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Campania Crea—A Collaborative Platform to Co-Create Open Data and Scaffold Information Visualization within the Campania Region

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Abstract: Open government data, as open data, are published to let interested stakeholders exploit data and create value out of them, but limited technical skills are a crucial barrier. Moreover, data silos within any public agency behave as a further obstacle in enabling collaboration between different working groups. This paper investigates the acceptance level of a collaborative platform to co-create, analyze, and visualize open government data within an Italian Regional Public Administration—the Campania region. This investigation first requires retracing and documenting the organizational changes applied to the Campania Region in moving from a siloed structure to a more horizontal and collaborative one. Second, it introduces the technical and technological contribution provided by the proposal of a Social Platform on Open Data (SPOD) as a regional public administration back-office, i.e., an internal platform, co-designed with public agency delegates and referred to as Campania Crea. Finally, it reports on the training session moderated by the University of Salerno to evaluate the acceptance rate of the proposed platform in real settings by involving 54 public agency members in actively using Campania Crea to co-create, analyze, and visualize open government data. The After Scenario Questionnaire was used to assess the acceptance level and attitude in using Campania Crea to report task-based results and the Technology Acceptance Model as an overall assessment of the platform acceptance level. As a result, Campania Crea supports regional public administration members in accomplishing their daily tasks concerning co-creation, analysis, and visualization of open data who positively accepted Campania Crea as a back-office tool. However, further effort should be invested in raising awareness and developing skills concerning open government data management.

Keywords: open government data; collaborative platform; social platform; co-creation; visual analytics; data visualization; empirical evaluation; technology acceptance assessment

Citation: Avella, S.; Cocchiarella, A.; Fonzo, D.; Luciano, C.; Palmieri, G.; Pellegrino, M.A.; Scarano, V. Campania Crea—A Collaborative Platform to Co-Create Open Data and Scaffold Information Visualization within the Campania Region. *Electronics* **2023**, *12*, 2409. https://doi.org/10.3390/electronics12112409

Academic Editors: Kawa Nazemi, Egils Ginters and Michael Bažant

Received: 15 March 2023
Revised: 22 May 2023
Accepted: 23 May 2023
Published: 25 May 2023

1. Introduction

"*Open Data (OD) are data that can be freely used, shared, and built-on by anyone, anywhere, for any purpose*" [1]. Open Government Data (OGD) is a philosophy and a set of policies that promotes transparency, accountability, and value creation by making government data available to all [2]. Public institutions become more transparent and accountable to citizens by making their datasets available. By encouraging datasets' use, reuse, and free distribution, governments promote business creation and innovative, citizen-centric services [2,3]. Since the government and public agencies are encouraged to open by default [4], OGD initiatives have exploded around the world [5]. The OGD process, also called OGD life cycle [6], is a complex process consisting of data creation, publishing, findability, usage, and discussion around data [7]. Hence, it is crucial to revise how government organizations author data and how they provide access to them.

The public sector and, mainly, Public Agencies (PAs) are often organized in silos [8], i.e., poorly coordinated bureaucratic structures. Silos were originally created as a way to

organize and manage processes keeping tasks and responsibilities separated. However, today, they are perceived as a limitation as they impede the development of a more collaborative, multi-disciplinary approach to manage resources [9]. Moreover, they are considered highly inefficient both for citizens and employees [10]. Thus, siloed structured organizations slowly break down vertical silos by enabling horizontal interoperability. Breaking down silos implies moving from closed, structured, and hierarchical into open, flat, and unstructured relationships by performing structural and organizational changes [8].

These changes at the organizational level create the basis for a more collaborative mindset and enable the possibility of providing public agencies with a collaborative platform to deal with OGD. It is precisely the premise at the basis of this article that documents the flagship project performed by an Italian Regional Public Agency (RPA), the Campania Region, to revise the internal organization and processes on the basis of OGD authoring and exploitation. One of the actions performed in this project is the proposal of a Social Platform for Open Data (SPOD) [11] as a back-office platform, i.e., as an internal platform [8], for the Campania Region. While the third sector already uses SPOD to co-create, publish and exploit OD, this article details how SPOD features have been adapted to satisfy RPA requirements. It is the result of a co-design approach actively involving RPA delegates, enabling a multi-disciplinary, multi-departmental, and cross-domain collaboration. The remaining article refers to the customized version of SPOD to satisfy the Regione Campania needs by naming it Campania Crea, while it names SPOD only when it refers to the original platform resulting from the ROUTE-TO-PA project.

To ameliorate the low level of skills in co-creating, analyzing, visualizing, exploiting, and dealing with OGD, SPOD developers organized training sessions with RPA members that took place in person. Participants were invited to test Campania Crea in real settings, co-create high-quality OD, and exploit information visualization to perform visual analysis and achieve data insights. The performed analysis aims to verify the acceptance level of Campania Crea by RPA members. Results underline that RPA members successfully experience Campania Crea to co-create and exploit OD. However, further efforts should be invested in improving their data literacy skills. Thanks to the free participation of communicators, administrators, and technicians belonging to heterogeneous sectors, we can underline the willingness to cooperate and collaborate within the Campania Region.

The contributionat the basis of this article is the assessment of the role played by Campania Crea within our RPA in performing technological changes to enable collaboration and break data silos. It is worth noting that the work on the basis of this paper relies on strict coordination, cooperation, and collaboration among the ICT field experts and Campania Region delegates. In fact, 3 of the authors belong to the Campania region and have curated and refined aspects concerning political reasons, organizational changes, and lessons learned actively involved in the co-design phase. As a result, the Campania Region revised the OD production and publication workflow by introducing Campania Crea to enable the co-creation and exploitation of high-quality OD.

The paper proceeds as follows: Section 2 overviews related work; Section 3 describes the context within this transformation that took place by overviewing the strategic plan adopted by the Campania Region to enable a more collaborative mindset by breaking down data silos; Section 4 details Campania Crea features; Sections 5 and 6 report and discuss the performed quantitative evaluation to assess to what extent Campania Region members accept Campania Crea to collaboratively create, analyze, and visualize OGD. Finally, the article concludes with some final remarks.

2. Related Work

According to the data–information–knowledge pyramid, the greater value for users is in the information that one can extract from OD to answer specific needs and gain knowledge. According to the OD definition, anyone can freely access, use, and modify data [12]. However, the process of obtaining information from data is not straightforward, as it requires a minimum of data literacy to manipulate, understand, and interpret data [13].

Collaboration might help as it is a key principle in the open government directive [14] and is related to open innovation [15]. Collaboration should be enabled between any service providers and consumers [16], such as among citizens and the government [14], but also across all departments within PAs [17].

Providing users with OD catalogs as web portals that store thousands of datasets is not enough to engage citizens [18]. From the late 1990s, several organizations developed central infrastructure designed around agile enterprise architectures that used discrete, modular platforms to share data and services [19]. The literature related to government as a platform and the adoption of platforms during the organizational configuration changes have reported the UK [20], the USA [17], and Italy [8] cases as success stories by demonstrating the overall efficiency increase in the service production and delivery thanks to participatory design and contribution by any stakeholder to the entire ecosystem [21].

Platforms might behave as content management systems, supporting the collection, management, and publishing phases [22], widely adopted within and by enterprises [23]. According to the outlined feature of content management systems, SPOD can be interpreted as a system to collect, manage, and publish OD and the extracted information. While SPOD has already been demonstrated to engage heterogeneous communities, such as citizens, learners, and associations [11], this article focuses on the interest and the acceptance rate of using SPOD within a regional PA. As platforms enabled radical changes in the previously reported stories at the national level, SPOD has the potential to drive innovation by supporting the collaboration within the Campania Region, breaking down silos among RPA departments. Silos within the RPA have broken thanks to the possibility to author OD collaboratively and to simplify inter-departmental data exchange thanks to a centralized platform.

3. The Strategic Flagship Project of the Campania Region

The Campania Region, one of the 20 Italian regional authorities, is a large and complex institution with over 5000 employees. In 2016, it was classified as the last one in a national ranking concerning OD due to a low level of data management maturity, poor integration between information systems, lack of data culture, and the adopted data-siloed model. Thus, our RPA experienced national political pressure in breaking silos, performing digitization and automation processes, and guaranteeing more comprehensive interoperability and data exchange within RPAs as part of a national digital transformation program.

Starting from 2017, our RPA promoted a technological and organizational intervention to acquire ICT services and adopt production methods to satisfy national constraints concerning mandatory datasets that any RPA must publish as OD. It resulted in the proposal of a strategic flagship project, named *Open Data Campania*, that aims to realize OD to spur and encourage public sector information reuse.

According to RPA delegates, digital transformation projects mainly concern people and processes. Consequently, our RPA performed consistent organizational transformations by revising the governance model and setting up a cross-department work group, i.e., the OD Team, based on multidisciplinary competencies in ICT, data analysis, communication, and content management skills. These organizational transformations overcame limitations and constraints posed by a data-siloed structure enabling inter-departmental collaboration. The staff has been involved through a bottom-up strategy aimed to engage RPA members by increasing their awareness about data value and encouraging their participation in the whole process of opening up public data. This strategy is based on RPA members' skill development by periodic activities and training courses. Hopefully, in the future, further efforts might be invested in hiring new personnel with data management skills as the OD team is aware of the benefits of introducing other skilled people to their team.

Concerning technological changes, the most outstanding project achievement consists in the revision of the OD production process (described in Section 4.1) and adoption of the Campania Crea infrastructure (detailed in Section 4.2) to support stable data production and publishing processes. Campania Crea has been integrated as a part of this technological

infrastructure to enable the collaborative creation of datasets among the RPA departments. Adopting Campania Crea, the Campania Region aims to promote and sustain an increment in the internal data production quality as a crucial step towards to ensure new data-driven services and a significant impact on citizens and community.

To fully take advantage of Campania Crea, it is required to involve both RPA members and citizens and stimulate their imagination and interest, demonstrating them the opportunities to adopt Campania Crea to create, modify, discover, and exploit open datasets. For this reason, the Campania Region organized the *Open Data Academia Campania* program, i.e., activities and training sessions with strategic groups to share objectives, perform actions to break data silos in our RPA, and supporting government to citizens collaboration. It mainly focused on RPA members and categories interested in OD, such as learners and journalists as separate sessions.

First, it encouraged RPA members to become aware of the fundamentals and crucial aspects of OD and their management by meetings, workshops, and seminars on data value, data creation, and data visualization. Participants were gently introduced to OD concepts by discussing how data can be defined and reuse according to users' background and skills. Then, they were guided to understand the OD creation process by focusing on data modeling, licenses, and data exploitation by visualizations to enhance the public information assets. Finally, they learned how to enhance and guarantee OD sustainability. Section 5 reports and discusses results related to a training session involving 54 RPA members.

In March and April 2019, our RPA organized two meetings with 300 high school learners from 18 regional institutes involved in a project concerning open cohesion, which uses public OD to perform civic monitoring and communication actions.

In April 2019, the Campania Region organized a seminar ending with a hands-on session with 100 professional journalists to demonstrate to them how to use data exploitation tools offered with Campania Crea in data journalism activities.

From May to June 2019, our RPA promoted a contest named "Represent your dataset!" to encourage learners, citizens, and data enthusiasts to choose a regional dataset and represent it through data visualizations offered within the regional CKAN, which is the same data exploitation mechanism implemented in Campania Crea. This activity resulted in a large engagement of citizens in exploiting and taking advantage of data.

In October 2018, the Campania Region presented the "Campania Open Data" project in Brussels, at the region headquarters, during a meeting scheduled in the European Week of Regions and Cities European Commission and attending European regions. Moreover, it was also presented in May 2019 during the event "Europe in my region" dedicated to best practices within the European Regional Development Fund. The aforementioned project was inserted in the Department of PA's catalog of experiences within the Steering Committee to coordinate interventions for strengthening the administrative capacity of a PA (Thematic Objective 11—OT11) and implementation of the Digital Agenda (Thematic Objective 2—OT2). Thus, it represents an inspiring experience recognized at the national level as a model for implementing an intervention to strength administrative capacities and realize RPA digitization. It ended up among the finalists of Open Government Champion 2019 (in the Transparency and OD category) by radically changing the Campania Region ranking at a national level for OD management processes maturity.

4. Campania Crea: An Open Data Co-Creation and Information Visualization Platform

This section reports about the modified process to produce OD within the Campania Region and the adoption of Campania Crea, the customized version of SPOD to satisfy RPA requirements and needs.

4.1. The Modified Open Data Production Process

To fully enable inter-department collaboration and universal participation of interested citizens, the Campania Region revised its OD Production Process graphically represented in Figure 1. Some components are deployed in the RPA datacenter and others in the

environment of a Cloud Service Provider. The infrastructure is designed with a modular architecture satisfying decomposition and modularity requirements [8].

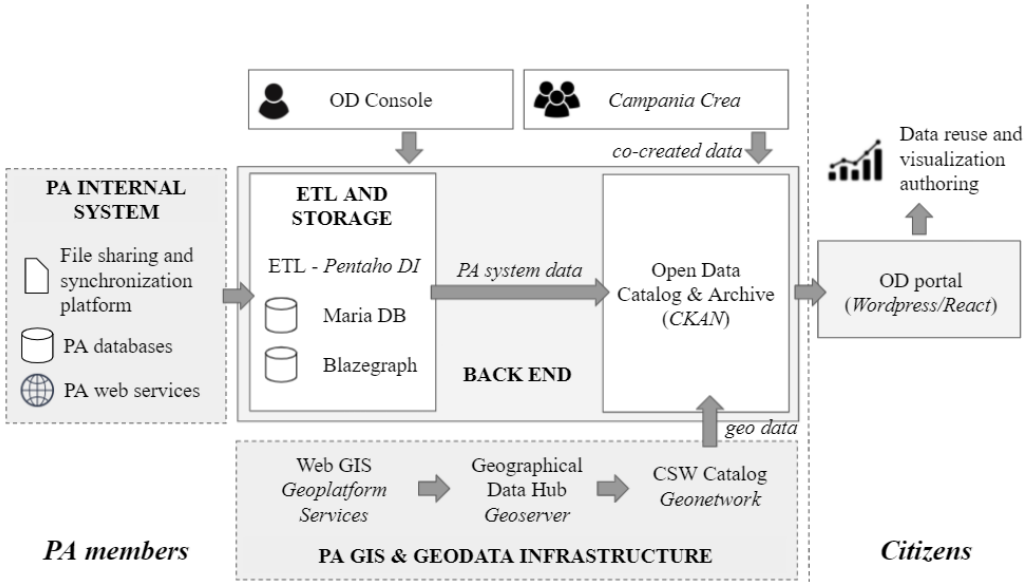

Figure 1. OD creation and exploitation architecture within the Campania Region.

The PA Internal system corresponds to file sharing and synchronization platforms, databases, web service end-points, and provides access to PA internal data. The OD Console represents a single access point from which the authorized high-level structure employees and RPA office members can upload datasets or modify existing ones, manage related metadata, such as data sources, load new sources, or define REST services to expose data. Both PA internal data and datasets produced by OD console behave as input for the extract, transform, load (ETL) and storage component. First, users can manually clean data by improving their syntactic and semantic data and, then, data are automatically transformed and stored as OD thanks to an ETL server, the Pentaho Data Integration (DI). The ETL workflow leads to meeting the scheduled publication frequency. While Relational Databases (DBs) are stored in Maria DB, Linked OD are stored in Blazegraph DB, which supports RDF/SPARQL APIs. Datasets can also be generated by Campania Crea that offers co-creation features and OD exploitation and reuse. RPA employees can create thematic online communities and socially interact in co-creation rooms as an opportunity to collect and produce data collaboratively. The implemented OD co-production mechanism enables real-time collaboration as multiple actors can concurrently modify data under definition. Moreover, Campania Crea also offers humans-in-the-loop quality-check mechanisms within the platform—further detailed in Section 4.2—to deal with the lack of quality that obstacles data exploitation [24]. Finally, co-created datasets are published as OD. The same publication process is followed both for data returned by the ETL and storage component and geo data resulting from PA Geographic Information System (GIS) and geodata infrastructure. The PA GIS and geodata infrastructure component is based on the Free and Open-Source (FOSS) GeoNetwork application, which is a cataloging application for spatially referenced resources. The geographical data, hosted on a geo-server, are harvested and stored on a catalog, i.e., the Catalogue Service for the Web (CSW), dedicated to the management of resources with spatial references. Finally, the Open Data Catalog and Archive (CKAN) harvests data. CKAN is an open source platform for managing, publishing, and researching OD-based archiving components. Datasets harvested or produced by heterogeneous workflows, e.g., manual co-production, CSW catalog harvesting, ETL processes, are published as OD respecting the national DCAT-AP metadata guidelines. The CKAN of Campania Region behaves as a source for the OD portal accessible by citizens. The OD portal corresponds to the front-end layer, and it is a WordPress component that enables content

management concerning events, news, latest publications, published datasets overview, and their details. Moreover, datasets behave as input for the data reuse and visualization authoring mechanism to create reusable and dynamic data visualizations. Therefore, users are guided in exploiting available datasets by a data visualization workflow to move from raw data to data visualizations. The user interface is developed using React to create the catalog front-end layout using the API services exposed by CKAN.

4.2. Campania Crea Features

Campania Crea is a Social Platform for Open Data that scaffolds OD co-creation and naturally enables discussions thanks to its social environment. It behaves as a collaborative platform that lets PA members author data collaboratively, supports information visualization, and enables reasoned decision-making. It is worth noticing that we refer to Campania Crea by calling it a social platform and not a social network, as it cannot be considered a general-purpose social network, but it is a social platform founded on OD where data curators can co-create data, discuss and exploit them.

Our RPA received a dedicated instance of SPOD, completely independent of any other instance distributed to other PAs and organizations. In this way, stakeholders and partners have a security and privacy guarantee. Moreover, it guarantees effectiveness since a dedicated platform avoids misleading topics and focuses on specific discussions.

A demo of the original SPOD is online and available for free via registration (SPOD: http://spod.routetopa.eu (accessed on 1 March 2023)), accessible also by a mobile application, while the instance of Campania Crea is used in a private intranet by the Campania Region. All the source code (SPOD source code: https://github.com/routetopa (accessed on 1 March 2023)), as well as documentation (SPOD wiki: https://github.com/routetopa/spod/wiki, (accessed on 1 March 2023)), is published on GitHub, while demonstration videos are freely available online (SPOD videos: https://www.youtube.com/@spodplatform1731, (accessed on 1 March 2023)).

4.2.1. Co-Creation of Open Data

To support data curators in authoring OD, Campania Crea enables the definition of co-creation rooms where interested and authorized users can access and contribute to the dataset population. Datasets are data tables classified as 3-star OD according to the 5-star schema defined by Tim Berners-Lee to classify and compare OD format [25]. All authorized users can concurrently edit the same datasets by working with different cells. An example of a co-creation room is reported in Figure 2. Co-creation rooms are virtual rooms to let (small) groups of users meet and co-creating tabular data in the CSV format. Each room is based on a shared spreadsheet that lets any contributor authors a new dataset or applies changes to an existing one. Besides concurrent modifications to the shared spreadsheet, co-workers can communicate via a private instant chat, also supporting threads.

To guarantee security and avoid unauthorized access, Campania Crea implements an agile orchestration by distributing roles to users [26]. To each role, tasks, and responsibilities are attached. The implemented roles include the creator, the filler, and the validator. The creator is the expert in the field who is in charge of defining constraints to the dataset under the definition. Besides defining the dataset structure, the creator can also attach data type constraints to each column or their subset. Moreover, the creator can specify parameters to guide fillers in populating the dataset without committing errors by indicating labels, descriptions, and tooltips. Finally, creators can ask for mandatory fields and define the default value. The filler is in charge of populating the dataset according to the creator's constraints. The filler role can be further distinguished in advanced and plain filler. The only difference lies in the visibility of the whole dataset: while the advanced role represents the filler with complete visibility in the reading mode of the whole dataset content, the plain role can only propose rows without looking at the entire dataset content. The role orchestrator may assign the advanced role to trustful users according to security requirements. Conversely, the plain role can be easily assigned to a wider audience by tak-

ing advantage of many contributors while avoiding the proposed rows altering the overall dataset content. Finally, validators are legal representatives of the dataset. Validators are in charge of accepting or discarding rows proposed by fillers but not confirmed yet. By assigning the validator role to experts in the field, this manual check avoids, or at least limits, semantic mistakes.

	La Vinicola del Titerno	Denominazione	Colore	Produttore	Descrizione Organolettica	Vitigno	Gradazione	Certificazi
1	La Vinicola del Titerno	Denominazi...	Colore	Produttore	Descrizione Organolettica	Vitigno	Gradazione Alcolica	Certifica:
2	Galluccio Aglianico	Aglianico	Rosso	Tenuta Adolfo Spada	Vino dal colore rosso rubino intenso. Profumo fruttato e floreale, con piacevoli rimandi minerali. Gusto piacevole e ricco. Evidenzia note di mora, lampone e sottobosco. Dotato di buona struttura, freschezza e persistenza.	100% Aglianico	12,5%	D.O.C.
3	Taurasi	Aglianico	Rosso	Michele Contrada	Colore rosso rubino intenso, offre un bouquet ampio, complesso, intenso con caratteri che ricordano tabacco, ciliegia , viola, frutti di bosco e un peculiare aroma speziato. Sapore avvolgente, elegante e persistente con aroma di prugna, ciliegia amara, confettura di fragole, pepe nero e cuoio.	100% Aglianico	13-15%	D.O.C.G.
4	Aglianico Riserva	Aglianico del Taburno	Rosso	Cantina La Fortezza	Il vino presenta colorazione rosso granato, al naso presenta un aroma intenso di frutti rossi, spezie, tabacco; al palato si presenta caldo, ben strutturato con tannicità non invadente ed un retrogusto di pepe nero.	100% Aglianico	14%	D.O.C.G.
5	Lino delle Fate	Aglianico del Taburno	Rosso	La Dormiente	Vino passito dal colore rosso rubino carico, con un aspetto denso. All'odore ricorda sentori di frutta a bacca rossa, ciliegia e prugna secca. Morbido e denso al gusto.	100% Aglianico		D.O.C.G.
6	Aglianico del Taburno Riserva	Aglianico del Taburno	Rosso	Il Poggio	Di colore rosso rubino carico con riflessi granata con l'invecchiamento.L'odore, complesso, ricorda la ciliegia nera ed il ribes nero. Al gusto, pieno ed equilibrato con tannini ben fusi, presenta un fondo aromatico persistente di tabacco e pepe nero.	100% Aglianico		D.O.P.
7	Safinos	Aglianico del Taburno	Rosso	Il Poggio	Rosso con riflessi rubino. Frutta rossa, tabacco e ginepro.Morbido al gusto con tannini ben fusi ed un finale persistente.	100% Aglianico		D.O.C.G.
8	Aglianico del Taburno Rosato	Aglianico del Taburno	Rosato	Il Poggio	I profumi fruttati, il color rosa corallo, il gusto rotondo e sapido, sono il risultato di una fermentazione termoregolata di un mosto svinato dopo una breve alzata di cappello.	100% Aglianico		I.G.P.

Figure 2. An example of co-creation room within SPOD.

The co-creation phase is also supported by a humans-in-the-loop quality check that supports users in detecting and correcting quality issues related to the completeness and accuracy of quality metrics. In more detail, starting from a non-empty dataset, users can ask for a reactive quality-and-privacy check [27]. It performs a datatype inference phase, followed by a quality check to assess both the accuracy and completeness level. While the accuracy is assessed in terms of datatype mismatch between cells and the remaining column, the completeness is computed by counting missing values. Moreover, it also detects any structural privacy leakage by looking at co-existing data types. For instance, it can notify the co-presence of data items that cause a unique identification of individuals.

4.2.2. Data and Metadata Publication

Campania Crea is completely interoperable with CKAN, an open-source data management system aimed at data publishers (national and regional governments, companies, and organizations) who want to release their data as OD. Once registered to CKAN, users can update and refine datasets by completing them with metadata, e.g., title, description, revision history, license, and tags. Data stored on the OD portals are valuable for PAs because they have one central repository for their data accessible to everyone within the administration. It leads to breaking silos and avoiding centralizing data by enabling data sharing within the PA and with any interested user. Moreover, the CKAN support guarantees interoperability with other standard data portal solutions, compliance with data quality requirements, simplifying data sharing and discoverability, and, consequently, maximizing data exploitation.

4.2.3. Information Visualization as Data Exploitation Mechanism

Once data have been published, OD should be enriched with further information to encourage reuse and interest. For instance, they can be presented in a fascinating way to catch citizens' and public agencies' interest Moreover, they should encourage data enthusiastic to use them for analysis, inquiry, economic, civic, monitoring purposes, or any other application context. Behind each dataset, there can be one or more stories to tell,

stories about the strategy of a public institution, performed actions, achieved objectives and still open gaps, social phenomena, strengths, and resources of a territory.

In the OD context, data visualization has the potential to be a powerful tool for understanding, interpreting, and gaining insight into datasets' content. Data reveals more insight when represented as visual communication and have a higher impact and effectiveness than a textual one. The mantra, "*Data displayed in a chart rather than a table are easier to understand and trends or patterns are easier to identify*" is well known [28]. End-users can be interested in accessing OD for various motivations. For example, businesses in road maintenance could be interested in accessing road data or statistics in subcontracting, start-ups can reuse data to propose novel services, while journalists may exploit data visualizations as evidence in their articles.

Visualizing tabular datasets may require technical skills in data exploitation. Thus, Campania Crea offers a guided workflow to support non-experts users, such as citizens, and expert ones, such as data journalists, in visualizing datasets by the most appropriate visualization options without requiring any technical skill [29]. Users are guided in selecting columns of interest, performing data manipulation or transformation [30], and, finally, visualizing them starting from a dataset. Users can filter and aggregate rows by a form-based interface during the data manipulation phase. For instance, by drop-down menus, users are guided in selecting a column to group by the table content, choosing the aggregation function, and filtering only rows compliant with the desired pattern. Technically speaking, this interface masks the creation and execution of SQL queries on the dataset. Once the dataset is ready to be visualized, users are guided in choosing charts and visualization options. They can choose a bar, column, pie chart, or histogram to compare values and attributes; tree maps to render hierarchies and relationships; timelines to explore temporal information or maps to represent geographical details; audio and media sliders to render media content; tables to list results. Campania Crea assists users in selecting visualization options that are compatible with the given dataset, disabling charts unsuitable for current data types. The visualization process is designed as a cyclic task where users can iteratively modify fields of interest, visualization, and parameters until they are satisfied with the result. As an example, Figure 3 shows the authored chart to visualize Italian cultural heritage sites on a national map.

The same guided workflow is directly accessible from our RPA CKAN. Consequently, both data curators and end-users can access the same exploitation mechanism to access datasets of interest and visualize their content.

The achieved visualization can be downloaded as a traditional image or embedded in any web page, e.g., blogs, institutional websites, or forums, as a dynamic, interactive, and real-time visualization. As an interactive visualization, users can interact with chart items by zooming in and out on the data or asking for additional information. As a real-time representation, it always visualizes up-to-date data. In other words, when the visualization is created, Campania Crea does not store the output of the visualization process. On the opposite, it keeps track of the dataset source and all the needed information to rebuild the desired visualization. If the dataset is updated, the visualization will be automatically updated. Furthermore, the proposed data representation mechanism guarantees data provenance enabling interested users to verify the trustfulness of information and data source. As a use case to underline the expected advantage in supporting data visualization mechanisms, we recall the contest "Represent your dataset!" where citizens and data enthusiasts have been encouraged to exploit open datasets to create engaging data visualizations. The winners exploited the dataset concerning air quality to discuss damages induced by air pollution. In particular, they studied the adopted mechanism to monitor air quality by considering data collected via air quality control units and their geographical position. As a result, they created a map representing the geographical distribution of control units in the Campania region and identified municipalities corresponding to the highest monthly mean value. Data also enable comparison. For instance, participants compared air quality data

concerning different Italian regions to identify the areas most at risk and any correlations between air pollution and respiratory diseases.

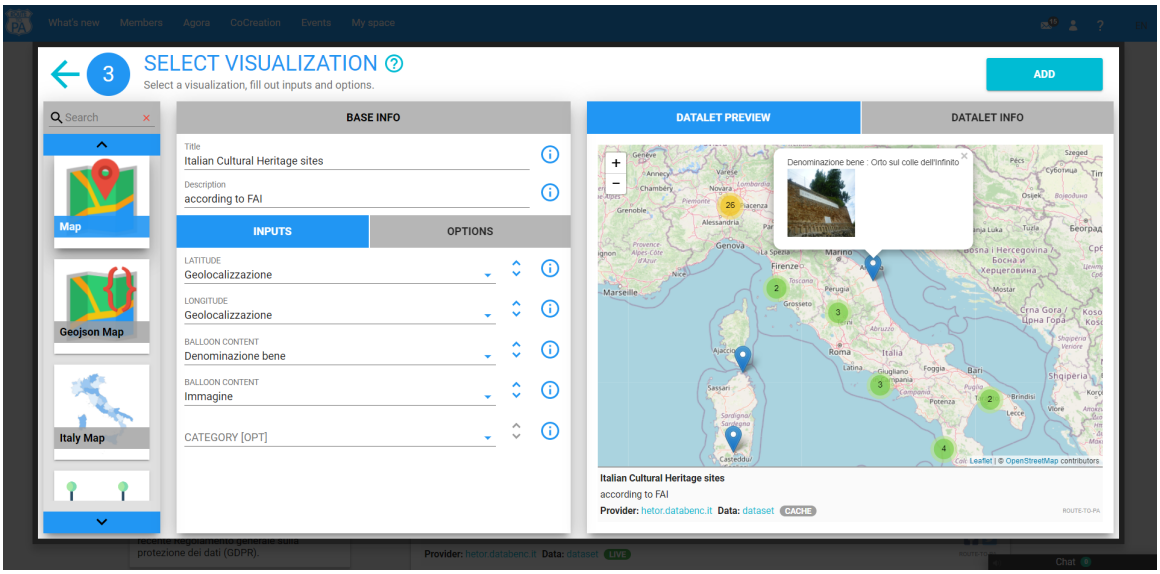

Figure 3. An example of datalet authored by SPOD to visualize Italian cultural heritage sites on a map.

4.3. SPOD Architectural Details

This section reports some technical details concerning the architecture at the basis of SPOD, which are fully described in [18]. SPOD is part of the ROUTE-TO-PA ecosystem, which is based on an architectural model originated from the Data–Information–Knowledge pyramid. The architectural model has three layers, adding the collaborative and presentation layers to the classical data layer.

- **Data layer** provides access to OD catalogs, organized in categories to support exploration and guided research fully. It is compliant with CKAN (CKAN: https://ckan.org, (accessed on 1 March 2023)), DKAN (DKAN: http://getdkan.com, (accessed on 1 March 2023)), OpenDataSoft (OpenDataSoft: https://www.opendatasoft.it, (accessed on 1 March 2023)), widely used by most of governments and PAs.
- **Collaborative layer** challenges users to form groups to author data via crowd-sourcing, create and share visualizations, and perform data-driven discussions [11] concerning topics of interest. It fully supports the collaborative dimension to co-create, visualize, and discuss driven by open information.
- **Presentation layer** includes the features concerning knowledge sharing and communication in the form of digital artefacts to engage the general audience.

Any external system or interested user, such as a PA member, can freely access any layer, as in open-layered architectures. In fact, each layer provides its own Application Programming Interfaces (APIs) to be fully interoperable with other layers of the same architecture and external systems to contribute to both pushing and exploiting data. Besides horizontal layers, authentication and visualization are cross-cutting layers. Visualization is a transversal feature because all the architectural layers can use it. For instance, the presentation layer can exploit visualizations to author data stories, such as articles and blog posts.

In the ROUTE-TO-PA ecosystem, SPOD realizes the collaborative layer, and it is based on the following components:

- **SPOD Data Co-creation** that corresponds to co-creation rooms where small groups of participants can (virtually) meet, co-create tabular datasets, and refine datasets collaboratively, as reported before. Heterogeneous communities have widely exploited

it. For instance, it has been used by associations, learners, and PAs to author cultural heritage open datasets within the HETOR project [31].

- **SPOD Agora for public discussion**, which supports any interested user to perform data-driven discussion in the discussion layer to foster OD transformation and support data interpretation.
- **SPOD Knowledge Co-creation** lets users (virtually) meet, visualize data to move data to information, and discuss any topic of interest within private rooms, gaining and sharing knowledge.

SPOD strongly relies on the Transparency Enhancing Toolset (TET), which implements the data layer in the ROUTE-TO-PA ecosystem and extends the CKAN platform to guarantee data transparency, quality, and understandability. It provides users with storage of datasets with metadata, a catalog of categorized open datasets, and a search engine, overcoming the CKAN usability barriers. Finally, SPOD takes advantage of DatalET-Ecosystem Provider (DEEP) [32], which implements the cross-cutting visualization layer, and it is an open-source, extensible, and scalable edge-centric architecture to visualize OD. DEEP is based on reusable, portable, real-time, and interactive visualizations, named datalets, and a user-friendly wizard, named controllet, to guide users in authoring visualization (Figure 3).

5. Results

This section describes the performed evaluation to assess the technology acceptance level of Campania Crea within the Campania Region. It reports the results collected during a training session that took place involving 54 RPA members.

5.1. Research Question

The performed evaluation focuses on the acceptance of a collaborative platform to co-create, improve data quality, and visualize OD withing the Campania Region. This goal can be formulated as the following research question (RQ): *Do the Campania Region members accept Campania Crea to co-create, analyze, and visualize OD?*

5.2. Participants

A total of 54 RPA members belonging to the Campania Region voluntarily joined the training session without being compensated for taking part. Participants were informed that all the collected data are stored in an anonymous form. Table 1 reports participants' demographic details. Most of the sample is male (67%), and all of them are over 40. Participants belong to three different PA fields, i.e., technical, administrative, and communication sectors. Participants have been asked to assess their expertise in OD by using a 5-point Likert scale where one corresponds to inexperienced and five corresponds to expert. Similarly, they assessed their experience in OD querying and visualization documenting if they have ever used a tool to query or visualize OD. Figure 4 compares the OD expertise level and previous experiences using OD querying and visualization tools, and Figure 5 graphically represents the comparison between the auto-assessed OD expertise and the RPA field. More in detail, Figure 4 reports the number of RPA members grouped by auto-assessed expertise level and details the experience in OD querying and visualization tools in each group. Extreme cases can be easily justified, as inexperienced members have no experience with OD tools, while experts master both visualization and querying tools. Intermediate cases are more heterogeneous, as it is questionable why users with experience in OD querying and visualization tools consider their level as beginners, while users without any experience in OD tools assess that they have advanced expertise. Figure 5 focuses on the OD expertise level grouped by application field, showing that all fields mainly consider their expertise at a beginning level, even technicians.

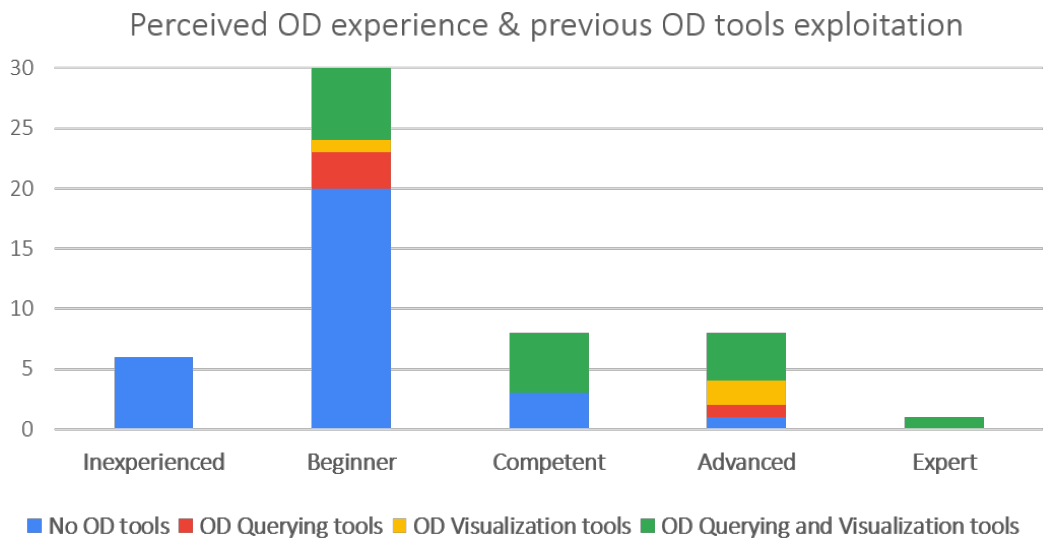

Figure 4. Comparison between OD expertise (interpreted as general knowledge) auto-assessment and previous experiences with OD querying and visualization tools.

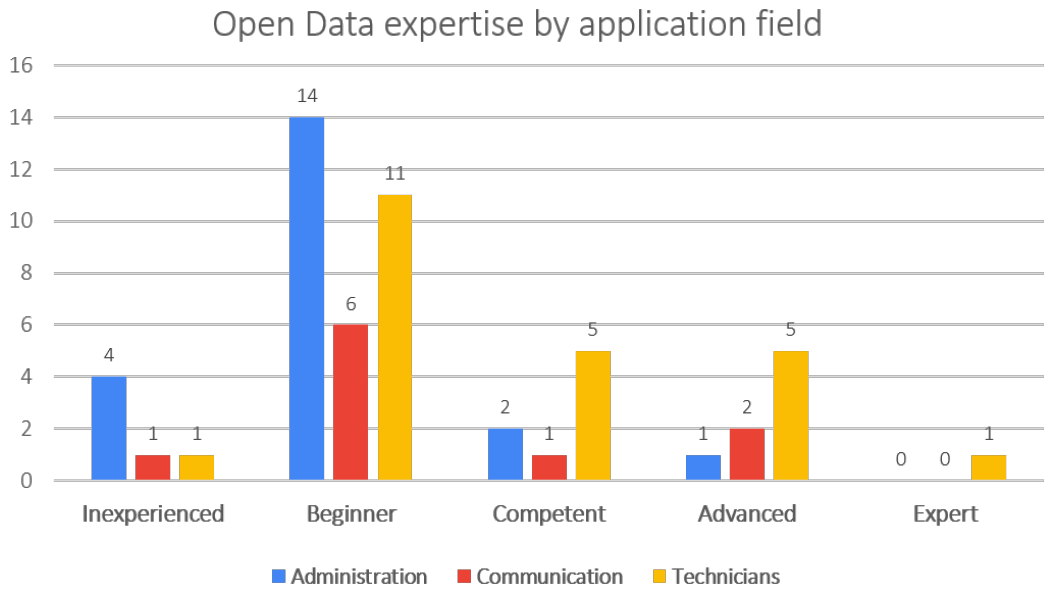

Figure 5. Comparison between OD expertise, interpreted as a general knowledge of OD, auto-assessment, and PA field.

5.3. Protocol

The training session and the related evaluation have been conducted within the Campania Region, as physical meetings, spanning over three days, 4 consecutive hours per day. Each session introduced a Campania Crea feature, describing the functionality, showing how to perform it within the platform, and describing use cases in which PA members may take advantage of that feature. Then, ICT experts behaving as moderators moved to the hands-on sessions focusing on a task concerning the overviewed feature, and each participant completed it autonomously. However, participants were allowed to cooperate and ask for ICT experts' help during the entire hands-on session. Introduced features concerned:

- **OD co-creation**. The moderator overviewed how to generate a co-creation room, import an incomplete dataset in CSV format, and edit it in the co-creation room.
- **Quality check.** During the co-creation, the moderator described how to perform a human-in-the-loop quality check to semi-automatically detect and correct typos and inconsistencies in the dataset under definition.
- **Data publication.** The moderator showed how to attach metadata to the complete dataset and how to publish it internally.
- **Information visualization.** The moderator demonstrated how to visualize datasets both as a data exploitation mechanism and as an approach to visually detect errors and inconsistencies.

Table 1. Participants' demographics and auto-assessment in ICT and OD experiences.

	Number	Percentage
Total Participants	**54**	
Gender		
Male	36	67%
Female	18	33%
Age		
41–45	11	20%
46–50	13	24%
>50	30	56%
Public Administration field		
Technical	23	43%
Administrative	21	39%
Communication	10	18%
Information communications technology experience		
Inexperienced	3	5%
Beginner	22	41%
Competent	14	26%
Advanced	9	17%
Expert	6	11%
Open Data expertise		
Inexperienced	6	11%
Beginner	31	57%
Competent	8	15%
Advanced	8	15%
Expert	1	2%
Previous Open Data querying experience		
Yes	21	39%
No	31	57%
Don't know	2	4%
Previous Open Data visualization experience		
Yes	20	37%
No	33	61%
Don't know	1	2%

5.4. Methodology

The evaluation concerns the assessment of the acceptance level of Campania Crea to create and exploit OD in the Campania region (see RQ). As part of the strategic flagship project performed by our RPA, ICT experts representing the SPOD developers were invited to organize and conduct a training session for RPA members who voluntarily joined. The evaluation is based on the Technology Acceptance Model (TAM) [33], a theoretical construct widely used to assess users' behavioral acceptance and intentions when accessing a new technology or system. TAM includes perceived usefulness and perceived ease of use, where perceived usefulness refers to "the degree to which a person believes that using a

particular system would enhance his or her job performance", while perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort". A system that is perceived to be easy to use is also likely to be accepted by users [33]. TAM model has been extended by introducing playfulness and attitudes to use over time [34]. We take into consideration the Perceived Usefulness (PU), the perceived Ease of Use (EOU), the Perceived Playfulness (PP), and the Attitude Toward Using (ATU).

5.5. Data Gathering

At the beginning of the first day and at the end of the last day of the training session, participants were invited to fill in a questionnaire composed of two main parts. The first part concerned (1) demographic details, i.e., gender and age, (2) ICT expertise, (3) OD expertise, and previous experiences in OD querying and visualization tools. The second part was based on TAM. The remaining sections only considers results collected at the end of the training session as most participants completed it.

During the hands-on sessions, the moderator asked participants to complete tasks (by detailing all the required subtasks) as reported in Table 2, which tested the acquired experience in all the introduced features.

At the end of each task, participants were invited to reply to a structured questionnaire, referred to as After Scenario Questionnaire (ASQ) [35] concerning (1) the degree of the perceived difficulty of the task by performing it through Campania Crea, (2) if the time to complete the task is reasonable, and (3) if the provided knowledge in the training phase is sufficient to complete the task. For each task, the score is assigned by using a Likert scale, 1–7. Finally, they also reported the required time to complete the task.

Table 2. Tasks provided during the evaluation phase.

Tasks	Task Description
Task 1	**Co-creation of High-Quality OD** Create a co-creation room. Upload a given CSV file in the co-creation room. Perform quality checks to detect and correct errors.
Task 2	**Geo-localized data visualization** In the previously created co-creation room, create a map. Create a map by filtering data related to `given province`.
Task 3	**Data analysis and information visualization** By filtering and visualization options, returns how many protected areas are in our region. By filtering and visualization options, returns how many protected areas are in each province of our region. Create a regional map to represent the number of protected areas for each province in our region. Create a word cloud to visualize different types of protected areas.

5.6. Technology Acceptance Model (TAM) Results

This section reports results related to the TAM questionnaire. We checked the internal consistency of multi-item scales using Cronbach's alpha [36], and we reached an alpha value greater than 0.9 in all the metrics (see Column Cronbach's alpha in Table 3), proving the consistency of the presented results.

Table 3 also reports TAM questionnaire results in general and for each involved RPA field. We computed the minimum, the mean value and its standard deviation, and the maximum level for each group.

Table 3. TAM questionnaire results. Legend: PU = Perceived Usefulness, EOU = Ease of Use, PP = Perceived playfulness, ATU = Attitude Towards Using.

TAM Section	Cronbach's Alpha	Metrics	All	Admin.	Comm.	Techn.
Range	0–1		1–7	1–7	1–7	1–7
PU	0.96	Min	1.0	1.0	4.0	2.0
		Mean	5.6	5.5	5.6	5.7
		St.Dev.	1.3	1.3	1.3	0.9
		Max	7.0	7.0	7.0	7.0
EOU	0.97	Min	1.0	1.0	1.0	2.0
		Mean	5.1	5.3	5.4	5.0
		St.Dev.	1.3	1.3	1.0	1.0
		Max	7.0	7.0	7.0	7.0
PP	0.96	Min	1.0	1.0	3.0	1.0
		Mean	5.4	5.4	5.7	5.6
		St.Dev.	1.5	1.5	1.3	1.1
		Max	7.0	7.0	7.0	7.0
ATU	0.93	Min	1.0	4.0	1.0	2.0
		Mean	6.0	5.9	6.1	6.1
		St.Dev.	1.1	0.9	0.9	1.0
		Max	7.0	7.0	7.0	7.0

5.7. After Scenario Questionnaire (ASQ) Results

This section reports on the results of the ASQ question items compared with the auto-assessed OD skill level, the previous experience with querying and/or visualization tools, and the PA field. While ASQ results related to OD auto-assessed level and previous experience in OD tools in reported in Table 4, ASQ results related to the PA field are reported in Table 5. As described in Table 2, task 1 (T1) concerns High-quality OD creation, task 2 (T2) concerns basic visualization, while task 3 (T3) concerns data analysis and information visualization. It is worth noticing that higher values correspond to higher confidence in completing tasks.

Table 4. ASQ questionnaire results considering participants OD expertise. Recall that Q1 concerns to the perceived complexity, Q2 concerns the perceived required time to complete the task by Campania Crea, and Q3 concerns the perceived required training and needed skills to perform the assigned tasks. Higher values correspond to higher confidence in completing tasks. Legend: I = inexperienced, B = beginner, C = competent, A = advanced, E = expert; Q = querying tool, V = visualization tool.

Task	ASQ	OD Skill Level			Prev. OD Tool Use		
		I + B	C	A + E	None	Q || V	Q & V
T1	Q1	5.0 (1.5)	5.1 (1.5)	5.4 (1.6)	4.9 (1.6)	5.4 (1.0)	5.8 (0.6)
	Q2	5.9 (0.7)	5.8 (0.7)	6.0 (1.2)	4.9 (1.5)	5.9 (0.7)	5.9 (0.8)
	Q3	5.6 (0.7)	5.8 (0.4)	6.2 (0.7)	5.2 (1.6)	6.1 (1.1)	6.1 (1.1)
T2	Q1	5.1 (1.4)	6.1 (0.8)	6.1 (0.8)	5.0 (1.6)	5.4 (0.5)	6.1 (0.9)
	Q2	5.1 (1.6)	5.8 (0.8)	6.3 (0.7)	5.0 (1.7)	5.8 (0.8)	6.1 (0.9)
	Q3	5.3 (1.6)	6.0 (1.1)	6.2 (0.4)	5.1 (1.7)	6.1 (0.7)	6.1 (1.0)
T3	Q1	5.0 (1.5)	5.5 (1.0)	5.8 (0.8)	5.0 (1.6)	5.1 (0.7)	5.6 (1.0)
	Q2	4.9 (1.7)	5.8 (0.9)	6.1 (0.8)	4.9 (1.8)	5.6 (0.5)	5.8 (1.0)
	Q3	5.2 (1.6)	6.0 (0.9)	6.2 (0.7)	5.1 (1.7)	6.1 (0.7)	6.0 (1.1)

Table 5. ASQ questionnaire results considering RPA field. Recall that Q1 concerns to the perceived complexity, Q2 concerns the perceived required time to complete the task by Campania Crea, and Q3 concerns the perceived required training and needed skills to perform the assigned tasks. Higher values correspond to higher confidence in completing tasks.

Task	ASQ	Field		
		Administration	Communication	Technicians
T1	Q1	5.3 (1.3)	5.0 (1.7)	5.3 (1.2)
	Q2	5.4 (1.3)	5.0 (1.7)	5.4 (1.2)
	Q3	5.4 (1.4)	5.5 (1.8)	5.8 (1.4)
T2	Q1	5.4 (1.3)	4.9 (1.7)	5.7 (1.2)
	Q2	5.5 (1.3)	5.0 (1.8)	5.5 (1.4)
	Q3	5.4 (1.4)	5.3 (2.1)	5.7 (1.3)
T3	Q1	5.5 (1.3)	4.0 (1.7)	5.5 (1.0)
	Q2	5.6 (1.3)	4.0 (2.1)	5.5 (1.2)
	Q3	5.6 (1.4)	4.8 (2.1)	5.8 (1.2)

6. Discussion

6.1. Multidisciplinary and Multi-Departmental Collaboration

Looking at PA fields participants belong to, visible in Table 1, technicians, administration, and communicators joined the training session. It implies that there is interest in a multidisciplinary and multi-departmental collaboration, which behaves as a step forward to break data silos. Moreover, it evidences the interest in investing in OD in different crucial sectors related to the internal organization, i.e., administration, in the technical and technological field, and in the communication area, that takes care of the communication with external partners and citizens.

6.2. Beginning Level of Expertise

As is shown in Figure 5, administration members considered their expertise at most as advanced by mainly considering themselves at a beginning level. The same pattern can be observed in the communication field. As it may be suspected, users who defined their knowledge at an expert level are technicians. It is interesting to note that also among technicians, PA members consider themselves as beginners. It underlines that no field can be left behind in training sessions concerning OD production and exploitation.

6.3. Theoretical OD Experience

Figure 4 compares OD expertise and previous OD tools exploitation. Inexperienced users never used OD tools. Most of the participants considered their OD experience at a beginning level, and only one out of three beginners used a tool for querying or visualizing OD. It can be justified by the consideration that the OD expertise auto-assessment is interpreted as general knowledge on the OD creation and exploitation concepts. One out of three participants considered at least "competent" in creating and exploiting OD, even if some of them have never used OD querying or visualization tools.

6.4. Positive Attitude in Using Campania Crea to Co-Create and Exploit OD

Looking at the TAM results reported in Table 3, the minimum and maximum levels for each TAM section are not relevant at a global level as they cover the entire range. However, it is interesting to notice that the minimum level changes in some PA fields. For instance, the communication group perceived Campania Crea extremely useful as the minimum value of PU for communication is 4. Moreover, the same group underlines that Campania Crea is perceived as a playful approach, probably for the emphasis posed to OD exploitation during the training. Administration demonstrated a remarkable intention to use Campania Crea as the minimum score for ATU is 4 for the administrative group. About the maximum level, there is at least a user in each group that appreciates Campania Crea

according to each reflection lens, i.e., in each TAM section. In fact, in each group and for each metric, the maximum value is 7, corresponding to the TAM questionnaire's maximum allowed score. In all the considered metrics, the mean value lies between 5 as 6, achieving the highest scores in ATU, demonstrating the interest in adopting Campania Crea in their daily activities. As the mean value is at least 5 and the maximum level is always 7 in all the metrics, RPA members positively perceived Campania Crea to create and exploit OD.

6.5. RPA Members Require Little or No Effort to Co-Create and Exploit OD via Campania Crea

ASQ results are reported in Tables 4 and 5. In T1, there are no significant differences among perceived difficulties, required time, and required skills or training grouping results by auto-assessed OD skill level. Differently, in T2 and T3, the higher is the auto-assessed OD skill level better are ASQ results in all the metrics. Concerning previous OD tool exploitation, already in T1, it is evident that participants who already experienced OD querying or visualization tools are more confident in completing the proposed tasks.

By grouping ASQ metrics by the RPA field, it is interesting to notice that administration members and technicians keep a constant confidence level while increasing complexity tasks. In contrast, the confidence level for communication members decreases while increasing the task complexity. Thus, the communication field members registered more difficulties in completing assigned tasks even if they were the more motivated users. In all groups, the provided limited training and the required skills (Q3) are perceived sufficient to achieve the highest scores in all the tasks. As the mean value is almost greater than 5—besides a few outliers equal to 4—in all the metrics, it demonstrates that RPA members invested a considerable effort in learning how to exploit Campania Crea in accomplishing their daily tasks concerning OD creation and exploitation.

7. Conclusions

The public sector, such as Regional or National PAs, usually has a data-siloed structure, which impedes collaboration and multi-disciplinary approaches. Recently, the exploitation of platforms has gained an increasing interest in performing public sector transformations. Thus, this article retraces organizational changes applied in the Campania Region, enabling a new mindset to accept a collaborative approach to co-create and exploit OD. Thanks to its strategic flagship project, the Campania Region invested in 2018 and 2019 to completely transform both its organization and technological support. By focusing on the technical and technological changes, our RPA transformed the internal workflow to produce and publish OD and adopted Campania Crea to support RPA members in co-creating, refining, publishing, visualizing, exploiting, and discussing OD. In particular, this article overviews how Campania Crea satisfies RPA requirements and analyses its acceptance rate by the TAM questionnaire. Results are rather positive, highlighting that the Campania Region succeeded in involving RPA members in this revolutionary plan. Moreover, RPA members positively accept a social platform to collaboratively create OD by enabling multi-disciplinary and multi-departmental inter-departmental collaboration (RQ). It represents a step forward in breaking its data-siloed structure.

Members of Campania Region also noticed a contribution concerning cultural factors related to the dissemination of the data culture in the institution. They appreciated the creation of a network of contacts, involvement of students, journalists, and other stakeholders in training activities, and the empowerment achieved by the adopted communication means. By focusing on the network of contacts, the community of the Campania Region members has been instrumental in satisfying OD requests, also during the pandemics. During the COVID-19 several stakeholders, such as businesses, professionals, and citizens, asked for datasets concerning production activities, job or training opportunities, and pressing, and cultural sites, to cite a few examples. Moreover, everyone was particularly interested in OD concerning public health related to the spread of the COVID-19 pandemic. Consequently, the Campania Region satisfied these requests due to the presence of the internal network of contacts interested in caring for OD as a result of the organizational changes.

Based on the experience and the developed skills concerning OD creation, manipulation, and refinement, our region succeeded in easily identifying which member(s) might satisfy each received request. It is worth noting that the Campania Region OD experience has been cited as a good practice in the catalog of national experiences in an initiative edited by the Presidency of the Council of Ministers and related to the "Strengthening the Administrative Capacity and Digitisation of the PA" by demonstrating the positive and promising effect of the performed strategic flagship project. During this nomination, some representatives of the Campania Region attended a seminar where several local authorities in our region joined due to their interest in replicating the regional OD project in their administrations. The reuse of the catalog experiences has no territorial limits and can be activated by all national PAs. During this initiative, the Directorate General's regional official and contact person for social and socio-health policies overviewed the organizational and operational phases, which led to the identification, analysis, management, and publication of a series of datasets and their visualization. It represents a real application context of Campania Crea as a collaborative tool to participate in taking care of open datasets and as an exploitation tool in creating data representation. Campania Crea results in an effective and decisive means to spread data and information and enable reasoned decision making.

Author Contributions: Conceptualization, A.C., G.P. and V.S.; Data curation, M.A.P.; Formal analysis, M.A.P. and V.S.; Funding acquisition, V.S.; Investigation, G.P. and V.S.; Methodology, M.A.P.; Project administration, V.S.; Supervision, V.S.; Visualization, D.F.; Writing—original draft, M.A.P.; Writing—review and editing, S.A., A.C., D.F. and C.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. However, part of the technologies presented in this paper has been conducted in the European project ROUTE-TO-PA (www.routetopa.eu, (accessed on 1 March 2023)) that received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 645860.

Data Availability Statement: Raw results are permanently stored on Zenodo. Please, refer to the results datasets by the following citation: Maria Angela Pellegrino, Giuseppina Palmieri, & Vittorio Scarano. (2023). Evaluation of SPOD within the Campania Region [Data set]. In Electronics. Zenodo. https://doi.org/10.5281/zenodo.7969584.

Acknowledgments: We thank Delfina Malandrino for inspiring and extremely useful discussions concerning the evaluation design.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

ASQ	After Scenario Questionnaire
OD	Open Data
RPA	Regional Public Agency
SPOD	Social Platform on Open Data
TAM	Technology Acceptance Model

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