Polifonia: a digital harmoniser for musical heritage knowledge, H2020

D1.1 Roadmap and pilot requirements 1st version

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1	UNIBO	ALMA MATER STUDIORUM - UNIVERSITÀ DI BOLOGNA	Italy
2	OU	THE OPEN UNIVERSITY	United Kingdom
3	KCL	KING'S COLLEGE LONDON	United Kingdom
4	NUI GALWAY	NATIONAL UNIVERSITY OF IRELAND GALWAY	Ireland
5	MiC	MINISTERO DELLA CULTURA	Italy
6	CNRS	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	France
	SORBONNE	SORBONNE UNIVERSITE (LinkedTP)	France
7	CNAM	CONSERVATOIRE NATIONAL DES ARTS ET METIERS	France
8	NISV	STICHTING NEDERLANDS INSTITUUT VOORBEELD EN GELUID	Netherlands
9	KNAW	KONINKLIJKE NEDERLANDSE AKADEMIE VAN WETENSCHAPPEN	Netherlands
10	DP	DIGITAL PATHS SRL	Italy

Project Summary

European musical heritage is a dynamic historical flow of experiences, leaving heterogeneous traces that are difficult to capture, connect, access, interpret, and valorise. Computing technologies have the potential to shed a light on this wealth of resources by extracting, materialising and linking new knowledge from heterogeneous sources, hence revealing facts and experiences from hidden voices of the past. *Polifonia* makes this happen by building novel ways of inspecting, representing, and interacting with digital content. Memory institutions, scholars, and citizens will be able to navigate, explore, and discover multiple perspectives and stories about European Musical Heritage.

Polifonia focuses on European Musical Heritage, intended as musical contents and artefacts - or music objects - (tunes, scores, melodies, notations, etc.) along with relevant knowledge about them such as: their links to tangible objects (theatres, conservatoires, churches, etc.), their cultural and historical contexts, opinions and stories told by people having diverse social and artistic roles (scholars, writers, students, intellectuals, musicians, politicians, journalists, etc.), and facts expressed in different styles and disciplines (memoire, reportage, news, biographies, reviews), different languages (English, Italian, French, Spanish, and German), and across centuries.

The overall goal of the project is to realise an ecosystem of computational methods and tools supporting discovery, extraction, encoding, interlinking, classification, exploration of, and access to, musical heritage knowledge on the Web. An equally important objective is to demonstrate that these tools improve the state of the art of Social Science and Humanities (SSH) methodologies. Hence their development is guided by, and continuously intertwined with, experiments and validations performed in real-world settings, identified by musical heritage stakeholders (both belonging to the Consortium and external supporters) such as cultural institutes and collection owners, historians of music, anthropologists and ethnomusicologists, linguists, etc.

Executive summary

Polifonia is driven by ten pilot use cases, which provide both a validation context and the input requirements to the other research and development work packages. The pilots are heterogeneous in terms of knowledge domains, e.g. bells heritage, popular Irish music, history of music in Bologna, music influence on children. They involve interdisciplinary teams that bring different experience and methodological practices. This report describes the effort made so far, in collaboration and accordance with the Technical Board (see Deliverable 1.3[1]), towards identifying and building a common methodological framework, called socio-technical roadmap, for developing the ten pilots. Three main tools have been designed and implemented to this end, following a bottom up approach: a) A story-based methodology that leads musicologists, linguists, music heritage actors and IT specialists to describe their scientific skills, requests and goals in a narrative plot; b) Interdisciplinary workshops called *Maninpasta* that support the creation and coordination of working groups focusing on specific development tasks; and c) A Survey to systematically collect information about the pilots, and to facilitate the identification of interconnections between them. After situating this deliverable in *Polifonia*'s overall architecture, the tools and methods are presented individually and then compared. The objectives achieved and the prospects are finally outlined. Six short appendixes make this report self-contained, including a glossary of terms, a description of the ten pilots, and a description of *Polifonia* work packages' organisation.

[1] Enrico Daga *et al.* 2021. *Pilots development – collaborative methodology and tools. Polifonia Deliverable 1.3.* See also Appendix 3 WP1 participants, efforts, objectives, tasks and deliverables.

Document history

Version	Release date	Summary of changes	Author(s) -Institution
V0.1	30/04/2021	First draft released	CNRS
V0.2	21/05/2021	Revisions and integration added in sections 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4 and 5; text revisions in sections 1.2; tables/graphs added in section 1.2.	CNRS, KCL, UNIBO, NISV, MiC, OU, KNAW
V0.3	09/06/2021	Internal review	KCL, CESR, Utrecht University
V1.0	30/06/2021	Final version submitted to EU	UNIBO

Table of contents

Introduction

Polifonia is driven by 10 pilot use cases addressing preservation, management, studying musical heritage (MH)[2], and interacting with it[3]. Being real-world use cases – for example the Italian bell heritage, organs in the Netherlands, access to musical heritage for deaf people or the identification of recurring melodic patterns – these pilots provide a means to validate *Polifonia*'s computational solutions; to strengthen the project's outreach; and to integrate new scenarios, early-adopters and stakeholders. They are developed by interdisciplinary teams of researchers from the humanities and social sciences, and from computer science.

A main goal of the project is to deliver a set of technologies (i.e., the *Polifonia* Ecosystem) and show their effectiveness through the pilots. The added value of the Ecosystem – compared to delivering the sum of the pilot applications – will be demonstrated through reuse and interoperability (of software and data) among the different pilots. Therefore, the pilots must be developed independently to show concrete applications (having separate deployment, customised interfaces, services, etc.). At the same time, the overlap of their requirements must be captured and monitored to minimise the software / ontology development effort and to maximise reuse. The diversity of the pilots' domains and goals and the interdisciplinary nature of the teams involved in the process make this goal challenging.

A "socio-technical roadmap", defined in Task 1 of work package 1 (WP1)[4], is intended to provide a shared technical, methodological, and scientific framework to support and guide this process. The roadmap must meet the following requirements:

- to coordinate the resources used by the pilots;
- to collect expectations and needs of internal and external users/stakeholders;
- to identify the pilot's individual objectives and describe how they fit into *Polifonia*'s overall plan;
- to translate the disciplinary and scientific requirements into technological specifications[5];
- to monitor the pilot's progress and validation.

The roadmap thus provides to the pilots a common reference framework to collect requirements and to communicate effectively. It constitutes a guide to the pilot's expectations, standards, resources, tools and results. Furthermore, it captures the project's internal dynamics and initiatives by describing the actions undertaken and the paths explored.

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[2] A glossary of abbreviations, acronyms and key concepts is provided in Appendix 1 with definitions where necessary.
[3] The pilots are listed and described in Appendix 2.
[4] All work packages are listed in Appendix 4.
[5] While the roadmap contributes to translate the disciplinary and scientific requirements into technological specifications, the Technical Board identifies synergies; addresses issues around compatibility and interoperability; define the common methodological approach; and outlines the supporting collaborative tools to be used (Appendix 3, Task 2). These technical points are the subject of a separate deliverable (Enrico Daga *et al. D1.3. Pilots development – collaborative methodology and tools*, Polifonia, 2021, see also Appendix 3, Deliverable 1.3) and will therefore not be discussed in detail here.

This task is carried out through two separate steps, each associated with a deliverable: the present one (D1.1), due at month 6 (M6), and a second one (D1.2), due one year later at M18[6]. In the first phase, reported in this deliverable, we adopt a bottom-up approach aimed to identify needs and expectations; to describe situations encountered; to present case studies; and to outline strategies and solutions implemented to get feedback. On this basis, a top-down generalisation will follow in the second phase and will be reported in the second deliverable. It will provide a formal methodological reference within the project and possibly for future use in analogous projects.

Three main tools developed and applied in the bottom-up approach are the focus of the current deliverable: 1. The Stories, 2. the *Maninpasta* with their satellite events, and 3 the Survey (SMS tools). These tools are first discussed individually (sections 1-3) according to the schema "Presentation", "Results" and "Lessons learned". They are then compared (section 4). A last section outlines conclusions and future work (section 5). A clear assessment of the tools cannot be fully covered at this early stage and will be addressed in the second deliverable at M18. As for the validation of the pilots, it is planned in four intermediate deliverables at M24 and one final deliverable at the end of the project at M40[7]. However, the critical presentation and comparison of the tools will report, as far as possible, on the monitoring and validation procedures that are beginning to crystallise.

1. Stories

Although the pilots are heterogeneous, they all share two expected outputs: an ontological model with its knowledge graph (WP2)[8], and an interaction component (WP5). For this reason, it was natural to look for a methodological convergence within the ontology engineering and the interaction design tasks. For both aspects, *Polifonia*'s team includes experts, who have discussed and shared their practices during dedicated meetings. The ontology engineering working group (WG) has expertise in applying pattern-based ontology design and in particular agile-inspired methodologies, such as eXtreme Design (XD). The user interaction team has experience in applying user-driven methodologies based on the definition of Personas. The combination of these practices led to defining a story-based approach for the collection of *Polifonia* pilots' requirements. Practically, we provide pilot experts with a template to describe their Stories in a shared environment with the teams of developers.

[6] D1.2 Roadmap and pilot requirements – 2nd version. All deliverables of WP1 are listed in Appendix 3, section "Deliverables".

[7] D1.4 Intermediate validation reports for pilots: ORGANS and BELLS; D1.5 Intermediate validation reports for pilots: INTERLINK and FACETS; D1.6 Intermediate validation reports for pilots: TONALITIES, TUNES, MUSICBO and CHILD; D1.7 Intermediate validation reports for pilots: MEETUPS and ACCESS; D1.8 Final ten-pilots validation report and lessons learned. See Appendix 3.

[8] While the ACCESS pilot does not necessarily embrace the ontological paradigm, it does not contradict it. On the relationship between the pilots and ontological models, see section 3.2.2. of this document.

1.1. Presentation

Stories helped to start a dialogue between the different areas of expertise represented in the pilots and to collect pilot-specific information. This method is based on a discursive approach which leads musicologists, linguists, music heritage actors and IT specialists to explain and to describe their scientific skills, needs, strategies and goals in a step-by-step structured narrative plot. The result of this interaction is the creation of a Story, that informs a template for collecting requirements. In the reminder of this section, after briefly introducing the two methodologies (eXtreme Design and User Experience Design), we describe the practical implementation of the combined approach and report on the results.

1.1.1 Extreme Design and competency questions

eXtreme Design[9] is an agile methodology for ontology engineering. At its core, there is modular design through the use of ontology design patterns (ODPs): small ontologies that work as reusable solutions to recurrent modelling problems. Based on a collaborative approach, XD is executed through multiple iterations of a set of steps that involve one or more teams: a) the *customer team* elicits the requirements, b) the *design team* models the ontologies, c) the *testing team* performs testing and validation of the produced components, and d) the *integration team* integrates these components. XD has been used in several ontology engineering projects, and has been applied to real world knowledge graphs[10].

The requirements elicitation step is based on the description of Stories, from which one or more competency questions (CQs) are derived. CQs are the natural language counterpart of structured queries that the resulting knowledge graph should be able to answer, and are a recognised practice for requirements collection in ontology engineering[11]. Considering a Story about a music historian that must prepare a conference about the composer Giacomo Antonio Perti, with a specific focus on his masses[12], some of the CQs to be satisfied are: "Where was the musical composition performed?" and "Which instruments are involved in the musical composition?". These competency questions guide the development of the ontologies by the design team.

1.1.2 User Experience Design

User Experience Design (UX Design) reflects a broadening in Human Computer Interaction (HCI) research from the design of the interface to the design of the human experience in which the interface can play a role. This brings into design focus a wider range of characteristics of the people for whom the design is being developed (i.e. their interests, likes) and the social, work and leisure contexts into which the design

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[9] See Eva Blomqvist *et al.* "Experimenting with eXtreme Design", in *Proceedings of EKAW 2010*, ed. by P. Cimiano, H.S. Pinto, Springer, 2010, pp. 120-134; and Eva Blomqvist *et al.* "Engineering Ontologies with Patterns - The eXtreme Design Methodology", in *Ontology Engineering with Ontology Design Patterns, vol. 25. Studies on the Semantic Web*, ed. by P. Hitzler, A. Gangemi, K. Janowicz, A. Krisnadhi, V. Presutti, IOS Press, 2016, pp. 23-50.

[10] Valentina Anita Carriero *et al.* "Pattern-based design applied to cultural heritage knowledge graphs", «Semantic Web», 12/2 (2021), pp. 313-357.

[11] Michael Grüninger and Mark S. Fox. "The role of competency questions in enterprise engineering", in *Benchmarking - Theory and practice*, ed. by A. Rolstadås, Springer, 1995, pp. 22-31.

[12] See table 2: "Sources cross analysis: Compile information about the composer Giacomo Antonio Perti from a range of sources".

will be situated. The approach adopted in *Polifonia* draws on a number of established techniques in UX Design[13].

A central element of UX Design is that the design process involves developing and evaluating a series of design objects. Each of these design objects is accessible and comprehensible to the intended users as well as the technology developers. The users are therefore able to participate at a number of stages throughout the design process[14]. The design objects generally used near the beginning of the UX Design process include Personas and Scenarios. Personas are research-based descriptions of typical users. They are not fixed and can evolve during the design process as more is learned about the typical user (figure 1).

Name: Sophia

Occupation:

- Primary role: Musicologist
- Secondary role:
  - musician
  - historian

Knowledge/Skills

Sophia's original qualifications, and her Ph.D., were in music and she is also a practising musician. She is a musicologist working in the music department of a university.

Interests

She has a particular interest in late 16th and early 17th century music, specifically that of a particular composer living and working in Rome during that period.

Figure 1: An example of a *Polifonia* Persona

A Scenario is a story of how the Persona's task or problem is solved before, during and after interaction with the software being developed. Scenarios give some insight into the Persona's activities and goals, describe what the Persona is doing and can include storyboards or comic strips (figure 2).

Sophia is interested in understanding the musical compositions of Frescobaldi, how they varied, relations between the music and the vocabulary, and identify similarities and differences to his contemporaries. Sophia is analysing a Frescobaldi composition and notices a particular motif that accompanies a reference to birdsong. She decides to see where else this motif can be found in the compositions of Frescobaldi, the compositions of his contemporaries and also investigate the language accompanying the motif. Sophia specifies a motif as a sequence of notes with a particular pitch and rhythm. She can search for precise matches of this motif across the catalogue. She can manipulate the precision level of the motif and colour code compositions depending on extent to which they match (e.g. a shade of blue is used to flag compositions containing a motif matching 3 of the 4 notes). Sophia can also see summaries of the words associated with the motif. Sophia can use the visualisation to see relationships to other composers in terms of the use of this motif and its variations. She also notices that the motif is sometimes associated with certain words or themes. The system can automatically provide Sophia with statistical analyses as to how the motif and its

[13] A number of guides have been written describing the motivations and practice of UX Design including Rex Hartson and Pardha S. Pyla. *The UX book: Agile UX design for a quality user experience*, Morgan Kaufmann, 2018; Russ Unger and Carolyn Chandler. *A Project Guide to UX Design: For user experience designers in the field or in the making*, New Riders, 2012.

[14] This can be contrasted with traditional design processes where requirements are elicited from users who have little or no further participation in the design until a version of the software product has been developed.

variations differ across composers and across compositions containing certain vocabulary. Sophia can save and annotate the result to use in her research.

Figure 2: An example of a *Polifonia* scenario

Customer Journey Maps (Kaplan, 2016), proposed by the Nielsen Norman Group as a way of visually organising the process in order to highlight its stages and the associated actions of the user have also been adopted (figure 3).

SOPHIA **Scenario:** Sophia is interested in understanding the musical compositions of Frescobaldi, how they varied, relations between the music and the vocabulary, and identify similarities and differences to his contemporaries.	**EXPECTATIONS** • Ability to search for musical motifs across a catalogue • Ability to define motifs with varying degrees of precision • Ability to compare motifs and language of a composition • Ability to search for similarities and differences between composers • Ability to statistically analyse differences between sets of compositions	
INFORMATION NEED	**SEARCH**	**ANALYSE RESULTS**
1. Sophia is analysing a Frescobaldi composition and notices a particular motif that accompanies a reference to birdsong 2. She decides to see where else this motif can be found in the compositions of Frescobaldi, the compositions of his contemporaries and also investigate the language accompanying the motif	3. Sophia specifies a motif as a sequence of notes with a particular pitch and rhythm 4. She can search for precise matches of this motif across the catalogue 5. She can manipulate the precision level of the motif and colour code compositions depending on extent to which they match (e.g. a shade of blue is used to flag compositions containing a motif matching 3 of the 4 notes) 6. Sophia can also see summaries of the words associated with the motif	7. Sophia can use the visualisation to see relationships to other composers in terms of the use of this motif and its variations 8. She also notices that the motif is sometimes associated with certain words or themes 9. The system can automatically provide Sophia with statistical analyses as to how the motif and its variations differ across composers and across compositions containing certain vocabulary 10. Sophia can save and annotate the result to use in her research.
OPPORTUNITIES • Compare the presence of motifs across compositions and vary the precision of the motif • Receive automated statistical support for the visual analysis • Annotate and save the result of the search process for future research • Visually code search results according to certain features such as composer, vocabulary and precision of match with the motif		

Figure 3: A *Polifonia* scenario represented as a journey map

It is essential that Personas and Scenarios are driven by evidence rather than speculated by the technology developer. Within *Polifonia*, Personas and Scenarios have been co-developed with domain experts and created from interviews with domain experts to ensure that they capture real users and tasks.

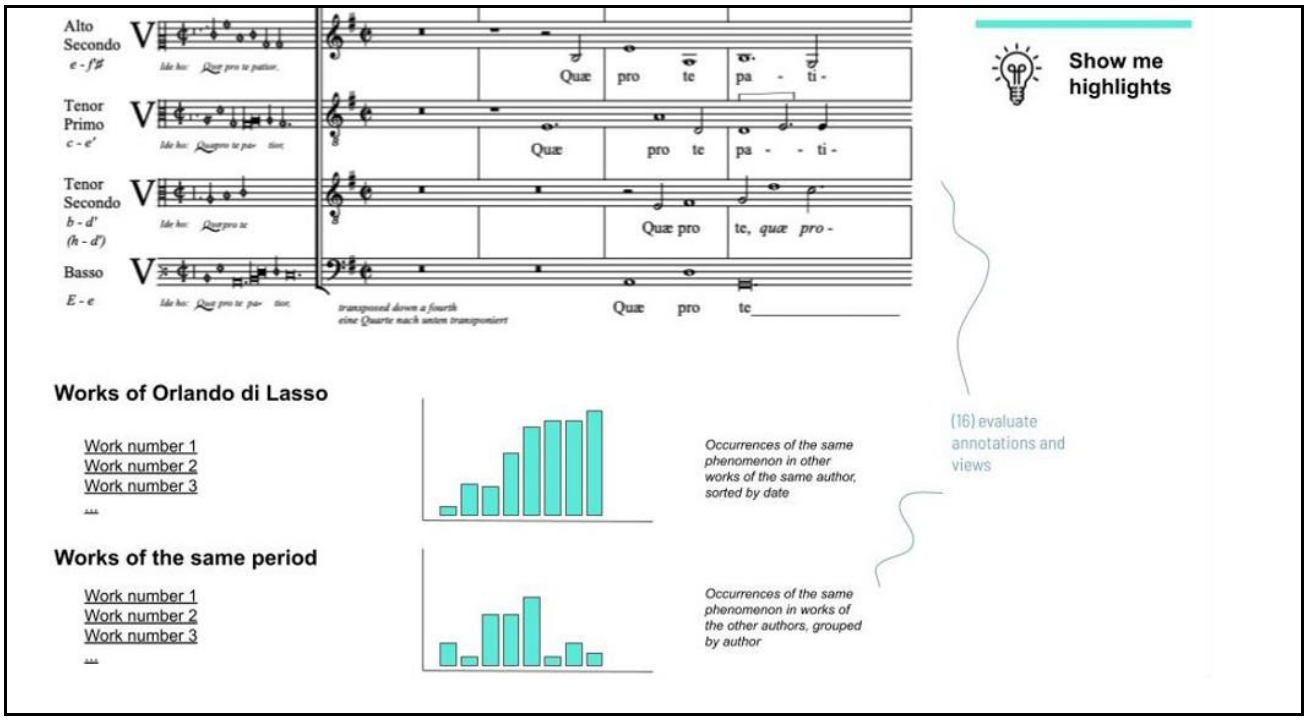

Figure 4: A screen from an example *Polifonia* mock-up

Personas and Scenarios are typically used to motivate the design of mock-up interfaces (figure 4). In the step from scenarios to mock-ups, the objects of design become more concrete: a decision has to be made as to how a particular process could be supported[15]. Mock-ups are developed in order to be shared between designers and domain experts, enabling them to discuss the assumptions contained in the interface and reach conclusions that can motivate the development of further candidate interfaces. A potentially wide range of mock-ups may be iteratively designed and tested[16]. User feedback drives the development of new designs, each with its own set of design choices, until the design process converges on solutions that can be taken forward to full implementation.

[15] Generally, a number of mock-ups could be made of the same scenario each adopting different design decisions.
[16] This process of incrementally developing and testing designs is described by Gaver as Research Through Design: each design object (e.g. mock-up or prototype) commits to a set of design choices. See William Gaver. "What should we expect from research through design?", in *Proceedings of the SIGCHI conference on human factors in computing systems*, ed. by J.A. Konstan, Association for Computing Machinery, 2012, pp. 937-946.

1.1.3. Implementation

	Date	Link to resource
Proposal/Conception	01/03/2021	Personas-CQs-scenarios
Development	10/03/2021 10/03/2021 15/03/2021 06/04/2021 21/04/2021 27/04/2021	WP4 Meeting Agenda Focus Meeting IReMus-UniBo teams WP1 Meeting Agenda 1st half-day *Maninpasta* WP1 Meeting Agenda 2nd half-day *Maninpasta*
Distribution	23/03/2021	Persona template Stories template
Results	16/04/2021	Stories created

Table 1: *Polifonia* Stories, table of initiatives and actions

Github[17] has been selected as a shared space to develop and to populate the template for Stories. The different stages of the design, development, distribution and population of the template are available in table 1 with links to the resources. The whole template for the Story is included in Appendix 5 and combines: a) competency questions from eXtreme Design[18] and b) techniques from User Experience Design[19].

So far, 12 Stories with 10 Personas[20] have been designed (table 2). These proposals have proven useful to establish the final version of the template available on GitHub.

Three Stories have been chosen to be analysed and discussed in two half-day *Maninpasta* sessions (on 6th and 27th of April 2021): the Carolina, Sethus and Keoma examples. These Stories, respectively centred on music history, music theory/analysis and sound practices relating to bell heritage, served as study-cases to identify conceptual categories, and the vocabularies and ontologies needed.

[17] The Stories repository is available here: https://github.com/polifonia-project/stories.
[18] See in this document section 1.1.1.
[19] See in this document section 1.1.2.
[20] A Persona is a research-based description of a typical user and corresponds to a dedicated part of the Storie's template. This description contains attributes such as name, age, occupation, and relevant characteristics such as knowledge and skills. Personas are defined in observation of specific required personal and disciplinary values since these are often a major stumbling block in collaboration if not properly acknowledged.

Stories and their summaries	Persona	Pilot
Sources cross analysis: Compile information about the composer Giacomo Antonio Perti from a range of sources	Carolina: Music historian	MUSICBO
Social history: Understanding the social history of brass band music	David: Music historian	MEETUPS
Sound practice and restoration: Drawing up a restoration plan for a belfry	Keoma: Architect	BELLS
Music and childhood: Historical understanding children's experiences of music	Ortenz: Music historian	CHILD
Musical social network: Analysing meetings between musicians and composers across time and space		MEETUPS
Identification of intangible elements: Understanding the transmission of intangible heritage related to campanology	Patrizia: Ethnoanthropologist	BELLS
Conflicting theoretical interpretations: Identifying and analysing conflicting modal interpretations	Sethus: Music theorist	TONALITIES
Musicians and their environment: Understanding socio-historical influences on music creation	Sophia: Musicologist and musician	MEETUPS
Europeana platform: Creating an online exhibition of the interconnectedness of European 20th Century folk music	William: Curator of the Europeana platform	INTERLINK
Music and haptic technology: Experiencing live music with the help of haptic technology	Anna: Fan of live music events who is hearing impaired	ACCESS
Dutch folk tunes: Starting from a collection of Dutch folk tunes, Mark attempts to relate these tunes to other documented music, using a variety of databases	Mark: Computational musicologist	TUNES
Dutch organs: Understanding the relationships between historic Dutch organs, and understanding the trends in organ construction over time		ORGANS

Table 2: Personas and Stories[21]

[21] The pilot FACETS has not yet proposed a Persona/CQs/Story. New proposals are expected for the months following M6, according to the progress of each pilot.

1.2. Results

The 12 Stories and 10 Personas, developed over a period of three months, cover several types of users including historians, architects, anthropologists, theorists, curators and music fans. Stories relate to user requirements of 9 different pilots (table 2). We plan to collect additional Stories and refine existing ones over the next project period.

The approach for collecting the Stories enables experts in the pilot's domains to express their requirements in an unconstrained way. The writing of the Stories (in the form of Personas, Goals, Scenarios and Competency questions) requires a general understanding of the problem, without the need of specifying technicalities or suggesting possible technological solutions to the problem. Even though the Stories have minimal constraints, they can be (re)used in the technical development. Scenarios are used to develop interface mock-ups and describe detailed user experience. Competency questions are used to define the expected queries that a pilot intends to submit to knowledge graphs. Hence, they inform the modelling of new, and identification of existing, ontologies and knowledge graphs. Personas and Goals are used to understand the functionalities that are appropriate for the target users. Section 2. *(Maninpasta)* of this deliverable provides details and examples of the Stories-based development so far.

1.3. Lessons learned

More time is needed to make an assessment about the effectiveness of Stories. Nevertheless, it is possible to report on the experience and lessons learned so far, which we consider encouraging. We will continue using this tool and improving it based on the inputs collected at each iteration.

Acceptance. Stories have been accepted by the whole team as a straightforward way to express, interpret and store requirements. The Stories template is shared with all *Polifonia* researchers and includes, for each of its sections, a brief explanation of the expected content, with an example. In short time, a good amount of Stories were collected, revealing the complexity of the pilots' requirements. This is not surprising as Stories are a widespread practice for supporting the requirements elicitation in different contexts such as agile methodologies in software engineering and ontology engineering[22].

A practical means to link pilots and WPs. The collected Stories are guiding the identification and selection of data sources, a key input to *Polifonia* development WPs: structured datasets to be integrated and ontologies/vocabularies to consider for reuse (WP2), music genres and styles to guide the selection of catalogues of audio and music notation (WP3), topics for narrowing and balancing the multilingual text corpus (WP4). We observe that Stories are providing a practical means to identify overlapping requirements between the pilots and inform/drive the development WPs.

Need for clearer conventions. GitHub allows us to upload Stories in a shared space and to collaboratively update them whenever is needed. Using a single working environment helps reducing the chaos that can be caused by a bottom-up approach. However, we have noticed that there are some discrepancies in using the provided template e.g., in naming the files, filling some sections of the Stories, linking Stories.

[22] Kent L. Beck and Cynthia Andres. *Extreme programming explained - embrace change*, The XP series, Addison-Wesley, 2005[2].

A hub for linking software, data, ontologies and interaction components. A common template may reduce the workload for requirements elicitation as they are shared by different teams: ontology engineers, software engineers and developers, and user interaction designers. These teams will develop their own technical specifications, but the shared template provides both a basis for future validation and a common reference for linking different components to the same requirements: e.g., a software component addressing a Story that is supported by an interaction component, modelled by an ontology component and relying on a set of knowledge graphs. In *Polifonia*'s Ecosystem of components and relationships, Stories (as a component) are integrated with development and deployment through the Experimentation component (in charge of software development and testing) which in turn has relationships with user interfaces and software libraries[23]. This is a reflection that emerged from discussions among partners and that led to assign an action point to the Technical Board (TB) to define clear guidelines and conventions to implement and keep track of these connections, within GitHub.

Ontologies and data integration. Stories, along with their competency questions, provide the basis for the ontology modelling task. A set of ontologies addressing the existing Stories are already available, although still in their draft versions and evolving. Nevertheless, Stories have been defined so far mainly based on experience and desiderata by pilot experts. This is acceptable but insufficient. Stories (and CQ, especially) must also derive from the analysis of existing datasets that need to be integrated (and possibly transformed) into knowledge graphs. This action, i.e., to refine Stories and add new ones based on existing datasets, is already ongoing. The template will be extended to include references to, and descriptions of, data sources (which can be of different types: sound, notations, text, metadata, etc.) that must be integrated to support the Story.

Validation of pilots. Stories shall be the basis for defining validation tests for monitoring the pilots' evolution and assess their results. As outlined in the introduction, this validation will be undertaken in five separate deliverables[24]. So far, the team focused on the template (initial) design and adoption and on using Stories as input for development activities (ontologies, software, interaction). The definition of validation tests and their associated criteria are ongoing, and we expect them to influence the refinement of the template.

2. *Maninpasta*

Polifonia requires continuous collaboration between researchers from different organisations, belonging to the consortium. Pilots can only succeed if the different competences and perspectives are involved in their definition and development throughout the entire process. This is challenging considering that the partners have never met in person yet and that physical meetings help kicking-off collaborative working activities. Hackathons are known to be successful in creating WGs and pushing productivity in software

[23] See Enrico Daga *et al. D1.3. Pilots development – collaborative methodology and tools*, Polifonia, 2021, section 4 and figure 4.1.

[24] D1.4 Intermediate validation reports for pilots: ORGANS and BELLS; D1.5 Intermediate validation reports for pilots: INTERLINK and FACETS; D1.6 Intermediate validation reports for pilots: TONALITIES, TUNES, MUSICBO and CHILD; D1.7 Intermediate validation reports for pilots: MEETUPS and ACCESS; D1.8 Final ten-pilots validation report and lessons learned. See Appendix 3.

projects. *Polifonia* pilots involve more than coding: addressing scientific, conceptual and methodological questions that relate to the pilots, ontology design, data integration, software development, corpus creation, interaction design. While the team agreed that the different activities should start in parallel and inform each other, the hackathon principle is still a valid inspiration. Based on these premises, we created *Maninpasta*: a half-day event, involving *Polifonia* experts, researchers and developers that engage in collaborative activities focusing on specific tasks. *Maninpasta* is an Italian expression that translates in English as "hands in the dough", a metaphor referring to moving from theoretical effort to practical work and the production of concrete results. By design, *Maninpasta* is not focused only on coding. It is open to developers, scholars and domain experts and requires their interaction.

2.1. Presentation

Maninpasta participants are divided into small WGs each focusing on a specific task e.g. ontology design for a specific Story, mock-up design for a specific Story. Each WG must maximise the collaboration between people with different expertise and having different affiliation. Each WG is also requested to include both a musicologist and a computer scientist. At the same time, it is recommended to minimise the WG dimension[25]. In the last half hour, all members gather in plenary to report their results, discuss possible issues, and inform about their next actions. The created WGs are given a name and associated with a Discord channel. They survive the *Maninpasta* and are recommended to organise weekly meetings to keep their work evolving. These simple rules have been defined after running the first event (April 6th, 2021) and further refined during the second one (April 27th, 2021). We plan to organise *Maninpasta* events on a regular basis to support the interaction of WGs and the creation of new ones.

Currently, WGs continue their work and coordination activities are carried out during WP meetings. *Maninpasta* events played a key role in creating an effective link between the pilots (which are part of WP1) and the technology provider work packages (WP2-5).

2.2 Results

During the first half-day hackathon several WG have been created:

- Building Knowledge Graphs (BuildingKG#1 on Carolina, pilot MUSICBO)

  This WG focuses on discussing the life-cycle of resources composing the knowledge graphs. The Carolina Persona and scenario was considered as a starting point for the discussion, which quickly evolved towards acknowledging the generality of the issues of developing pipelines for acquiring and curating content of the knowledge graphs, particularly in relation to incorporating and linking existing resources of interest. The WG consisted of technologists and musicologists. Together, they identified the need of a curatorial workflow supporting a registry of resources relevant to musical cultural heritage. As a preliminary work, the plan is to reuse the musoW catalogue of Musical Resources on the Web (http://musow.kmi.open.ac.uk) and to extend it with the following capabilities: a) a user interface to support the collection of resources of interest (crowd-sourcing);

[25] It is recommended to keep the number of members below ten, five is an ideal number.

and b) a pipeline to store the registry on GitHub, possibly testing the collaborative methodology under development[26].

- Mock-up Design#1 (on Sethus, pilot TONALITIES)

  In the first *Maninpasta*[27], this WG outlined a basic user interface workflow or user journey that would address the issues outlined in the Sethus: Music Theorist Story and satisfy all four of the core competency questions described. With two of the three members of our WG representing the technical user interface (UI) development angle, we naturally focussed on core UI requirements. An overview of the required user journey steps is as follows:

  - The user has selected the motet *Vide Homo* (originally published in the cycle *Lagrime di San Pietro* by Orlando di Lasso, 1594) from some catalogue.
  - Sethus is shown a webpage dedicated to the motet *Vide Homo.*
  - [INTRO] Basic descriptive metadata are shown: author, title, date, place.
  - [MULTI-MODAL] Further detailed info/page may include a number of resources that define the piece of music, including a musical score, audio file(s), description.
  - [SCHOLARLY DATA] Summary of linked data/existing annotations and classifications.
  - [EXPLORATION / DETAIL ON DEMAND] Traverse the graph according to one or more interpretations. Triggered by the previous [SCHOLARLY DATA].
  - Annotations of the score (with references to the provenance, the author of the annotations).
  - [CREATION OF NEW DATA] Running extractive processes to unearth new data. It is unclear whether this might be done via the portal interface in real-time via a web-API, requested for offline batch processing or will have been pre-run.
  - [ANNOTATIONS] Multi-modal resources that define the piece of music to be annotated, either directly or via links with other resources alongside metadata to describe these links. The annotations and links should provide answers to the questions posed in CQ2. Combined, this metadata can be used to inform a decision on the classification of the piece of music (CQ1), which itself can be selected as an annotation to the resource.
  - [STATISTICS] Create your own queries to traverse the graph and get collections of other resources matching specific criteria that may help answer the questions posed in CQ3/CQ4. This may include tools for comparative and contextual visualisation.

- Mock-up Design#2 (on Carolina, pilot MUSICBO)

  The second Mock-up Design WG focuses on the Story 'Carolina - Sources cross analysis'. The author of the Story, professor Angelo Pompilio, was able to elaborate from his perspective as a domain expert. The WG interactively sketched out a possible user flow, asking professor Pompilio for feedback along the way. This user flow includes an initial search and filter step to arrive at a set of possibly relevant musical scores held across different archives. Then we identified a number of challenges such as differences in maintaining, archiving and representing scores versus contracts (archival documents), each containing valuable information for music historians.

[26] See Enrico Daga *et al. D1.3. Pilots development – collaborative methodology and tools*, Polifonia, 2021.
[27] Full notes from this session are available here: https://github.com/polifonia-project/stories/issues/10.

Professor Pompilio validated the potential of data visualisation to help explore scores and contracts, both based on existing metadata and data derived from audio analysis. Natural language processing (NLP) analysis of musical texts as well as text from archival documents pertaining to the music performances could also give helpful insights for music historians. We are currently not aware of a useful vocabulary / thesaurus that is more specific to music than Dublin Core.

- Music annotation#1 (on Sethus, pilot TONALITIES)

  In the perspective of formalising what an analytical point of view is and how it can be confronted with others, this WG focuses on formalising the intellectual processes from which these points of view emerge. A formalisation of the activity of scholarly reading was proposed in which musicologists *understand*, *discuss*, *relativise* and *connect* arguments in order to produce new knowledge about scores, thus becoming part of an interpretative tradition. Although not specifically musicological, these "scholarly primitives" (*reading*, *inferring*, *sourcing*, *arguing*...) constitute the fundamental structure of any scientific annotation activity. A dataset was produced with the CRMinf ontology. This session brought out the desire to extend these questions to the other musicologists and knowledge engineers.

- Ontology modeling#1 (on Sethus, pilot TONALITIES)

  This WG formalises elements of music theory relevant to the Sethus Persona, whose purpose is to confront different modal interpretations of an intrinsically ambiguous piece, *Video homo*, from the cycle *Lagrime di San Pietro* by Orlando di Lasso (1594). Therefore, the analytical results obtained from different theoretical frameworks, both historical (Heinrich Glarean, Gioseffo Zarlino, etc.) and contemporary (Powers, etc.), will be put into dialogue. We organise the WG by a) inspecting the competency questions; b) engaging in question-answer sessions between two different roles, music theorists and knowledge engineers; and c) reaching consensus between these two roles on the appropriate terms (concepts and their relations) that ontologically represent the domain. We start with simple, flat lists of terms, and we work them up into increasingly formal taxonomies and ontologies; we also make use of diagrams and simple ontology notation[28] to discuss conceptualisations.

- Ontology modeling#2 (on Carolina, pilot MUSICBO)

  The initial step for modelling the Carolina Story was to examine the Stories template thoroughly. During this examination, competency questions that were unclear or overly specific were revised and additional ones were formulated. Furthermore, key concepts of the domain were defined for the context of the Story. Some patterns were chosen for additional analysis, such as: membership, author attribution, role, event, participation. A taxonomy/ontology diagram was created for a better understanding of the domain.

- Ontology modeling#3 (on Keoma, BELLS)

[28] E.g. Graffoo, graphical framework for OWL ontologies, https://essepuntato.it/graffoo/.

This WG focuses on the Keoma Persona, an architect involved in the protection of bell towers. The activities of the WG include: a) inspection of the Persona, b) inspection of the competency questions, with possible clarifications and discussions for defining a shared vocabulary, c) identification of the main concepts and relations that emerge from the competency questions, with possible overlaps, d) definition of patterns and ontologies to reuse, and some formal constraints.

The first half-day Hackathon (on 6th of April) produced several interesting outputs, but we noticed in the participants a natural tendency to group according to their disciplines. This encouraged the formation of disciplinary WGs (with all IT experts, or all musicologists, or all participants to the same Pilot) at the expense of the interdisciplinary dimension that we wish to stimulate. The idea for the next half-day Hackathon was to invite to differentiate the composition of each WG to improve the sharing of competencies and knowledge.

During the second half-day Hackathon four WGs continued to develop their work[29]:

- Ontology Design#2 (on Carolina, pilot MUSICBO)

  This WG carries on the work on the Story of Carolina. The activities include: a) reordering of the competency questions based on the conceptual areas they address, b) an initial ontology model for the concept of musical performance, reusing the time-indexed situation pattern, c) identification of ontologies to reuse, d) initial discussion on the concept of medium of performance, which needs to be clarified with a musicologist. An open problem to discuss with the whole ontology design team is the methodology that should be followed for ontology reuse (direct or indirect).

- Mock-up Design#1 (2) (on Sethus, pilot TONALITIES)

  In the second *Maninpasta* session, this WG discussed the design of an interface for associating alternative interpretations with an object (whether that be a text, score, or other media). An example interpretation could be "X thinks that musical score Y is in mode Z". The interface should support linking an interpretation to evidence (e.g. X thinks that musical score Y is in mode Z because of A). It should also support claims about an interpretation (e.g. B disagrees with X's interpretation that musical score Y is in mode Z). The interface should support viewing as well as adding interpretations, e.g. visualising alternative interpretations of the same score, who made each interpretation, on the basis of what evidence, who agrees/disagrees with each interpretation and why.

  WG members went on to research and identify 'argumentation tools' that could assist in formalising these musical interpretations. Collected resources include web-based argument mapping tools and libraries and a visual mock-up of what an argument mapping interface might look like along with detailed explanatory notes.

[29] For the coming months we expect to enlarge the action of *Maninpasta* meetings to other Personas/CQs/Stories that have been developed by the other pilots within the *Polifonia* Stories, as well as to those ones that will be published on GITHUB in the meanwhile.

- Music annotation#1 (2) + Ontology modelling#1 (2) (on Sethus, pilot TONALITIES)

  This WG set aside the scholarly processes from which the annotations originate to focus on their informational products, and thus brought out some central concepts such as the observation of musical objects or the association of an interpretation formulated with explicit reference to a theoretical framework. The methodology used relied on dialogue between musicologists and knowledge engineers for a mutual exploration of competency questions, and on the implementation of classical ontological patterns (*observation*, *provenance*, *situation*...). The need for a more advanced reflection on score fragments addressability has also been confirmed.

- Sources and methods definition#3 (on Keoma, pilot BELLS)

  During the second *Maninpasta*, the BELLS WG started a reflection on methods and resources to build a corpus of texts. The WG was formed by two ethnoanthropologists for the domain and one expert in linguistics. The elements already identified during the previous meeting (Ontology modeling#3 on Keoma) were examined, and for each competency questions it was considered which sources could be relevant for knowledge extraction. Many types of sources have been identified (written, oral, bibliographic and archival) from different producers and conservators. The WG continues to work on a regular basis and the aspects relating to the domain will be soon investigated also together with local actors directly involved in a collaborative way (for feedbacks on the concepts modelled, on the sources found, on the vocabularies and local terms used), in an iterative and top-down / bottom-up circular process.

2.3. Lessons learned

Enabling collaboration and co-creation. Maninpasta meetings constitute the 'grassroots' of the collaborative methodology for pilot developments, explained in detail in D1.3[30]. Indeed, *Maninpasta* meetings enabled a collaborative and co-creative process starting from several high-level research trajectories (the group themes) and creating the context for the identification of pragmatic focal points for research. These are associated with pilots – to drive the research towards concrete project outputs; and to WP tasks – to effectively situate the activities within the scope of the project framework. The WGs discuss ideas and different approaches and allow the development of a community alongside the domain experts to find a common ground. Working in heterogeneous small WGs and sharing different experiences in digital human sciences results in effectively tracing needs and strategies, collecting useful tools and finding inspiring solutions.

Building the Polifonia Ecosystem. Maninpasta showed its effectiveness since its first edition: it fostered the creation of focused WGs that are continuing their work and populating the *Polifonia* GitHub repository (as well as our internal shared space) with results. They are *de facto* putting the basis for building the first version of the *Polifonia* Ecosystem.

"*Adopt a musicologist or a computer scientist".* After the first *Maninpasta*, we made sure that all teams included specialists with diverse backgrounds to make sure that each problem was analysed from all

[30] See Enrico Daga *et al. D1.3. Pilots development – collaborative methodology and tools*, Polifonia, 2021.

relevant perspectives. In all tasks, the input of the domain experts proved crucial and provided a thorough insight of the Stories.

3. Survey

The tools presented so far focus on the pilot's individuality (with their particular problems, issues and needs) and on the effective implementation of IT solutions to address them. The Survey has been conceived to offer mutual support in defining general goals, roles and expectations. It aims not only to systematically collect information relating to the pilots but also to facilitate the identification of interconnections between them. This tool will thus play an important role in the generalisation and standardisation process that will be undertaken in the coming months. The Survey is part of an iterative process: the answers can be progressively integrated, updated and/or modified on GitHub by each pilot on the basis of the analyses carried out and/or the pilot's new requirements or improvements. The stages of design, completion and analysis are summarised in table 3.

	Date	Link to resource/documentation
Proposal/Conception	24/01/2021	WP1 Meeting Agenda
Development	End of January-05/02/2021	
Distribution	05/02/2021	Google Forms
Results	22/02/2021	Survey first iteration
Analysis	24/02/2021 21/04/2021	Wp1 Meeting Agenda Survey analysis
Results update	until 14/05/2021	Survey second iteration
Update formats and standards according to Data Management Plan (DMP)	17/06/2021	Survey update

Table 3: WP1 Survey, table of initiatives and actions

3.1. Presentation

The Survey is structured in three key sections (Appendix 6): Section 1 aims to identify the pilot's research domain. It shows how the pilots are built on resources (a collection, a specific dataset, a part of a dataset, etc.) to produce results (an answer to a question, a solution to a problem, etc.) through their methodologies and tools (either designed as part of the project or relying on earlier work). To this end, the Survey collects the input data (i.e. the heritage collections that form the starting point for scientific exploration) on the basis of their accessibility, nature and legal status (1.1.). It also identifies the research outcomes according to their form, type and length (1.2.) and discusses the scientific assumptions, the nature of the knowledge produced and the pilot's contribution to the state of the art. An additional section is dedicated to the analytical categories and tools produced (1.3.).

Section 2 deals with the technical part of the dataset(s) used and produced and has three main goals: a) to identify the current practices of the consortium in terms of the use of data formats and standards that lay out the meaning of these data; b) to identify among the pilots the broad strategies for producing new knowledge and articulating it into existing knowledge in the context of the Web and Linked Open Data for cultural heritage; c) to identify the software processes and artifacts that will make the data meaningful for users, in particular the expectations in terms of data access and visualisation on the *Polifonia* Web portal, which is the cornerstone of the dissemination and valorisation of the knowledge produced within the project.

Section 3 focuses on the socio-pedagogical aspect of the dataset(s), identifying the target groups (amateurs, musicians, students, etc.) and their conditions (disabilities, specific reference person for the pilot's socio-pedagogical implications). In this context, the pilots were also asked to identify themselves success criteria for their own initiatives (for example: time and accuracy of tasks which are carried out, usability surveys, measures of interface aesthetics, observational studies, interviews, etc.). The analysis of these criteria and their application at the end of the project will provide valuable information for the validation of the initiatives carried out.

3.2. Results

The answers collected[31] reveal a remarkably rich and varied panorama in terms of sources, research problems/questions, tools and methods, target audiences and planned interaction methods. This information is not only useful for designing the pilot's roadmap but also for ultimately providing an overview of all resources, tools and approaches in a 'book of pilots'. It is also essential for the tasks of the TB, for the implementation of the Data Management Plan (DMP)[32] and for initiating the work of the technology provider WPs (WP2-5).

3.2.1. Domain specific part

The Domain specific part shows that the (digital) availability of the sources is heterogeneous: some of them are fully (6 pilots) or partially (3 pilots) digitised, whereas in one case the observations remain to be collected. The pilots are far from focusing only on musical sources (scores, sound sources, audio-visual sources) nor textual ones. They also integrate image collections and material objects (diagram 1). Thus, different sets of pilots emerge, for example, pilots based on one type of source include ACCESS, TONALITIES, whereas the ones integrating different materials consist of TUNES, MUSICBO.

Another key issue revealed by the Survey is the portion of the source from which new knowledge is derived. In three cases (MUSICBO, BELLS, FACETS) the new knowledge is related to the document as a whole. In two other cases (TUNES and TONALITIES) the information relates to both the whole document and fragments. In all other cases, the pilots aim at producing knowledge units[33] that relate to source

[31] Links to the results are provided in table 3.
[32] See Andrea Scharnhorst *et al. D7.1. First Data Management Plan*, Polifonia, 2021.
[33] A knowledge unit is understood as a knowledge fragment produced by the pilot through the analysis of the input data. This unit may correspond for example to a cadence in a score, to the identification of a previously anonymous author of a source, to the type of a bell, etc. See Appendix 1: Glossary.

fragments. This raises from the start the question of how these fragments can be addressed, given their varied nature and the numerous research questions that are associated with them.

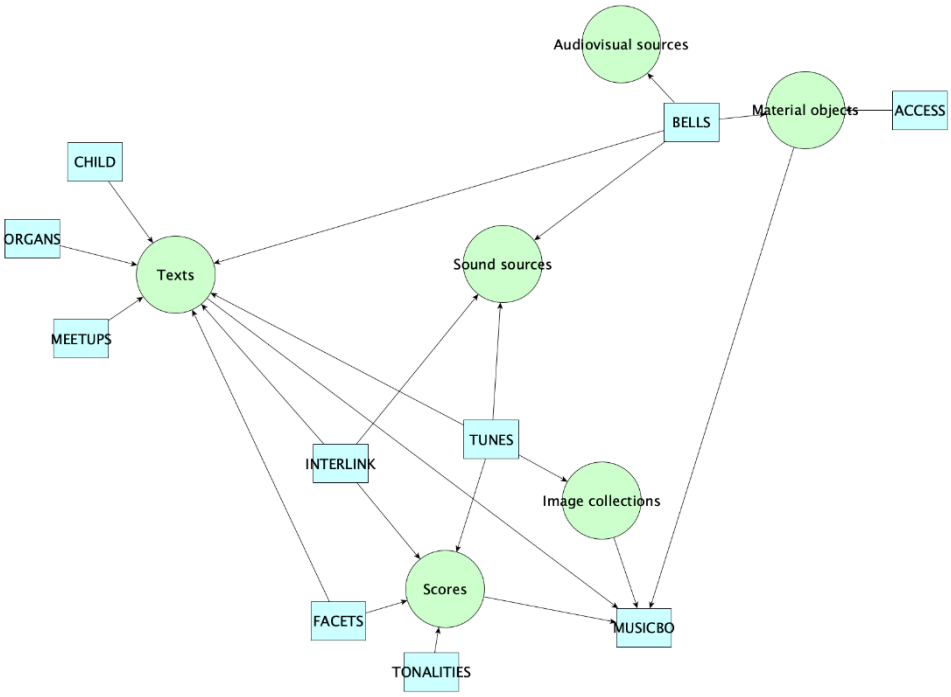

Diagram 1: Survey – Source types investigated by the pilots

As shown in diagram 2, despite the wide range of research fields and goals, the Survey helps to identify constants in the nature of the scientific objects to be produced or analysed: composers and compositions (CHILD, MEETUPS, MUSICBO and INTERLINK), contextual information (BELLS, CHILD), melodic schemes (FACETS, TUNES, INTERLINK, CHILD), harmonic patterns (INTERLINK, TONALITIES). These constants provide opportunities for cross-pilot collaboration that will help to identify common standards, methods and tools to be adopted in the midterm and formalised in the second version of the roadmap. As the diagram provides a snapshot of the individual pilots at a given point in time, the granularity of the knowledge units is uneven. The granularity will become more homogeneous during the course of the project. Furthermore, the diagram only identifies the knowledge units considered by the pilots themselves as being central to their research. As such, metadata is only at the heart of INTERLINK which establishes interconnections between different corpora. While the other projects have not identified metadata as a central issue, it is clear however that they are relying on and producing metadata that will be exploited in the project.

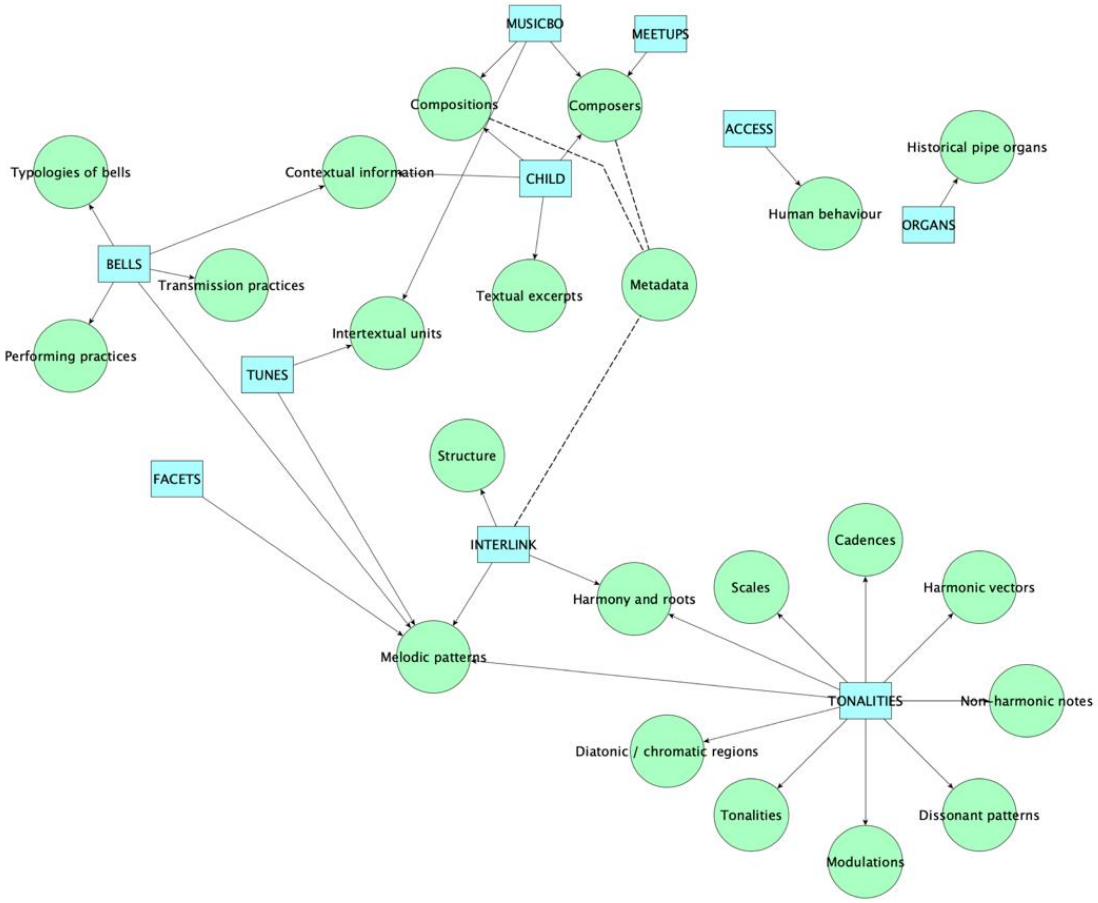

Diagram 2: Survey – Knowledge units investigated by the pilots

Another central challenge shown by the Survey concerns the relationship between the source – i.e. the input data used to generate new insights – and the produced knowledge units. While knowledge relating to a particular composition or composer (CHILD or MUSICBO) may often be linked directly to the observation units, different and more complex issues may arise: In the case of intertextual units (MUSICBO, TUNES), it is often difficult to identify the exact beginning and end of the text or music fragment that are reused. The boundaries of musical units – for example the beginning of a cadence (TONALITIES) – may also be blurred. Finally, some knowledge units – musical concepts (INTERLINK, FACETS, TUNES) or performative practices (BELLS) – may not be directly anchored in the document or not directly addressable. Apart from the technical issue of addressability (see below), these challenges are also partly related to the interpretative and contextual dimension of the knowledge units produced. This dimension makes that the link between the material's source and the intangible knowledge units produced is often indirect and context dependent[34]. By showing that the knowledge produced by the pilots is not

[34] This is for instance a key problem in TONALITIES and also plays an important role in BELLS, where a specific sound can have different meanings according to different traditions and/or interpretations.

only factual (c. 40%) but also conceptual (53%) and procedural (c. 7%), the Survey offers important keys to explore the articulation of the tangible and intangible that lies at the heart of *Polifonia*[35].

3.2.2. Technical part

Regarding the use of data formats and standards, it appeared that the different pilots are able to converge naturally towards semantic data encoded in the standard RDF format. The knowledge produced would be entrusted to generic ontologies being international quasi-standards for the expression of information related to scientific research on cultural heritage (ARCO, CIDOC-CRM, LRM, etc.). This is mainly confirmed by table 4, that outlines the different pilots' approaches to data formats. However, the table also shows a notable exception: the pilot ACCESS – whose objective is to co-design, to develop and to evaluate technologies enabling deaf people to engage in live performances – does not directly rely on semantic data. Therefore, attention should be paid to the fact that the dominant paradigm within the project does not exclude other pilots' specificities[36].

Concerning the production of knowledge, although it is still too early for each pilot to definitively identify the third-party data likely to be reused, everyone announced a willingness to reuse and extend controlled vocabularies or other knowledge organisation systems. These will enable interoperability with the different actors of the cultural heritage Web at the international level). The Survey thus highlights the key knowledge reuse and production aspects required for the progress and dialogue between the pilots. This constitutes crucial information for the WP2 and the TB.

Finally, regarding the presentation of the data produced in the project, the pilots expect the *Polifonia* Web portal to provide visualisation functions. These functions should allow the data to be linked to their historical, geographical, social, and theoretical contexts (maps, multimedia viewers, 'augmented' scores, network views and search engines whose heuristic function is decisive with regard to the extent of the data). They should also provide functions to overcome scientific and technological bottlenecks in the dissemination and appropriation of data produced with semantic technologies (ergonomic LOD browser, search engines to explore annotated musical documents according to different points of view, etc.).

The Survey results reveal the common need from all pilots of formalising their various interconnected domains. Some of these domains, in particular the ones underlying the TUNES, FACETS, INTERLINK and TONALITIES pilots, are strongly related to concepts in music notation. Some of these concepts are more

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[35] The project aims to identify and to make explicit the links between tangible cultural artefacts – for example buildings, bells, scores, books about music – and their intangible and conceptual meaning: the historical context in which these artefacts appear, their socio-cultural significance and, in the case of musical scores, texts set to music, or texts about music, their internal logic. This issue is at the heart of the H2020 call under which Polifonia is funded, https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/dt-transformations-12-2018-2020: "So far, digitisation focused mainly on capturing the visual appearance of individual objects, collections or sites. There is a real need to establish a comprehensive picture of the studied assets, capturing and re-creating not only visual and structural information, but also stories and experiences (stored in language data), together with their cultural and socio-historical context, as well as their evolution over time."

[36] This issue is also addressed in D7.1: Andrea Scharnhorst *et al.* *D7.1. First Data Management Plan*, Polifonia, 2021, section 1.

abstract and high-level (for example melodic patterns). Some others are very concrete and low-level, and hence much closer to the notation itself (for example, scales). But in both cases, we observe a necessity to express links about how particular instances of these concepts manifest in the music notation, for example in MEI (Music Encoding Initiative) scores. This will be only possible if every element of the target MEI score is represented through a unique and globally de-referenceable identifier (i.e. a URI). It will then allow the *Polifonia* knowledge graph to refer and link to concrete MEI documents, fragments and notes (the MEI community is currently working in standards towards achieving this, through its MEI Linked Open Data Interest Group[37]).

Characterization of existing data 1	Metadata: What formats are used?
MUSICBO	n/a
TONALITIES	RDF, Turtle, Filemaker, CSV
CHILD	RDF
MEETUPS	RDF
ACCESS	n/a
BELLS	XML, RDF, MAG and other formats
INTERLINK	TXT, MIDI, Filemaker, CSV, XML
FACETS	MIDI
ORGANS	n/a
TUNES	CSV, Filemaker, XML, TXT, HTML

Characterization of existing data 2	Metadata: What standards are used?
MUSICBO	
TONALITIES	CIDOC-CRM, CRMdig, LRMoo, DCTERMS
CHILD	n/a
MEETUPS	n/a
ACCESS	n/a
BELLS	ArCo, Unimarc
INTERLINK	n/a
FACETS	MEI, MusicXML
ORGANS	n/a
TUNES	n/a

Characterization of existing data 3	Datasets: What formats are used?
MUSICBO	Relational database; RDF
TONALITIES	XML, PNG, PDF, Filemaker, MIDI, PDF, TXT, JSON
CHILD	RDF
MEETUPS	RDF
ACCESS	n/a
BELLS	JPEG, TIFF, XML, RDF, HTML, various
INTERLINK	TAR, GZIP, RDF, N-triples, RDF, RDFS,
FACETS	MIDI, PNG, PDF
ORGANS	DOC, DOCX, WP5
TUNES	MIDI, PDF, PNG, JPG, TXT, MP3, Filemaker, JSON, HTML

Characterization of existing data 4	Datasets: What standards are used?
MUSICBO	n/a
TONALITIES	MEI, MusicXML, LY, KERN
CHILD	n/a
MEETUPS	n/a
ACCESS	n/a
BELLS	n/a
INTERLINK	MusicXML, MEI, MARC-XML, LY
FACETS	MEI, MusicXML, LY
ORGANS	n/a
TUNES	MusicXML, MEI, MARC-XML, Essen associative code, ABC, HUMDRUM, LY, KERN

Interoperability 1	Please list the controlled vocabularies, taxonomies, thesaurus, ontologies, etc. that you will use in your pilot
MUSICBO	CIDOC-CRM; FRBRoo;
TONALITIES	Too early to say
CHILD	Too early to say
MEETUPS	Too early to say
ACCESS	n/a
BELLS	ArCo Ontologies ICCD Vocabulary for Musical
INTERLINK	MIDI ontologies, MIDI instrument taxonomies
FACETS	--
ORGANS	We have a thesaurus of organ terms.
TUNES	Not yet clear

Interoperability 2	Please indicate if you plan to expand existing knowledge organization systems or if you plan to create a specific one
MUSICBO	
TONALITIES	Create new ones, for analytical purpose
CHILD	Too early to say
MEETUPS	Too early
ACCESS	n/a
BELLS	We plan to expand ArCo Ontologies and ICCD Vocabularies and Thesauri
INTERLINK	MIDI ontologies, Chords ontologies, structure ontologies, etc.
FACETS	We will probably do both: expand works from WP2 on ontologies, and
ORGANS	If there exists a KO system for musical
TUNES	Probably a specific one, not only for the TUNES pilot, but also for other parts of the project related with WP3.

Table 4: Survey – Characterisation of existing data and interoperability

3.2.3. Socio-pedagogical part

The socio-pedagogical part of the Survey clearly highlights two main audiences. On the one hand, academic audiences and their different specialities[38] and, on the other, specific non-academic audiences[39].

[37] The aim of the Interest Group is to discuss applications of Linked Data to interconnect the rich music and music-related information resources available on the Web with MEI encodings, see https://music-encoding.org/community/interest-groups.html and https://lists.uni-paderborn.de/mailman/listinfo/mei-linked-data-ig.

[38] History of music, organology, music bibliography, music iconography, music analysis, digital musicology, cultural studies on music, anthropology ethnomusicology, music information retrieval, music creativity/generation, machine learning, music education.

[39] People with hearing impairments and other disabilities (ACCESS), local Institutions involved in protection and landscape planning (BELLS), organ building companies (ORGANS), musicians (MUSICBO, TONALITIES, INTERLINK, ORGANS, TUNES).

Some pilots also reach the broad public (MUSICBO) and/or music lovers. Finally, most of them concern students. The panel of pilots thus targets a maximum of audiences from various backgrounds and strives to a certain representativeness (table 5).

	What is the target group of your pilot?
MUSICBO	Musicians;Amateur Internet users;Students;Academics;Curators;Others;
TONALITIES	Musicians;Students;Academics;Amateur Internet users;
CHILD	Academics;
MEETUPS	Academics;Students;
ACCESS	Others;
BELLS	Amateur Internet users;Students;Academics;Curators;Others;
INTERLINK	Musicians;Curators;Academics;
FACETS	Musicians;Academics;Amateur Internet users;
ORGANS	Musicians;Curators;Amateur Internet users;Academics;Students;Others;
TUNES	Amateur Internet users;Musicians;Academics;

	If academics, specify
MUSICBO	history of music; organology; music bibliography; music iconography
TONALITIES	Music analysts, digital musicologists
CHILD	Cultural Studies on Music, Musicology
MEETUPS	Cultural studies in music, musicology
ACCESS	n/a
BELLS	Anthropologists, Ethnomusicologist
INTERLINK	Music information retrieval, music creativity/generation, machine learning
FACETS	Musicologists and all academics interested in musical content (sociologists, historians, ethnologists, etc.). Computer scientists?
ORGANS	Organology
TUNES	Music historians

	Other?
MUSICBO	music lovers
TONALITIES	
CHILD	
MEETUPS	
ACCESS	People with hearing impairments and other disabilities who visit the Stables Theatre in
BELLS	Local Institutions involved in protection and landscape planning
INTERLINK	
FACETS	
ORGANS	Organ building companies.
TUNES	

Table 5: Survey – target audiences

This leads to carefully consider the choice of suitable interfaces. Pilots that reach large audiences will necessarily have to provide tools that are adapted in terms of attractiveness, speed and efficiency of responses. For ACCESS, which targets people with hearing impairments and other disabilities, the interface's innovation degree and ergonomics is a key issue. This dimension is also taken into account in FACETS. For more specialised audiences, the possibility of varying presentation formats, navigating from one source to another (for example different scores of the same work), and integrating shared annotation systems are important issues.

The socio-cultural impact of several pilots can already be anticipated. They concern first of all the analysis of tangible and intangible heritage data and their impact on its valorisation (ORGANS and BELLS). More generally, it can be expected that the conscious consideration of the socio-pedagogical dimension by the pilots will renew in depth the access to cultural heritage.

A last focal point in the socio-pedagogical part concerns the identification of success criteria identified by the pilots themselves (table 6). At this stage, these criteria seem to concentrate on user evaluation. Beyond quick and accurate tools (TONALITIES, FACETS) the focus is on user experience involving ergonomic and intuitive interfaces (MUSICBO) with new kinds of engagement (ACCESS).

	In order for the pilot to be successful, what criteria would the new tools and methods need to satisfy (e.g. certain tasks carried out more quickly or accurately, the amount or type of data that can be used in the task, number of people who are able to use the tools, the attractiveness of the interface, new tools being easy to learn, etc.)?
MUSICBO	new tools being easy to use and accessible to the wide public attractiveness of the interface
TONALITIES	Tools easy to be used/understood in a guided historical/analytical/methodological environment
CHILD	Retrieval and characterization of documentary evidence more quick and accurate.
MEETUPS	Too early to say
ACCESS	• Improved or new kinds of engagement • New forms of access • Proven ability to engage with music in new ways • Illuminating feedback from potential users
BELLS	
INTERLINK	certain tasks carried out more quickly or accurately: amount of relevant links between scores and other sources discovered the amount or type of data that can be used in the task: amount of different symbolic formats supported and linked
FACETS	The tool should be easy to use. Search-engine is now widespread, so we should provide a similar to standard interfaces. The tool shoud be efficient, ie, retrieve relevant content based on the provided queries, rather quickly. The accessibility (e.g., for disabled people) will be derived from standard web technologies.
ORGANS	A good User Experience. Human Centered design.
TUNES	

	Do you have any thoughts on how the success of the new tools and methods could be measured (e.g. time and accuracy with which tasks are carried out, usability surveys, measures of interface aesthetics, observational studies, interviews, etc.)?
MUSICBO	
TONALITIES	time and accuracy with which tasks are carried out
CHILD	Too early to say (any of the above).
MEETUPS	Too early to say
ACCESS	Views of users. Demonstrated new affordances for people with disabilities. New tasks and experiences enabled. Views of music educators and music venues involved.
BELLS	Interviews, use of oral and bottom-up sources for the building of a conceptual knowledge
INTERLINK	Precision, recall, f-measure about the discovered links Competency questions (for the ontologies) User surveys
FACETS	usability surveys, measures of interface aesthetics could be used. Yet to be defined, though.
ORGANS	The amount of time a advisor for a restoration project needs to assemble the factual basis for a restoration or maintenance plan.
TUNES	The methods would be successful if the results are interpretable by a music historian.

Table 6: Survey – Success criteria

3.3. Lessons learned

The Survey is effective when it comes to investigating the status of the pilots and identifying their methodologies and resources. The insights obtained offer a detailed snapshot of the pilot's current state of the art. They also allow to compare the individual pilots in terms of approaches, technical needs, observation units, and to identify methodological constants and common standards that will be formalised in the second version of this report (M18).

So far, the pilots have entered and updated their data in a 'centralized' way on two occasions at M2 and M4. It is planned that this update will be done more and more individually in the future using version control on GitHub. The iterative approach thus allows each pilot to complete their answers based on their individual progress.

To complement the gradual enrichment of data by the pilots, the Survey ensures a progressive adjustment of the questions asked with regard to the individual field work conducted. In the case of ACCESS, for example, the Survey brought out that many questions, especially, from the technical part, were not in line with the pilot's scientific problem. This makes sense in consideration of the fact that this pilot is not focused on exploring data collections but on making it easier for people with disabilities to access and to experience musical heritage. These tensions will be taken into account in future adaptations and iterations of the Survey.

Despite its obvious benefits, the survey method reaches its limits on several levels. Since only information that is in line with the categories and criteria outlined in the questions can be easily understood, this tool only partially complies with a bottom-up approach that takes its starting point in the closest possible observation of individual problems and needs. The fact that a progressive adaptation of the Survey is

expected and that generic questions are asked – "What else has to be reported that is not covered by this part? Do you have any remarks?" – does not completely overcome this limitation.

Furthermore, the knowledge collected is essentially static in nature and the Survey is more prescriptive and declarative than descriptive. The answers provided require that the problems and solutions – including technical ones – should be well identified. As part of the bottom-up approach of this deliverable, the Survey must therefore be complemented by the other tools developed.

Finally, at this stage, the Survey does not lead to a hierarchy of use cases and related key concepts. It proves however to be a good starting point for identifying challenges and needs (either pilot specific or shared between the pilots). This information will be central for refining models of interactions and procedures that aim to reinforce the overall cohesiveness of the project. Building on the information collected so far and taking into account its further enrichment, a major goal for the coming months will thus be to conduct scientific work to achieve interconnection of the data and metadata between the different use cases.

4. General comparison of approaches and tools

The SMS tools – Stories, *Maninpasta* and Survey – are the result of previous projects and research carried out at the partner institutions, especially University of Bologna (UNIBO), Open University (OU) and the IReMus research institute[40]. Their joint use in the project is justified and explained by their complementary nature as they involve different situations in terms of temporalities, exploration scopes, results, knowledge types and actors (table 4).

	Survey	**Stories**	***Maninpasta***
Temporality	Long term, gradual updates	Medium term, gradual updates	Weekly, almost daily, interaction
Scope / Granularity	Pilot specific and cross-pilot comparison	Pilot specific	Pilot specific but allowing extrapolation / generalisation
Nature of knowledge/results	Prescriptive, declarative	Discursive	Interactive, executive
Actors involved	Reference person in the pilot's team	Pilot's team	Cross-team, interdisciplinary WGs

Table 7: Synoptic comparison of tools and devices

Whereas the Survey brings out common needs, helps to identify resources and leads to building bridges between the pilots, the Stories discursively highlight the pilots' specificities, particular research questions

[40] See references quoted in this document in sections 1.1.1 and 1.1.2, and Christophe Guillotel-Nothmann. "Les signes musicaux et leur étude par l'informatique. Le statut épistémologique du numérique dans l'appréhension du sens et de la signification en musique", «Revue Musicale OICRM», 6/2 (2020), pp. 45-72, https://www.erudit.org/fr/revues/rmo/2020-v6-n2-rmo05202/1068385ar/.

and individual approaches. While specific to the Stories, the *Maninpasta* WGs help to identify generic problems and shared needs thanks to the interplay of specialists from different disciplines and backgrounds. Their interactive and executive nature plays a key role in both the materialisation and implementation of *Polifonia*'s conceptual and technological ecosystem.

The identification of common problems and needs occurred first during the plenary discussion after the *Maninpasta* and during the WP1 meetings. Additionally, it is now carried out by a focused 'CQs and datasets' WG which is conducting a detailed analysis of recurrent concepts at the cross-pilot level based on the Survey and on the Stories' CQ. The goal of this WG is threefold. First, it ensures the harmonisation of CQs in terms of terminology and technical vocabulary through the development of a glossary that defines core concepts of the CQs for common understanding. Second, it iteratively rephrases CQs so they have an equal level of detail, ensuring that CQs are specific and granular enough so they can effectively be tested in further ontology unit tests. Third, it establishes clear and practical relationships between CQs and datasets from the Survey, explicitly indicating what datasets are adequate to provide valid answers to CQs through the ontologies and knowledge graphs being designed in WP2. Far from co-existing independently, the SMS tools are thus mutually beneficial.

The application of the SMS tools and their practical ramifications also show their essential importance for monitoring and validation tasks within methodological frameworks that have yet to be defined. The Survey allows to monitor the pilots' progress and provides success criteria that the pilots defined themselves. Conversely, the Stories, in conjunction with the ontology design WG and the TB, are currently implementing an iterative test-driven validation methodology that will allow to verify as accurately as possible whether the modelling provides the expected answers. The XD ontology design methodology used in this context paves the way for *Polifonia* in how the three tools enact the creation of high-quality, satisfactory ontologies and knowledge graphs[41].

Despite some possible improvements mentioned above, the SMS tools seem currently to fulfil their functions and to be self-sufficient. It cannot be excluded however that other approaches and devices will be added to these in order to further collect information and implement the pilots. For example, it may be convenient to establish clear and explicit relationships between the tools and the collection of harmonised CQs and datasets. The validation of these tools, planned for M18 in the second deliverable relating to the roadmap, will be based on their ability to collect and analyse the information necessary for the implementation of the pilots. The methodological framework used to this end remains to be specified by then.

5. Conclusions and future actions

This report describes the effort so far devoted to define a 'socio-technical roadmap', which must provide a common methodological and monitoring framework for the development of *Polifonia* pilots. In the first six months of the project, the focus has been to coordinate the collection of requirements. A challenge is

[41] For example, XD guides the process of turning the well-curated, homogenised CQs into modular ontologies; and how to write ontology unit tests that will empirically certify that these modular ontologies can satisfactorily answer the CQs. These activities are currently being performed in the weekly ontology design WG.

to make sure that overlaps and synergies between the pilots are captured and kept visible. To address this issue three reference tools are put in place: 1) Stories, 2) *Maninpasta*, and 3) Survey (SMS). Although it is early to make a rigorous assessment on their effectiveness, we observe that they are well accepted by the project interdisciplinary team and that they enabled collaborative and productive work. This report will be updated at M18 and will then present the final version of the roadmap, which must address the following issues:

1. to coordinate the resources used by the pilots;
2. to collect expectations and needs of internal and external users/stakeholders;
3. to identify the pilot's individual objectives and describe how they fit into *Polifonia's* overall plan;
4. to translate the disciplinary and scientific requirements into technological specifications;
5. to monitor the pilots' progress and validation process.

We are confident that the SMS tools are contributing to achieving this goal, although we are aware that additional, complimentary actions need to be undertaken. The coordination of resources used by the pilots (1) is supported by the organisation in WGs. The collection of expectations/needs (2) and the identification of the pilot's aims (3) are progressing and evolving iteratively, as presented in this report. The translation of scientific needs into technical specifications (4) is ongoing as a joint work with the TB, the DMP and the 'CQs and datasets' WG. In addition to continuing iterating and improving these issues, the next months will focus on establishing methods for monitoring pilots' progress and for their validation (5).

To achieve a final version of the roadmap (by M18), we plan the following actions that correspond to important ongoing and future workflow steps:

- To continue the information gathering process through the SMS tools;
- To constantly keep and update a centralised view (through the Survey) of the information collected in other tasks, actions and deliverables: DMP, TB, 'CQs and datasets' WG, etc. that are relevant to the pilots;
- To foster the interconnection and reuse of resources and tools identified by the pilots and the WGs;
- To carry out a systematic analysis of the information collected through the Survey and Stories templates, and make sure that their output informs all pilots;
- To generalise and to standardise methods, approaches and procedures for pilots' monitoring and validation;
- To define a methodology for validating the SMS tools as well as the others to come.

In the coming months we will put our focus on creating a robust approach to keep an updated centralised view on the data collected during the pilots' development. The aim of this action is a) to reach a high level of granularity of the collected information across all pilots, b) to provide all information necessary to the TB to improve conventions and technical guidelines, and c) to check that all documents and products are organised and clearly identifiable, and d) to support reuse and interoperability between pilots, when appropriate. This centralisation will lead to better identify and to enhance the interconnections between the pilots. It will also ensure that the roadmap is compliant with the DMP and the TB. The systematic analysis of incoming data will support the generalisation and standardisation of the final version of the

roadmap, due at M18. We also plan to define a set of criteria for validating the effectiveness of the roadmap in supporting monitoring the progress of pilots, maximising their interconnection e.g. by identifying overlapping requirements, and enhancing the communication and collaboration between the pilots and the other WPs.

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Appendices

Appendix 1: Glossary

Term	Definition/description
ArCo	**Ar**chitettura della **Co**noscenza. A project for developing the Italian cultural heritage knowledge graph.
CIDOC CRM	CIDOC Conceptual Reference Model (CRM) is a theoretical and practical tool for information integration in the field of cultural heritage.
CQ	Competency Question: a question that an ontology would need to answer.
CRMinf	CRM_{inf}: the Argumentation Model. An Extension of CIDOC-CRM to support argumentation.
D	Deliverable.
Discord	Instant messaging and digital distribution platform designed for creating communities.
DMP	Data Management Plan.
Domain specific part/aspect	Any scientific, epistemological and methodological considerations concerning one or more pilots.
eXtreme Design (XD)	Pattern-based ontology engineering methodology, which collects requirements in the form of Competency Questions.
Github	Git is an open-source software for managing versions of documents. The documents typically managed in Git repositories are computer source code files, but it is in fact perfectly suitable for text data in general, including humanities data. The development of Git is closely related to that of GitHub a service for hosting Git repositories.
Goal	A short textual description of the goal(s) that the Persona needs to be addressed in the Story.
H	Human(s).
HCI	Human Computer Interaction.
IReMus	Institut de Recherche en Musicologie, UMR 8223. Joint research unit composed of the CNRS, the BnF, Sorbonne University and the French Ministry of Higher Education and Research.

Knowledge unit/type	New knowledge produced by the pilot through the analysis (by algorithms, machine learning and/or human annotation) of the input data. This unit may correspond for example to a cadence in a score, to the identification of a previously anonymous author of a source, to the type of a bell, etc. (see diagram 2. Survey – Knowledge units investigated by the pilots).
M[1-40]	Month counting from the start of *Polifonia* on 1 January 2021: M6 (= June 2021), M18 (= June 2022), etc.
MEI	Music Encoding Initiative.
MH	Musical heritage.
NLP	Natural language processing.
Observation unit	A portion of input data on which the pilot relies to provide new units of knowledge through algorithms, machine learning and/or human annotation. These observation units may correspond for example to a sentence in a text, a score fragment (for example a cadence) or the dedicatee engraved on a bell.
ODP	Ontology design patterns which correspond to small ontologies that work as reusable solutions to recurrent modelling problems.
OEI	Office of ethics and integrity.
OU	The Open University.
OWL	Web Ontology Language (OWL) is a Semantic Web language designed to represent rich and complex knowledge about things, groups of things, and relations between things.
Persona	A research-based description of a typical user. This description contains attributes such as name, age, occupation, and relevant characteristics such as knowledge and skills.
POPD	Protection of personal data.
Scenario	A description of how in a Story the Persona's task/need/problem is solved before, during and after interaction with the resource/software/service being developed.
SMS tools	The three tools at the core of this deliverable: Story, *Maninpasta* and Survey.
Socio-pedagogical aspect	An item linked to a holistic and relationship-centred way of working in care and educational settings with the possible final users of *Polifonia*.

Source	Within a dataset, it is meant to define the origin of the input data, in opposition to the output data, that are the results collected by the pilot.
Story	A Story is a template for collecting requirements.
TB	The Technical Board, within the WP1, is in charge of the technical development, making sure that synergies are identified in a timely manner and issues around compatibility and technical interoperability are addressed harmonically during the development phase. The TB defines the common methodological approach and identifies the supporting collaborative tools to be used.
UI	User interface.
UNIBO	Alma mater studiorum – Università di Bologna.
URI	A Uniform Resource Identifier is a unique sequence of characters that identifies a logical or physical resource used by web technologies.
UX	User Experience Design.
WG	Working group.
WP	Work package.

Appendix 2: List of the pilots

***Polifonia*'s Pilot**	**Action**
BELLS	Bell structures are widespread both in urban and rural areas. They contribute to the distinctive shape of a landscape, to defining its soundscape and play as markers of daily, festive and ritual times. Bell heritage is complex and fascinating and influences our perception of the places we live daily. Both its tangible and intangible assets, and their dependencies are hardly encoded explicitly: most of this heritage is transmitted orally. This pilot intends to encode this valuable information in a knowledge graph, which will be publicly available and particularly relevant for scholars and cultural institutes.
ORGANS	The history of pipe organs is rich and diverse, and highly interrelated to economic, religious and artistic contexts. Currently, the information about building practices and characteristics of ~2000 Dutch pipe organs is only retrievable by manually paging a 15 volumes (4,500+ pages) encyclopaedia: the Orgelencyclopedie (1997-2010). This pilot will build a knowledge graph out of the text of Orgelencyclopedie, which will provide digital (and quick) access to such huge and detailed knowledge, including connection to data about aspects of their wider historic contexts.
FACETS	Music libraries currently lacks well-founded information retrieval tools. This pilot will design a faceted search engine (FSE) for music score collections, supporting explorations and discovery of scores of interest in large collections, based on features such as melodic, harmonic or rhythmic patterns, style, structure, instrumentation, metadata leveraged at the collection level.
INTERLINK	In order to answer research questions, musical heritage scholars need to combine diverse datasets (music scores, audiovisual materials, metadata) from European digital music libraries and audiovisual archives. They need to identify common entities and concepts implicitly present in the data, across different collections in different institutions. This process is mainly conducted manually in isolation and the diverse results are rarely connected. This pilot will focus on revealing and make compatible the entities and concepts hidden in digital music libraries and audiovisual archives.
CHILD	This pilot will build a knowledge graph of the historical experience of music in childhood, using life writing (letters, diaries, memoirs, travel writing) and other historical texts as sources for adult reflections on music heard in childhood, third-party observations on children's engagement with music, and children's own first-hand accounts. The resulting knowledge graphs will inform an interface enabling the exploration and analysis through the dimensions of themes, time, and space.
MUSICBO	Music has always played a central role in the city of Bologna. Nevertheless, its musical heritage is only partly known and enjoyed compared to its full potential. This pilot will

	create multilingual (English, French, Spanish and German) digital corpora, containing the testimonies of scholars, journalists, travellers, writers and students from medieval to modern times through published documents showing diverse discourse styles such as stories, letters, reports, news, reportage, etc. These corpora will be the base to build a knowledge graph available to researchers, cultural institutes and public administrations for reuse.
TUNES	The digital music collection of the Meertens Instituut (Amsterdam) includes thousands of melodies from Dutch popular culture, spanning a period of more than five centuries. To trace possible international origins of Dutch early popular music culture, this pilot will interlink the entire melody collection of the Meertens Institute with a large number of other European collections. The linked melodic data sets will be highly valuable for musicologists and music historians interested in cultural evolution of musical style and in oral transmission and variation.
TONALITIES	The modal-tonal organisation of Western music is decisive for its inner coherence, its dramatic plot and, ultimately, for its artistic meaning. This pilot develops tools for the modal-tonal identification, exploration and classification of monophonic and polyphonic notated music from the Renaissance to the 20th century.
ACCESS	The aim of this use case is to co-design, develop and evaluate wearable haptic technology to enable people who are Deaf or hearing impaired to engage as audience members in live performances.
MEETUPS	This pilot focuses on supporting music historians and teachers by providing a Web tool that enables the exploration and visualisation of encounters between people in the musical world in Europe from c.1800 to c.1945, relying on information extracted from public domain books such as biographies, memoirs and travel writing, and open-access databases. These encounters will be explored in a timeline and map interface and may reveal unexpected connections and relationships that cast new light on aspects of European music history. The tool will provide persistent, citable identifiers in order to support referencing in scholarship outputs.

Appendix 3: WP1 participants, efforts, objectives, tasks and deliverables

WP number	1			**Lead beneficiary**			IREMUS			
Title	Web Portal and pilots									
Participant	1	2	3	4	5	6	7	8	9	10
	BO	OU	KCL	NUIG	ICCD	ICBSA	IREMUS	CNAM	NISV	KNAW
Person months	8	10	10	6	6	5	12	11	4	11
Start month	1			**End month**			40			

Objectives

WP1 is *Polifonia*'s validation WP, it contributes to achieve O3 (Tailor), and O5 (Share & Engage). As such it drives the whole development. It also delivers a registry of all resources and materials retrieved, used and produced in the project, in the form of a Web portal. Its goal is twofold: 1) to demonstrate that the methods and tools developed in the technology provider work packages (WP2-5) are effective in facilitating management of large musical heritage collections and supporting enhanced understanding, preservation of, and interaction with, musical heritage, 2) to contribute to push the state of the art in relevant, though specific, musical heritage use cases. It includes seven tasks: T1 delivers a socio-technical roadmap to all partners ensuring supervision for the co-creation process; T2 provides a Technical Board supervising the development; T3 delivers a Web portal / registry and associated services; T4-7 develop ten pilots. Each task represents a theme relevant to the scope and challenges of the call: Preserving MH (T3), Managing MH (T4), Studying and understanding MH (T5), Interacting with MH (T6). Notice that ten "external" early adopters have already expressed their interest in participating in seven pilots, as explicitly indicated in the pilot descriptions (see also attached support letters).

Tasks

Task 1: Socio-Technical Roadmap *(Leader: IREMUS - Participants: ALL)*

This task provides a common framework to all pilots (T4-7) for: 1) coordinating collection of resources for use in the pilots, 2) gathering requirements from internal and external adopters/stakeholders, 3) setting objectives and challenges and mapping them from specific domains to the technology provider work packages (WP2-5), 4) monitoring validation within the pilot tasks. The goal is to maximise synergy and methodological soundness.

Task 2: Technical Coordination *(Leader: OU - Participants: ALL)*

This task will provide the pilots and the technology provider WPs with a reference Technical Board (TB) which, according to the roadmap defined in T1, will supervise the technical development making sure that synergies are identified in a timely manner and issues around compatibility and technical interoperability are addressed harmonically during the development phase. The TB will define the common methodological approach and identify the supporting collaborative tools to be used. It will

interact with WP6 to make sure that all the developed components are released according to the FAIR protocols defined in T7 of WP6. This task will also collect and report validation results from the pilots.

Task 3: *Polifonia* Web portal: an aggregator of digital musical heritage collections *(Leader: UNIBO - Participants: OU, NUIG, KCL)*

By extending musoW, a catalogue of Musical Data on the Web [http://musow.kmi.open.ac.uk/] (Daquino et al. 2018), this task will develop the *Polifonia* Web portal. It will include: 1) a reference registry of MH resources, including but not limited to all collections used and produced in the project, 2) methods for continuous indexing of MH resources, 3) methods for automatic and semiautomatic generation of metadata according to the *Polifonia* ontologies, 4) methods for searching, querying, browsing MH resources. The task will also provide input to WP6 about recommendations for the sustainability of the Web portal, beyond the lifespan of the project.

Task 4: Preserving musical heritage through knowledge graphs *(Leader: KNAW - Participants: UNIBO, OU, KCL, NUIG, ICCD, ICBSA, Nationaal Instituut voor de Orgelkunst (NiVO) (external), Soprintendenza Archeologica Bologna (external), Soprintendenza Archeologica Genova (external)]*
This task includes two pilots focusing on building knowledge graphs for musical heritage that currently is hardly or not accessible, e.g. orally transmitted practices, embedded in texts, etc.

Task 5: Managing musical heritage collections through knowledge graphs *(Leader: KCL - Participants: ALL (except DP) + External adopters: BNF, CLARIN, DARIAH, CLARIAH, Europeana*
This task includes two pilots focusing on building knowledge graphs for supporting curators, owners, etc. in managing their large collections

Task 6: Studying musical heritage through (interlinked) knowledge graphs *(Leader: IREMUS - Participants: UNIBO, OU, KCL, NUIG, KNAW, Biblioteca Universitaria di Bologna (external))*
This task includes pilots for demonstrating how *Polifonia* technologies can be leveraged to demonstrate, discover, document, support etc. research hypotheses/theories.

Task 7: Interacting with musical heritage knowledge graphs *(Leader: OU - Participants: UNIBO, ICBSA, The Stables Theatre, Milton Keynes, UK (external))*

This task includes pilots demonstrating novel interaction solutions. The goal is to show how musical heritage knowledge graphs can be leveraged for supporting accessible and improved user experience.

Deliverables

- D1.1: Roadmap and pilot requirements - 1st version (M6)
- D1.2: Roadmap and pilot requirements - 2nd version (M18)
- D1.3: Pilots development: collaborative methodology and tools (M6)
- D1.4: Intermediate validation reports for pilots: ORGANS and BELLS (M24)
- D1.5: Intermediate validation reports for pilots: INTERLINK and FACETS (M24)
- D1.6: Intermediate validation reports for pilots: TONALITIES, TUNES, MUSICBO and CHILD (M24)
- D1.7: Intermediate validation reports for pilots: MEETUPS and ACCESS (M24)

- D1.8: Final ten-pilots validation report and lessons learned (M40)
- D1.9: *Polifonia* Web portal - 1st version (M18)
- D1.10: *Polifonia* Web portal - 2nd version (M36)

Appendix 4: Work packages in *Polifonia* project

Acronym	Title	Tasks
WP1	Web portal and pilots	1. Socio-Technical Roadmap 2. Technical coordination 3. *Polifonia* web portal: an aggregator of digital musical heritage collections 4. Preserving musical heritage collections through knowledge graphs 5. Managing musical heritage collections through knowledge graphs 6. Studying musical heritage through (interlinked) knowledge graphs 7. Interacting with musical heritage knowledge graphs
WP2	Musical heritage knowledge graphs	1. Ontology-based knowledge graphs for music objects 2. Ontology-based knowledge graphs for music objects context 3. Interlinking knowledge graphs 4. Licences, ownerships, and conditions of use
WP3	Mining musical patterns	1. Pattern extraction 2. Pattern recognition and definition in monodic and polyphonic music 3. Network of musical patterns 4. Music classification from musical patterns
WP4	Extracting musical heritage knowledge from text	1. Building and evaluating multilingual text corpora on musical heritage. Themes, reception, and… 2. Automatic extraction of time, space, events, people and musical artifacts from text

		3. Automatic extraction of socio-cultural and historical context of musical heritage 4. Evaluation of automatic knowledge extraction methods
WP5	Human music interaction and engagement	1. Evaluation of interaction components 2. Multidimensional searching, browsing and exploration of musical assets and knowledge 3. Haptic and gestural interaction with music 4. Pattern exploration, composition and visualisation 5. Publishing, accessing and reusing musical scholarly objects
WP6	Dissemination and exploitation	1. Plan for exploitation and dissemination of results (PEDR) 2. Web presence and *Polifonia* image 3. Dissemination of project results 4. Innovation drive: stakeholder network 5. Enhanced accessibility and inclusion strategies 6. Musical heritage promotion: the *Polifonia* open source artistic digital installation 7. Data Management Plan
WP7	Project coordination and management	1. Overall coordination of project activities, monitoring, quality control, reporting 2. Overall legal and contractual management 3. Consortium agreement, management of the knowledge generated by the project and IPRs 4. Ethical compliance 5. Financial and administrative management and reporting 6. Project governance and partnership communication
WP8	Ethics requirements	1. OEI – Requirement No. 1 2. H - Requirement No. 2

		3. H - Requirement No. 6 4. H - Requirement No. 7 5. H - Requirement No. 8 6. POPD - Requirement No. 9 7. POPD - Requirement No. 10

Appendix 5: Story (Persona–QC–Scenario) Template

- **Persona**
  - It is a research-based description of a typical user.
  - It contains attributes such as name, age, occupation (if the Persona has more than one role, indicate which one is their primary role and which one(s) the secondary role(s)), and relevant characteristics of the person such as their knowledge and skills and their interests.
- **Goal**
  - It is a short textual description of the goal(s) that the Persona needs to be addressed in the Story.
  - maximum number of characters: 1200.
  - The goal(s) is(are) also represented by a short (maximum 5) list of keywords.
- **Scenario**
  - It is a Story describing how the Persona's task/need/problem is solved before, during and after interaction with the resource/software/service being developed.
  - maximum number of characters: 1200.
- **Competency questions (CQs)**
  - Question(s) the Persona needs the resource/software/service to answer for satisfying their task/need/problem.
- **Resources (optional)**
  - List of resources (with references/links) where it is expected or known that the Persona can find what she's looking for.

Appendix 6: Survey template

1. **DOMAIN SPECIFIC PART**.
    - 1.1. Identification & characterisation of the sources, and available digital corpora or datasets.
        - 1.1.1. Availability
            - 1.1.1.1. Are the sources digitized?
            - 1.1.1.2. If so, are the sources born digital?
            - 1.1.1.3. Can you provide links to the sources in a (partial) list?
            - 1.1.1.4. Where is the data stored?
            - 1.1.1.5. How scattered is musical knowledge data over different sources?
        - 1.1.2. Source characterisation. What is the nature of the sources?
            - 1.1.2.1. Score
            - 1.1.2.2. Sound source
            - 1.1.2.3. Image collection (iconographic items, diagrammatic items, etc,)
            - 1.1.2.4. Texts (poetry, librettos, writings about music, correspondence, theoretical sources, documents about gestuality, technical documents, etc.)
            - 1.1.2.5. Audiovisual sources
            - 1.1.2.6. Material objects (bells, instruments, theatre equipment, sources listed above explored from the perspective of their materiality)
        - 1.1.3. Legal issues
            - 1.1.3.1. Are there any copyright or licensing issues?
            - 1.1.3.2. Who has the rights to the used datasets?
    - 1.2. Form, type, extent of research outcomes
        - 1.2.1. What are your scientific assumptions and/or initial hypotheses?
        - 1.2.2. What kind of scientific knowledge do you intend to produce (for example factual knowledge, conceptual knowledge, procedural knowledge, or metacognitive knowledge)? The data that embody the new knowledge generated should be characterized:
            - 1.2.2.1. According to their nature (melodic patterns, intertextual units, networks of composers and compositions, ...)
            - 1.2.2.2. According to their "documentary & technical" relationships with the sources:
                - 1.2.2.2.1. Is the new knowledge anchored to a specific fragment in a source? (e.g. "The note identified by the xml:id "m-69" in a MEI file is analysed as a passing note")
                - 1.2.2.2.2. Is the new knowledge about a whole document (e.g. "The composer of this piece is H.I.F. von Biber")
            - 1.2.2.3. According to their "status" with regard to the sources and to socio-scientific practices:
                - 1.2.2.3.1. Is the new knowledge purely descriptive? (e.g. a diplomatic transcription)
                - 1.2.2.3.2. Can the new knowledge be the subject of dissensus?
                - 1.2.2.3.3. Does the new knowledge involve an interpretation? And should the interpretative context made explicit through linked

data? (e.g. "Mrs X hypothesizes that this specific note N1 is an escape note, basing her opinion on these three annotations A1, A2, A3 and on this theoretical statement S1.")

1.2.2.3.4. Could the knowledge be inferred by algorithms, or can it only proceed from human interpretation?

1.2.2.3.5. Should it be possible to represent hypotheses and/or statements with varying degrees of certainty?

1.2.2.3.6. Could the knowledge proceed from collaborative scientific practices?

1.2.2.4. According to their relationships with formalized "meta-knowledge":

1.2.2.4.1. Does the new knowledge rely on a controlled vocabulary? (e.g. "A note could be a 'Consonant note', a 'Passing note', a 'Neighbor note', an 'Anticipation', a 'Suspension', an 'Escape note';)"

1.2.2.4.2. Does the new knowledge involve the creation of new controlled vocabularies to reflect specific scientific analytical concepts?

1.2.2.4.3. Could the links to the socio-cultural context be made explicit?

1.2.3. How do the methods and results contribute to the state of the art?

1.2.3.1. To which discipline/subdiscipline/specialty do you aim to contribute knowledge?

1.2.3.2. Can you provide examples of research questions that the pilot will allow to explore?

1.3. Methods used to derive the results from the sources and to articulate them with other sources.

1.3.1. Identification/creation of analytical categories

1.3.2. Identification/creation of analytical and conceptual tools

1.4. Please provide a specific contact person for questions related to the pilot's scientifical dimension (pilot coordinator)?

1.5. What else has to be reported that is not covered by this part? Do you have any remarks?

2. **TECHNICAL PART**. The technical part specifies the actual implementation of the conceptual model:

2.1. Characterisation of existing datasets (more specific technical questions will be addressed in the data management plan).

2.1.1. Metadata

2.1.1.1. What formats are used?

2.1.1.2. What standards are used?

2.1.2. Datasets

2.1.2.1. What formats are used?

2.1.2.2. What standards are used?

2.2. Knowledge organisation systems and interoperability

2.2.1. Please list the controlled vocabularies, taxonomies, thesaurus, ontologies, etc. that you will use in your pilot
2.2.2. Please indicate if you plan to expand existing knowledge organisation systems or if you plan to create a specific one
2.2.3. Do you plan to support interoperability towards third parties?
2.2.4. Do you have API's on your resources?

2.3. Are there planned overlaps (already defined or envisioned) between the pilot's resources and other resources used within *Polifonia*?
2.4. What algorithms will be developed for knowledge extraction or alignment?
2.5. How should the pilot's resources be presented, linked, or stored on the website dedicated to the pilot?
2.6. What type of knowledge you expect can contribute to the *Polifonia* Web portal?
2.7. What type of interaction do you expect should be supported by the Web portal?
2.8. In which ways the Web portal shall link to the (separate) pilot demonstrator (if any)?
2.9. What kind of 'augmentation/enrichment' do you expect to get out of being displayed via the portal?
2.10. What do you expect in terms of technologies from the technical providers?
2.11. Can you provide a specific contact person for questions related to the pilot's technical aspects?
2.12. What else has to be reported that is not covered by this part? Do you have any remarks?

3. SOCIO-PEDAGOGICAL PART. The socio-pedagogical part aims to identify the target groups and their conditions
   3.1. What is the target group of your pilot?
      3.1.1. Amateur Internet users,
      3.1.2. Musicians
      3.1.3. Students
      3.1.4. Academics (specify, if possible, their field of expertise)
      3.1.5. Curators
      3.1.6. Others (please specify)
   3.2. In order for the pilot to be successful, what criteria would the new tools and methods need to satisfy (e.g. certain tasks carried out more quickly or accurately, the amount or type of data that can be used in the task, number of people who are able to use the tools, the attractiveness of the interface, new tools being easy to learn, etc.)?
   3.3. Do you have any thoughts on how the success of the new tools and methods could be measured (e.g. time and accuracy with which tasks are carried out, usability surveys, measures of interface aesthetics, observational studies, interviews, etc.)?
   3.4. What facilities, if any, does the pilot make available for people with disabilities?
   3.5. Can you provide a specific contact person for questions related to the pilot's socio-pedagogical implications?
   3.6. What else has to be reported that is not covered by this part? Do you have any remarks?
4. Do you have any general comments and remarks?