
Terminology Services in the DACH Region Landscape – What Are the Essential Requirements?

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Terminologies and terminology services play a crucial role in the National Research Data Infrastructure (NFDI) and related fields, especially in the DACH region, to ensure the generation of FAIR research (meta)data. The primary objective of the Base4NFDI basic service Terminology Services 4 NFDI (TS4NFDI) is to standardize and harmonize terminology services, establishing an interoperable and sustainable solution. This solution will be integrated into the long-term NFDI infrastructure, ensuring consistency and reusability across domains, improving terminology management, and fostering cross-domain collaboration within the NFDI community.

A comprehensive requirement analysis was conducted during the initialization phase of TS4NFDI, providing insights for its future development. A survey comprising 69 participants has provided valuable insights into the current challenges and needs for terminology services. The analysis focused on three key groups: 1) developers (of web services), 2) managers of web services which want to interact with terminology services and 3) users working with terminologies.

TS4NFDI developed work packages for the integration phase in response to survey participant feedback. The following key objectives have been identified: 1) The creation of collections and entity sets of terminologies (WP1), 2) the establishment of a NFDI-wide mapping service (WP2), and 3) the provision of support for term requests (WP3).

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Furthermore, user requirements will be addressed in WP6, focusing on community engagement, communication, and training. This includes incubator projects to integrate terminology services into user services.

Keywords: terminology services, terminology, ontology, FAIR, metadata

1 Introduction

Given the exponential increase in data volume, occurring at a rate of doubling every three years (Henke et al. 2016), FAIR machine-actionable (meta)data is needed to prevent the loss of meaningful insights. In order to create FAIR machine-actionable (meta)data, it is necessary to establish an overarching research data management framework. Such a framework should be built upon metadata that describes research data and their generation across all domains. To ensure that disciplines can create and share a common understanding of the concepts and relations used to describe data, terminologies must be employed as a formal representation of domain knowledge.

Terminologies have a long tradition. The term was first used in 1770 by Christian Gottfried Schütz. The term ‘Terminology’ is derived from Medieval Latin ‘terminus’, signifying ‘word’ or ‘expression’, with the latter element deriving from the Greek ‘-logia’, signifying ‘a dealing with’ or ‘a speaking of’.¹ It is widely acknowledged that Eugen Wüster is the founder of modern terminology theory (Humbley 2022). Trojar has authored a scientific article on Wüster’s perspective on terminologies. Trojar (2017) implies that Wüster’s discourse on synchrony is related to modern semantics. Wüster prepared six ISO recommendations and one ISO standard as part of a committee for the international standardization of terminology ISO/TC37 (Trojar 2017). In ISO 1087-1 (2000) a terminology is defined as a set of designations or terms belonging to one special language. Moreover, terminologies could include several types of relations such as hierarchical, associative, sequential associative, temporal sequential and causal associative relations (Zemmouchi-Ghomari and Ghomari 2012).

In this manuscript the term terminology is used as an umbrella term for the terms terminology, ontology, vocabulary and thesauri. For a comprehensive analysis of the distinctions between these terms, readers are directed to consult the work of Pieterse and Kourie (Pieterse and Kourie 2014). Similarly, in the context of EOSC you may read the term semantic artefact, which is used even a bit broader (Jonquet et al. 2023).

A terminology service (TS) can be defined as a web-based service which is used for the management and provision of access to terminologies, including vocabularies, terminologies, ontologies, and classifications or thesauri. These services are crucial in various do-

¹ <https://www.etymonline.com/word/terminology>; *Visited on March 26, 2025.*

mains where standardized terminologies are essential for effective data interoperability. The functionality of a terminology service encompasses querying, browsing, visualisation, and mapping between terminologies (Koepler et al. 2024).

A comprehensive overview of terminology services is available at the Basic Register of Thesauri, Ontologies & Classification (BARTOC, see Ledl 2015). BARTOC lists comprehensive metadata about terminology services and links to their original source. As shown in BARTOC the most commonly used software stacks for individual terminology services are the Ontology Lookup Service (OLS), OntoPortal and Skosmos. In this context, a software stack is defined as the technology used to host terminologies. OLS was developed in the early 2000 at EMBL European Bioinformatics Institute (EMBL-EBI, see Jupp et al. 2015). The OntoPortal system is developed by the OntoPortal Alliance, a consortium of research and infrastructure teams, and is derived from the BioPortal system (Jonquet et al. 2023). BioPortal was developed in 2007 at Stanford University (Noy et al. 2009). OLS and BioPortal are repositories for biomedical ontologies, supporting the W3C standards Resource Description Framework (RDF)² and the Web Ontology Language (OWL)³. The development of Skosmos was initiated in 2014 at the National Library of Finland (Suominen et al. 2015). It is specified for the W3C standard Simple Knowledge Organization System (SKOS)⁴ model. All of these solutions are open-source. Other well known terminology service software stacks are Ontobee (Xiang et al. 2011), Aber-OWL (Hoehndorf et al. 2015) and the commercial solution CENTree⁵.

In addition to terminology services, a range of open-source tools is available to support terminology engineers in the creation of terminologies. Examples of such tools include Protégé (Musen 2015), VocBench (Stellato et al. 2020) or ROBOT (Jackson et al. 2019). Proprietary and commercial tools such as SDL Trados Multiterm⁶, Topbraid Composer⁷ and Congree TermTiger⁸ are also available.

2 Terminology Services and their usage in the DACH region landscape

To manage the complexity of existing software stacks for terminology services, this paper focuses on services provided in the DACH region. However, there are multiple terminology services hosted in the DACH region which are based on OLS such as the TIB

2 <https://www.w3.org/TR/rdf11-concepts/>; Visited on March 26, 2025.

3 <https://www.w3.org/TR/owl2-overview/>; Visited on March 26, 2025.

4 <https://www.w3.org/TR/skos-reference/>; Visited on March 26, 2025.

5 <https://scibite.com/solutions/ontology-management/centree/>; Visited on March 26, 2025.

6 <https://www.trados.com/product/multiterm/>; Visited on March 26, 2025.

7 <https://allegrograph.com/topbraid-composer/>; Visited on March 26, 2025.

8 <https://www.congree.com/en/product/congree-termtiger>; Visited on March 26, 2025.

Terminology Service (Strömert et al. 2023), SemLookP (Baum 2024), the BERD Terminology Service (Shigapov, Koepler, and Baum 2024), the Plasma-MDS Ontology Lookup Service (Becker, Chaerony Siffa, and Baum 2024) or the ANNO Terminologieserver⁹. Bio-divPortal (Karam et al. 2024), MatPortal¹⁰, and TechnoPortal¹¹ are based on OntoPortal. Furthermore, the Skosmos technology has multiple instances in the DACH region, including ACDH-CH/DARIAH Vocabularies¹², BARTOC Skosmos¹³, Thesaurus for the Social Sciences (TheSoz, see Zopilko et al. 2013), ZPID Vocabularies (Trillitzsch 2022) and ZBW classifications (Gastmeyer, Wannags, and Neubert 2016).

In addition to these instances, several other (self-developed) terminology services exist in the DACH region such as DATendrehzscheibe für Normdaten und TERminologien (DANTE, see Helms 2018) developed at the VZG in Göttingen. Federal institutes also host terminology services, such as the WFS Geographische Namen GN-DE¹⁴ managed by the Federal Agency for Cartography and Geodesy, and the Checklist API¹⁵, hosted by the German Red List Centre on behalf of the German Federal Agency for Nature Conservation (BfN). It is important to note that all three of these terminology services provide their own API, with their own specific schema. Additionally, there is the Central terminology server¹⁶ for the healthcare sector, hosted by Federal Institute for Drugs and Medical Devices (BfArM). This BfArM – Terminology Server reuses the software stack from the Austrian e-Health Terminology Browser (ELGA)¹⁷. Alongside SemLookP and the BfArM – Terminology Server, the Service Unit Terminological Services (SU-Term-Serv Ingenerf et al. 2023) is a third terminology service for the medical domain in Germany and used by the Medical Informatics Initiative.

The BfArM Terminology Server, ELGA and the SU-TermServ facilitate the provision of terminologies with a HL7® FHIR® API which is widely used in hospitals and is the standard for the electronic patient record (ePA).¹⁸ In Switzerland, the DCC Terminology Service (Krauss et al. 2021), hosted by the Swiss Personalised Health Network (SPHN), makes its data available to machines via RDF. While the Integrated Authority File (GND)¹⁹ serves a broader purpose than a traditional terminology service, certain parts of the GND are typically used similarly to terms in terminology services. Finally,

9 <https://ols.imise.uni-leipzig.de/>; *Visited on March 26, 2025.*

10 <https://matportal.org/>; *Visited on March 26, 2025.*

11 <https://technoportal.hevs.ch/>; *Visited on March 26, 2025.*

12 <https://vocabs.dariah.eu/en/>; *Visited on March 26, 2025.*

13 <https://skosmos.bartoc.org/en/>; *Visited on March 26, 2025.*

14 <https://gdz.bkg.bund.de/index.php/default/wfs-geographische-namen-gn-de-wfs-gnde.html>; *Visited on March 26, 2025.*

15 <https://checklisten.rotelistezentrum.de/api/public/swagger-ui>; *Visited on March 26, 2025.*

16 https://www.bfarm.de/EN/Code-systems/Services/Terminologieserver/_node.html; *Visited on March 26, 2025.*

17 <https://termgit.elga.gv.at/index.html>; *Visited on March 26, 2025.*

18 <https://www.bundesgesundheitsministerium.de/ministerium/ressortforschung/handlungsfelder/digitalisierung/sd-epa-fhir-cdr.html>; *Visited on March 26, 2025.*

19 https://gnd.network/Webs/gnd/DE/Home/home_node.html; *Visited on March 26, 2025.*

the ORGANON²⁰ terminology toolbox, developed at the Free University of Berlin, also provides information to a term, but with a different scope than a traditional terminology service. A term in ORGANON must be used in several discursive contexts.

The use of terminology services in the DACH region is characterised by a greater breadth, as many widely used terminology services are not hosted within the region. Well-known examples include OLS (Jupp et al. 2015), BioPortal (Noy et al. 2009), AgroPortal (Jonquet et al. 2018), Iconclass (Couprie 1983), NERC Vocabulary Service (Leadbetter, Lowry, and Clements 2014), Getty Thesaurus of Geographic Names²¹, and SNOMED CT Browser²².

The National Research Data Infrastructure (NFDI), with its discipline-specific consortia, can be seen as the representative of the DACH region in terms of gathering requirements for terminology services. Despite the fact that the various consortia of the NFDI address distinct knowledge domains, there is a considerable degree of overlap in the topics they tackle. These cross-cutting topics are addressed in the five sections of the NFDI listed below: 1) Common Infrastructures, 2) Ethical, Legal and Social Aspects, 3) (Meta)data, Terminologies, Provenance, 4) Training & Education and 5) Industry Engagement. Specific working groups are established within each respective section to ensure comprehensive and systematic handling of the various topics.

As terminologies and terminology services are of significant importance across various NFDI consortia, two dedicated working groups have been convened to address these issues. The two working groups are: 1) Ontology Harmonization and Mapping and 2) Terminology Services. The working group Ontology Harmonisation and Mapping focuses on the consistent use of terminologies and the organisation of vocabulary items into structured ontologies (Anders, Arera-Rütenik, et al. 2022). These are prerequisites for FAIR data, in particular regarding cross-community reuse and machine-actionability of research data. Furthermore, the Terminology Services working group aims to foster joint developments, share best practices and reduce barriers to the use of terminologies and terminology services (Anders, Bailly, et al. 2022).

As demonstrated in the preceding paragraphs, the DACH region is characterised by a diverse and heterogeneous landscape of disparate terminology services. The NFDI consortia and sections are fostering multiple approaches to harmonise the different terminology services. The working group Terminology Services was the genesis of the basic service Terminology Services 4 NFDI (TS4NFDI), which is funded by Base4NFDI.

20 <https://organon-lexicon.org/>; *Visited on March 26, 2025.*

21 <https://www.getty.edu/research/tools/vocabularies/tgn/>; *Visited on March 26, 2025.*

22 <https://browser.ihtsdotools.org/>; *Visited on March 26, 2025.*

3 Terminology Services 4 NFDI

Terminology Services 4 NFDI (TS4NFDI) is a cross-domain basic service for the provision, curation, development, harmonization and mapping of terminologies. TS4NFDI is funded by Base4NFDI, which itself is a joint initiative of all NFDI consortia. The objectives of TS4NFDI are as follows: 1) to standardise and harmonise the management of terminology within the NFDI and 2) to facilitate consensus-building and the interoperability of services across disciplines in order to achieve a common representation of knowledge and engineering framework. TS4NFDI provides a way to integrate and converge individual solutions into a standardized, interoperable, sustainable service suite embedded in a long-term NFDI infrastructure, thereby improving the overall efficiency and effectiveness of terminology management and use, as well as cross-domain collaboration within the NFDI community.

In order to gain a structured understanding of how terminology services and terminologies are used in the different NFDI consortia and beyond, a comprehensive requirement analysis (Baum et al. 2024) was conducted by TS4NFDI. The creation of a survey was an essential step in the process of producing a comprehensive requirement analysis. The survey shall capture the requirements of the NFDI consortia and identify potential use cases to support them in integrating terminology services to their applications. The following sections present the key findings of the survey.

4 TS4NFDI Survey Methodology

An online survey (LimeSurvey platform²³, hosted by the TIB in Hannover) was conducted targeting researchers, developers of web services and data managers within the 26 NFDI consortia and Base4NFDI. Furthermore, the survey targeted users who work with terminologies. The survey consisted of multiple-choice, list-based, and open-text questions, structured around key user roles: developers, managers, and terminology users. Participants were recruited via NFDI mailing lists, consortium meetings, and community outreach efforts. The survey remained open for six weeks (from 6th May 2024 to 14th June 2024), and 69 individuals completed it. Nevertheless before the first question an overview of technical terms used in the survey was shown (see Table 1).

²³ <https://www.limesurvey.org>; Visited on March 26, 2025.

Table 1: This table contains explanations of technical terms used in the survey.

Explanation of technical terms
We refer as a terminology to any terminological resource, also referred to as semantic artifacts. This can be a formal ontology, a taxonomy, or any useful source of Semantic Web-compliant collections of terms (e.g. locations available through a geographical database such as Geonames).
A terminology service , also referred to as an ontology repository, is a system for managing and providing access to terminologies. These services are crucial in various domains where standardized terminologies are essential for effective data interoperability. They offer functionalities such as browsing, searching, mapping, and annotation as well as APIs to access those programmatically.
Term mapping involves linking different terms describing the same concept, thereby enabling more effective search and information retrieval. In data management and integration, term mapping helps align terminologies used in different datasets or databases, facilitating data interoperability and integration across various systems or domains.
In knowledge representation and reasoning, a knowledge graph is a knowledge base that uses a graph-structured data model or topology to represent and operate on data. Knowledge graphs are often used to store interlinked descriptions of entities – objects, events, situations, or abstract concepts – while also encoding the semantics or relationships underlying those entities.
Annotation or tagging is the process of attaching relevant metadata about concepts (e.g., people, places, organizations, products, or topics) to a text document or other unstructured content. Unlike classic text annotations, which are intended for the reader’s reference, semantic annotations can also be used by machines. Semantically tagged documents are easier to find, interpret, combine, and reuse.

The survey itself was structured in eight sections (see Figure 1). The first and the last section contained questions for all participants. The remaining sections were only presented to participants who had provided specific answers in the survey. The survey was further segmented into three distinct sections, each tailored to specific target groups. The three possible branches are: 1) Developer, 2) Manager and 3) User/Other. Prior to and following these three branches for the specific target groups, general questions were posed to participants who had previously encountered terminologies. The general questions were divided into two sections due to the presence of a discrepancy in their respective contexts. To clarify, the subsequent query was posed at the conclusion of the survey, following the administration of questions pertaining to specific features: ‘Can you

think of new terminology service features that would improve your system/workflows?’. This approach allowed participants to propose any missing features that may have been overlooked during the initial conception of the survey. Nevertheless, concomitant with these five branches, a branch was present for participants, for the purpose of potential new users of terminologies.

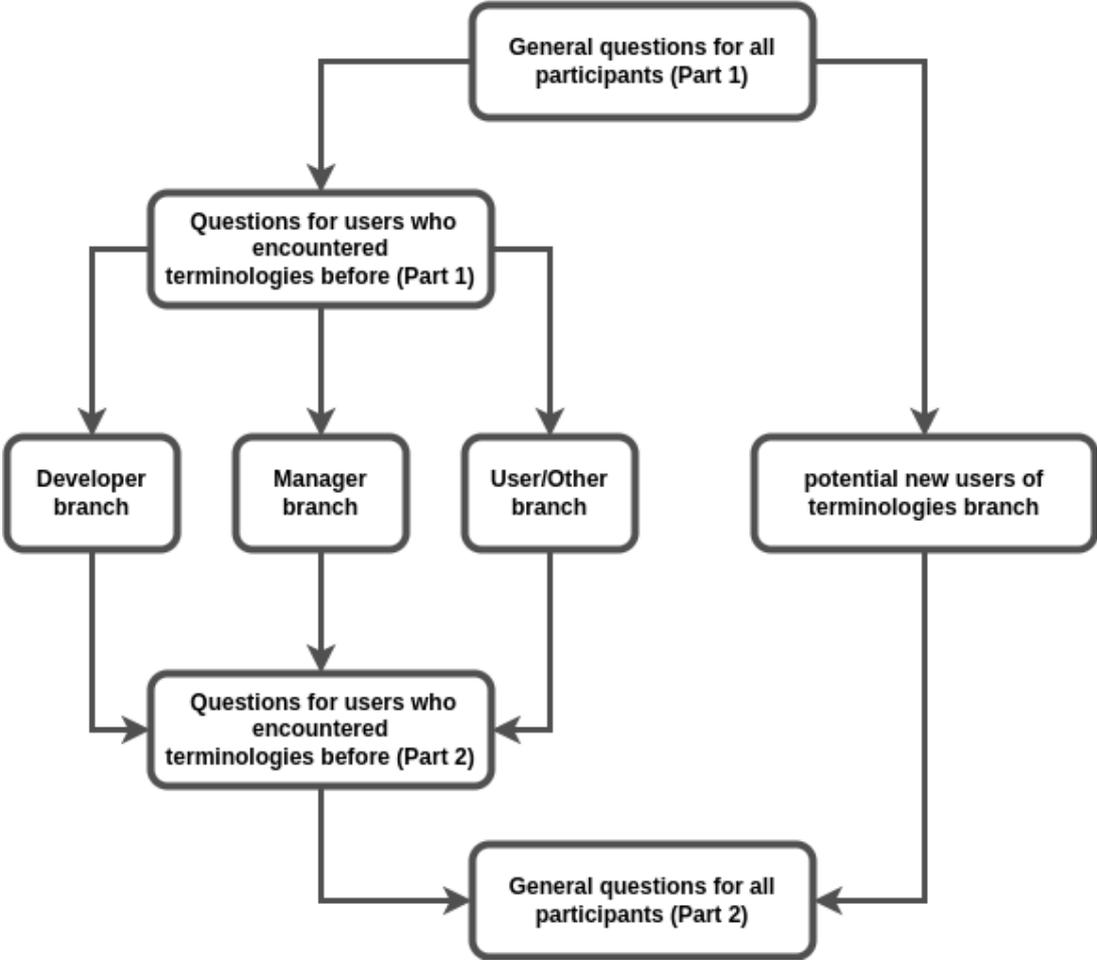


Figure 1: Structure of the survey.

The survey comprised a combination of three distinct question types: multiple choice, list ratio and free text. It was also possible to combine these types (see Figure 2). The majority of questions that incorporated a free text answer option were not required. However, the majority of questions incorporated multiple-choice or list-ratio types.

What exchange formats do you use for terminologies? *

(Multiple Choice)

- a. RDF/XML; Turtle; JSON-LD
- b. SKOS
- c. HL7 FHIR
- d. JSON
- e. XML
- f. OBO
- g. Other: (Free Text)

Figure 2: A question from the survey is depicted as an example. The red asterisk at the end of the question marks that an answer from the participant is required. If the participant selected the option 'Other:', a free text was provided to enter the used format(s).

5 Results & Discussion

The full questionnaire and all the multiple choice and list response results from the survey are published in the TS4NFDI Requirements Analysis Report (Baum et al. 2024). The free text responses could not be published for privacy reasons. In this paper, however, we want to focus on the key findings.

A total of 69 participants completed the survey. The survey successfully reached all 26 consortia and Base4NFDI, indicating a comprehensive representation of the target group. Of the 69 participants, at least one was associated with one of these consortia. It was possible for a participant to select more than one consortium in the survey, as an individual could be a member of different consortia. The TS4NFDI Requirements Analysis Report (Baum et al. 2024) also provides a more detailed overview of the number of participants related to each consortium. Only 2 participants didn't encounter terminology before this survey and are not part of the following presentation of the key findings. The remaining 67 participants were divided into the three specific target groups as follows: Developer (40.30 %, 27 participants); Manager (46.27 %, 31 participants); and User (4.48 %, 3 participants)/Other (8.96 %, 6 participants).

Among the 67 participants who responded to the question about creating or using custom collections of terminologies, 64 % (43 participants) expressed a clear need for such functionality (Figure 3). A smaller fraction (12 %, 8 participants) indicated no need, while 24 % (16 participants) were uncertain. This suggests that while most users value the ability to customize terminology subsets, a significant portion may lack the necessary

experience or knowledge to determine their need. Supporting these users with guidelines and use cases could increase terminology use.

The majority of participants (84 %, 56 out of 67 participants) indicated the necessity of mappings between terms, emphasizing the importance of interoperability across different terminologies (Figure 4). Only 5 participants (7 %) stated that they did not require mappings, while 6 (9 %) were unsure. These findings reinforce the idea that terminology services must prioritize robust mapping mechanisms to facilitate seamless data integration and interoperability across domains.

The need for a feature that allows users to request missing terms was assessed within the Manager branch of the survey (n=31). An overwhelming 94 % (29 participants) agreed that terminology services should support term requests, while only 2 participants (6 %) found it unnecessary (Figure 5). This strong consensus highlights the dynamic nature of terminologies and the necessity of continuous updates to reflect evolving research needs.

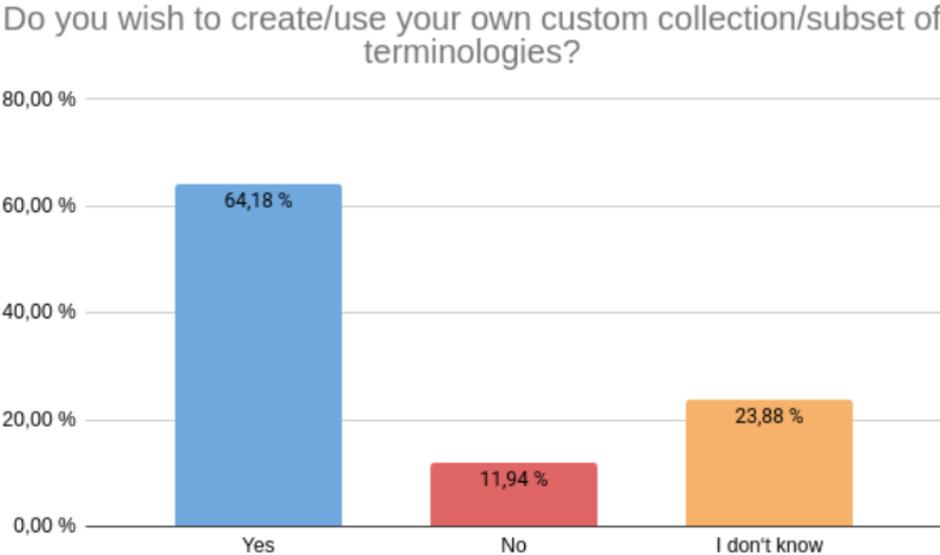


Figure 3: The figure presents three distinct potential responses for the x-axis, while the y-axis depicts the corresponding percentage values. The blue bar represents the answer “Yes”, the red bar represents the answer “No”, and the orange bar represents the answer “I don’t know” (n=67).

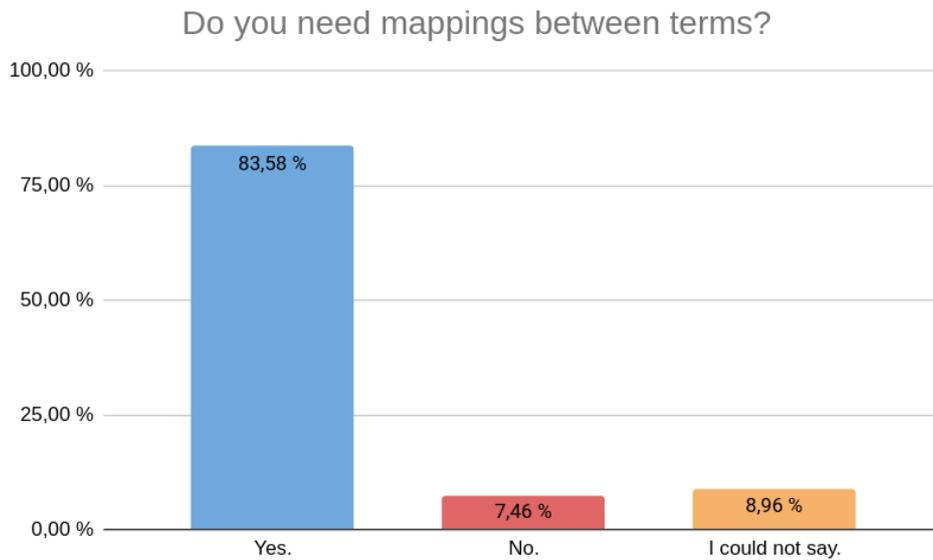


Figure 4: The figure presents three distinct potential responses for the x-axis, while the y-axis depicts the corresponding percentage values. The blue bar represents the answer “Yes”, the red bar represents the answer “No”, and the orange bar represents the answer “I could not say” (n=67).

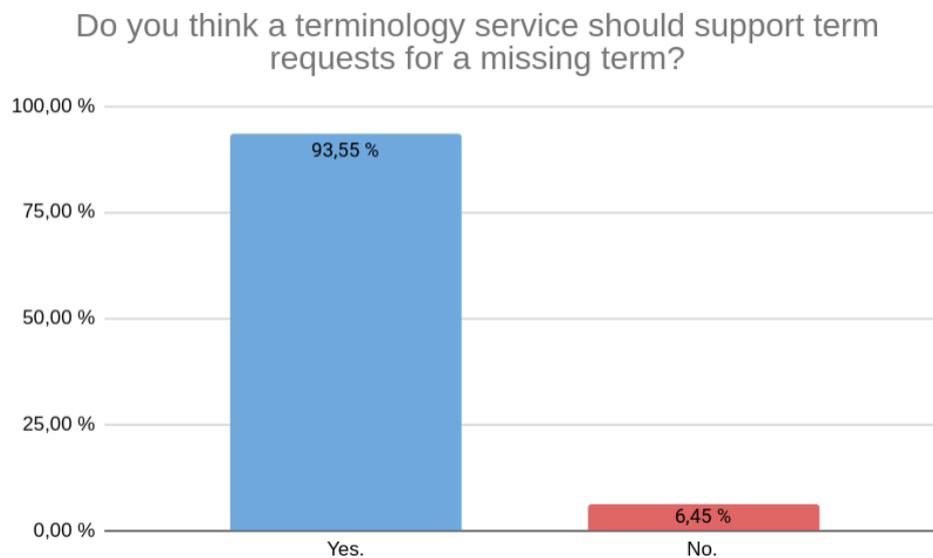


Figure 5: The figure presents two distinct potential responses for the x-axis, while the y-axis depicts the corresponding percentage values. The blue bar represents the answer “Yes”, and the red bar represents the answer “No” (n=31).

Participants were asked about their expectations from TS4NFDI in its cross-consortium work. The results indicate high demand for multiple forms of support (see Figure 6). The

findings underline the necessity of a broad support offer that extends beyond technical implementations. Transfer of knowledge and best practices seems to be a critical factor in the successful harmonization of terminology services across the NFDI.

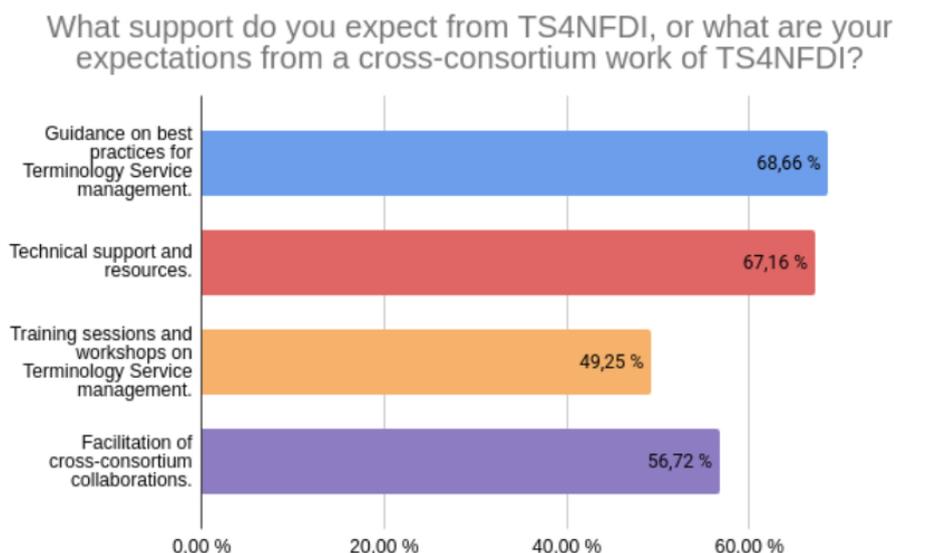


Figure 6: The figure presents four distinct potential responses for the *y*-axis, while the *x*-axis depicts the corresponding percentage values. The blue bar represents the answer “Guidance on best practices for Terminology Service management.”, the red bar represents the answer “Technical support and resources.”, the orange bar represents the answer “Training sessions and workshops on Terminology Service management.”, and the purple bar represents the answer “Facilitation of cross-consortium collaborations” (n=67).

6 Conclusion and Outlook

The TS4NFDI team has aligned the requirements and expectations of the survey participants with the work packages (see Table 2) for the integration phase proposal. The survey results highlighted a strong demand for custom terminology collections (64 %), term mappings (84 %), and support for term requests (94 %). These findings directly shaped the objectives of TS4NFDI’s integration phase, which focuses on: 1) creating collections and entity sets of terminologies (WP1), 2) Establishing an NFDI-wide mapping service (WP2) and 3) Providing support for term requests (WP3).

Table 2: Workpackages of TS4NFDI.

Work package Title	Description of the Work Package
WP1 TS4NFDI Service Portal	The TS4NFDI Service Portal is designed to facilitate the creation and management of entity sets and terminology collections. This enables domain experts to configure the response of the API Gateway or the TSS following their specific requirements.
WP2 Mapping Service	This work package aims to create and establish a mapping service. A mapping registry will be developed to store all relevant NFDI terminology mappings, accessible via APIs and open data formats (JSKOS, SSSOM, RDF, CSV) to adhere to FAIR principles.
WP3 Workflows for terminology curation	This work package will promote the possibility to request new terminologies or missing terms.
WP4 Extension of the API Gateway	The functionality of the TS4NFDI API Gateway will be extended with respect to the requirements of the TS4NFDI Service Portal (e.g. collection and entity set management) and additional user requirements (e.g. adding new terminology software stacks as backend resources) collected via incubator projects in WP6.
WP5 Extension of the Terminology Service Suite	The functionality of the Terminology Service Suite will be extended with respect to the requirements of the TS4NFDI Service Portal and the user requirements collected via incubator projects in WP6.
WP6 Community engagement, communication, and training	This work package will foster community interaction and integration with the TS4NFDI service, supporting user-driven development of new and existing features. Incubator projects will be conducted to integrate TS4NFDI into consortia services by exploring and testing new features with the TS4NFDI team.

Additionally, survey participants expressed a clear expectation for guidance, technical support, training, and cross-consortium collaboration, reinforcing the importance of Work Package 6 (Community engagement, communication, and training). This work package will provide support and a framework for incubator projects that integrate terminology services into user workflows. The incubator projects will enable hands-on collaboration between TS4NFDI and service providers, supporting activities such as: hosting of terminologies, establishment of a terminology service, addition of terminology services to the TS4NFDI API Gateway, integration of Terminology Service Suite widgets into other ser-

vices, and provision of collection(s) via the TS4NFDI API Gateway. Each incubator will run for six months, with dedicated resources (e.g. developer capacity) to support integration into another service. The first cycle, launched in Q1/2025 with five projects, will be completed in Q3/2025, followed by additional cycles. TS4NFDI will offer at least four of these cycles. A minimum of four incubator cycles is planned during the integration phase, with progress tracked via an incubator dashboard on the TS4NFDI Service Portal.

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Authorship Contributions

- Roman Baum: conceptualization, supervision, writing first draft.
- All authors: writing & editing.

All authors read and approved the submitted version of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of Interest.

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