view of all badges owned by the user.

This granular control ensures that administrators can both troubleshoot user issues and enforce consistent platform policies.

3.5.3. User Email Links Management

The UserEmailLinks table focuses on the relationships between primary and linked emails. Administrators can view:

- The primary email address associated with each user.
- All secondary emails connected to that account.
- Badge summary statistics, including the total number of badges, how many are verified, how many are linked, and other aggregated information.

This view provides a high-level overview of user activity and credential distribution across multiple email identities.

3.5.4. Benefits of Administrative Structure

The separation of data into Users, UserEmailLinks, and OpenBadges tables enables clarity and scalability:

- Clarity – administrators can easily navigate between user-specific information, badge metadata, and email associations without overlap.
- Scalability – the structure supports large volumes of users and badges, while keeping data relationships manageable.
- Flexibility – administrators have both detailed and summarized views, allowing them to intervene at either an individual or systemic level.

Together, these tools ensure that the platform remains secure, transparent, and properly maintained, while also supporting the needs of both users and organizations relying on digital credentials.

4. SUGGESTIONS AND FUTURE UPDATES

At present, the system works only with badges in English. Extending its application to other European languages would be an important step forward, though it also represents a significant challenge.

Currently, badge classification is limited to a binary distinction—green or not green. Future developments could introduce more detailed categories of labeling, and emerging AI technologies may provide advanced solutions to support this process.

In terms of functionalities, a useful improvement would be the possibility for users to remove previously added email addresses, with the automatic deletion of the badges associated with them, a feature not required in the current version.

Finally, platform updates could include support for a wider range of Open Badge formats, and to ensure compliance with the latest IMS Global standards. Obtaining official certification from IMS Global would also be a valuable step to enhance the platform’s reliability and recognition.

5. CONCLUSION

The development of the platform, now hosted online at op4c-passport.csciformazione.eu, has demonstrated the feasibility of creating an IMS Global Open Badge v2.1–compliant passport for recognizing climate action, environmental awareness, and sustainability achievements.

The design choices, particularly the adoption of Python and the Django framework, enabled the creation of a secure, efficient, and extensible system. At the same time, the project demanded significant technical work, especially in updating and adapting the open-source library for badge verification, which now supports modern dependencies and ensures reliable validation.

This approach enhances the relevance of the platform compared with other digital passports, making it a valuable tool for learners, professionals, and organizations engaged in environmental and climate-related objectives.

In conclusion, the platform not only fulfills the technical requirements defined by the project but also establishes a strong foundation for future developments, such as expanding badge format support and refining classification methods. It represents a meaningful contribution to the digital recognition of skills in sustainability, helping to connect individual learning achievements with broader societal challenges.