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KGE-MN 2025 - Knowledge Graph utilizing open data from the State Registration of Legal Entities of Mongolia

Document Data:	Reference Persons:
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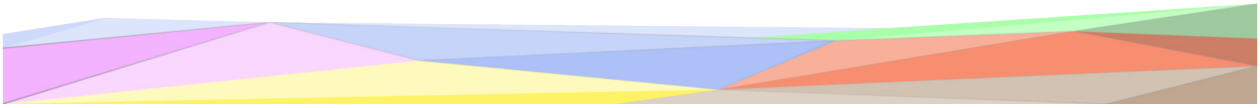

Contents

1 Introduction

Reusability is one of the main principles in the Knowledge Graph Engineering (KGE) process defined by iTelos. The KGE project documentation plays an important role in enhancing the reusability of the resources handled and produced during the process. A clear description of the resources as well as of the process (and sub-processes) developed, provides a clear understanding of the project, thus serving such information to external readers for the future exploitation of the project's outcomes.

1.1 Project Overview

This project focuses on the construction of a Knowledge Graph utilizing open data from the State Registration of Legal Entities of Mongolia. The primary objective is to visualize, in a graph structure, the complex relationships among various stakeholders within the Mongolian corporate ecosystem. Specifically, the project addresses the following relationship categories:

- **Shareholders and Members**: Individuals and entities holding ownership stakes in legal entities, including their classification and country of origin.
- **Officials and Controlling Entities**: Persons authorized to represent legal entities without a power of attorney, including their official positions and appointment dates.
- **Ultimate Beneficial Owners**: Natural persons who ultimately own or control legal entities, enabling transparency in corporate ownership structures.

Furthermore, for companies listed on the Mongolian Stock Exchange, the project aims to link and visualize relevant open datasets, creating an integrated view of corporate information that spans both registration data and capital market participation.

1.2 Motivation and Significance

The transparency of corporate ownership structures is essential for various stakeholders, including regulatory authorities, financial institutions, investors, and the general public. In Mongolia, as in many jurisdictions, complex corporate structures can obscure the true ownership and control of legal entities. This Knowledge Graph addresses this challenge by:

- Enabling the visualization of multi-layered ownership networks
- Facilitating the identification of individuals with significant influence across multiple entities

- Supporting regulatory compliance and anti-money laundering efforts
- Providing investors and business partners with comprehensive due diligence capabilities

1.3 Document Structure

The current document aims to provide a detailed report of the project developed following the iTelos methodology. The report is structured as follows:

- **Section 2**: Definition of the project's purpose and its domain of interest, establishing the scope and objectives that guide all subsequent development activities.
- **Section 3**: High-level description of the project development, based on the Produce role's objectives, providing an overview of the production strategy and key milestones.
- **Sections 4, 5, 6, 7, and 8**: The description of the iTelos process phases and their activities, divided by knowledge and data layer activities. These sections detail the systematic approach taken to formalize the purpose, design the knowledge architecture, and implement the data integration processes.
- **Section 9**: The description of the evaluation criteria and metrics applied to the project's final outcome, ensuring the quality and fitness-for-purpose of the resulting Knowledge Graph.
- **Section 10**: The description of the metadata produced for all (and all kinds of) resources handled and generated by the iTelos process while executing the project, supporting long-term maintainability and reusability.
- **Section 11**: Conclusions and open issues summary, reflecting on the project outcomes and identifying opportunities for future development and enhancement.

2 Domain of Interest (DoI)

This section defines the boundaries of the Knowledge Graph Engineering project in terms of spatial and temporal dimensions. The Domain of Interest establishes the scope within which the project purpose—visualizing relationships among shareholders, officials, controlling entities, and ultimate beneficial owners of Mongolian legal entities—will be realized.

2.1 Spatial Boundaries

2.1.1 Primary Geographic Scope

The Domain of Interest is geographically bounded to **Mongolia**, specifically encompassing:

- **National Coverage**: All legal entities registered with the State Registration of Legal Entities of Mongolia, regardless of their physical location within the country's 21 aimags (provinces) and the capital city of Ulaanbaatar.
- **Administrative Divisions**: The registered addresses of legal entities span all administrative levels, including:
  - Ulaanbaatar (capital city) and its districts (düüregs)
  - Provincial capitals (aimag centers)
  - District subdivisions (khoroos and bags)

2.1.2 International Dimension

While the primary focus is Mongolia, the domain necessarily extends to include international elements due to the nature of corporate ownership:

- **Foreign Shareholders**: Legal entities may have shareholders from foreign countries (e.g., Singapore, Hungary, as seen in the example data with "Хайнекен Азиа Пасифик Пте Лтд" from Singapore and "Steppe Beverage KFT" from Hungary). The Knowledge Graph will capture the country of origin for these foreign stakeholders.
- **Cross-Border Ownership Chains**: The graph will represent ownership relationships that cross national boundaries, though detailed information about foreign parent companies is limited to what is recorded in the Mongolian registry.
- **Boundary Limitation**: The project does not extend to foreign corporate registries. Information about foreign shareholders is limited to their name, country of origin, and relationship to Mongolian entities as recorded in the State Registration system.

2.1.3 Spatial Boundary Justification

The geographic boundaries were defined based on the following considerations:

1. **Data Availability**: The open data from the State Registration of Legal Entities covers all legally registered entities within Mongolia's jurisdiction, providing comprehensive national coverage.

2. **Legal Framework**: The Mongolian Company Law and relevant regulations govern entities within these boundaries, ensuring data consistency and regulatory compliance.

3. **User Needs**: The identified personas (investigators, business analysts, portfolio managers, compliance officers) primarily operate within the Mongolian legal and business environment, making national scope most relevant to their needs.

2.2 Temporal Boundaries

2.2.1 Historical Scope

The temporal dimension of the Domain of Interest encompasses:

- **Start Date**: The Knowledge Graph will include data from **January 1, 2000** onwards. This date was selected because:
  - It captures the modern era of Mongolia's market economy development
  - Most currently active legal entities were registered after this date
  - Data quality and completeness improve significantly from this period
- **End Date**: The temporal scope extends to the **present day**, with the expectation of ongoing updates as new registrations and changes occur in the source registry.
- **Historical Records**: For entities registered before 2000 that remain active, their historical information (as available in the registry) will be included, though with the understanding that older records may be less complete.

2.2.2 Temporal Granularity

The Knowledge Graph captures temporal information at the following levels of granularity:

- **Registration Dates**: Precise dates (YYYY.MM.DD format) for:
  - Initial entity registration
  - Shareholder/member registration
  - Appointment of authorized representatives
  - Ultimate beneficial owner registration
  - Business activity registration
  - Restructuring events

- **Validity Periods**: For certain business activities (particularly licensed activities such as alcohol production), the data includes validity periods with start and end dates (e.g., ”2019.04.14 - 2022.04.14” for alcohol production licenses).
- **Change Tracking**: The system captures the dates when changes occurred, enabling temporal analysis of corporate evolution.

2.2.3 Temporal Boundary Justification

The temporal boundaries were established based on:

1. **Data Completeness**: Records from 2000 onwards demonstrate higher data quality and completeness compared to earlier periods.
2. **Relevance to Current Analysis**: The 20+ year historical window provides sufficient depth for:
   - Tracking corporate evolution and restructuring
   - Identifying long-term patterns in ownership and control
   - Supporting due diligence investigations requiring historical context
3. **Regulatory Evolution**: Mongolia’s modern corporate governance framework, including beneficial ownership disclosure requirements, has developed primarily within this timeframe.

2.3 Domain Boundary Summary

Dimension	Boundary Definition
Geographic Scope	Mongolia (all 21 aimags and Ulaanbaatar)
International Elements	Foreign shareholder countries (as recorded in Mongolian registry)
Institutional Scope	State Registration of Legal Entities, Mongolian Stock Exchange
Temporal Start	January 1, 2000
Temporal End	Present (with ongoing updates)
Temporal Granularity	Daily (date-level precision for all recorded events)

Table 1: Summary of Domain of Interest Boundaries

2.4 Out of Scope

To provide clarity on the Domain of Interest boundaries, the following elements are explicitly **excluded** from the project scope:

- **Foreign Registry Data**: Detailed corporate information from foreign jurisdictions (beyond what is recorded in the Mongolian registry)

- **Informal Enterprises**: Unregistered businesses or sole proprietorships not captured in the State Registration system
- **Historical Records Pre-1990**: Data from the socialist period before Mongolia's transition to a market economy
- **Non-Corporate Entities**: Government agencies, international organizations, and diplomatic missions (unless they appear as shareholders in registered companies)
- **Real-Time Transaction Data**: Stock trading data, financial transactions, or other real-time market information beyond static company registration data

3 Project Development

This section describes, at top level, how the project's objectives (or "The Purpose") will be satisfied. More in details the current section aims at describing how the dta production process is performed.

3.1 Data Production

The description of which (quality) data needs to be created to satisfy the project purpose. This sub-section highlights the role of the data producer. The sub-section aims at describing how the data producer creates the data required to satisfy the project's purpose.

4 Initial Resources

This section describes the already available resources considered for the project. More in detail the resources here described, are quality resources (compliant with the quality and reusability guidelines defined by iTleos. 6*, or at least 5*) which don't need to be processed or created by a data producer. The resources described in this section are those that can be already composed by the data consumer to satisfy the project's purpose.

In this section are described both the resourced selected, and the sources from which such resources have been retrieved.

This section describes the two kind of resources considered by a projects, by filling the two sub-sections here below.

- **Knowledge resources**: iTelos compliant reference schemas and ontologies initially collected to satisfy the purpose along the KGE process. The knowledge resources initial metadata have to be reported here.
- **Data sources**: iTelos compliant datasets initially collected to satisfy the purpose along the KGE process. The data resources initial metadata have to be reported here.

5 Purpose Formalization

This section documents the activities and results achieved during the first phase of the iTelos methodology for constructing a Knowledge Graph based on the State Registration of Legal Entities in Mongolia. The project aims to visualize relationships among shareholders, members, officials, controlling entities, and ultimate beneficial owners, with additional linkages to Mongolian Stock Exchange data for listed companies.

5.1 Scenarios Definition

The following usage scenarios describe the multiple aspects considered by the project purpose:

5.1.1 Scenario 1: Corporate Ownership Investigation

A financial investigator needs to trace the ownership structure of a company suspected of involvement in financial irregularities. The investigator must identify all shareholders, their respective ownership percentages, and any connections to other legal entities. The system should reveal complex ownership chains, including nested corporate structures where companies own shares in other companies, ultimately leading to the identification of ultimate beneficial owners.

5.1.2 Scenario 2: Due Diligence for Business Partnerships

A business development manager at a Mongolian corporation is evaluating potential partners for a joint venture. Before entering negotiations, they need to understand the governance structure of target companies, including who has authority to represent the company without power of attorney, the company's business activities, and any organizational restructuring history that might indicate instability or strategic pivots.

5.1.3 Scenario 3: Stock Market Investment Analysis

An investment analyst researching publicly traded companies on the Mongolian Stock Exchange requires comprehensive information about company leadership, ownership con-

centration, and cross-holdings between listed entities. The analyst needs to identify potential conflicts of interest where the same individuals serve as officials across multiple companies or where significant ownership overlaps exist.

5.1.4 Scenario 4: Regulatory Compliance Monitoring

A compliance officer at a regulatory authority monitors legal entities for adherence to ownership disclosure requirements. They need to identify companies where ultimate beneficial owner information is incomplete, track changes in controlling persons over time, and detect patterns that might indicate attempts to obscure true ownership.

5.1.5 Scenario 5: Anti-Money Laundering (AML) Analysis

An AML specialist investigates networks of companies that may be used for layering illicit funds. The specialist needs to visualize connections between entities through shared shareholders, officials, and beneficial owners, identifying clusters of related companies and individuals who appear across multiple entities in patterns suggesting coordinated control.

5.2 Personas

5.2.1 Persona 1: Investigator Batbold

- **Role:** Financial Crimes Investigator at the Financial Regulatory Commission
- **Age:** 42 years old
- **Background:** 15 years of experience in financial investigation, former police detective
- **Technical Skills:** Moderate; comfortable with databases but prefers visual interfaces
- **Goals:** Quickly identify ownership networks, trace beneficial owners, and document evidence chains for legal proceedings
- **Pain Points:** Currently relies on manual searches through multiple registries; difficulty connecting entities across different data sources
- **Primary Scenario:** Scenario 1, Scenario 5

5.2.2 Persona 2: Business Analyst Oyungerel

- **Role:** Senior Business Development Manager at a mining corporation
- **Age:** 35 years old
- **Background:** MBA graduate, 10 years in corporate strategy
- **Technical Skills:** High; proficient in data analysis tools and visualization platforms
- **Goals:** Conduct thorough due diligence on potential partners, understand corporate governance structures, assess business stability
- **Pain Points:** Time-consuming process to gather information from multiple sources; difficulty assessing company history and restructuring events
- **Primary Scenario:** Scenario 2

5.2.3 Persona 3: Portfolio Manager Enkhjargal

- **Role:** Portfolio Manager at an investment fund
- **Age:** 38 years old
- **Background:** CFA charterholder, specializes in Mongolian equities
- **Technical Skills:** Very high; uses quantitative analysis tools daily
- **Goals:** Identify investment opportunities, assess governance risks, understand ownership concentration in listed companies
- **Pain Points:** Limited integration between stock exchange data and corporate registry information; manual effort required to build comprehensive company profiles
- **Primary Scenario:** Scenario 3

5.2.4 Persona 4: Compliance Officer Munkhbat

- **Role:** Senior Compliance Officer at the General Authority for State Registration
- **Age:** 45 years old
- **Background:** Legal background, 20 years in public administration
- **Technical Skills:** Moderate; familiar with government databases
- **Goals:** Monitor compliance with disclosure requirements, identify incomplete registrations, generate compliance reports

- **Pain Points:** Difficulty tracking changes over time; no automated alerting for suspicious patterns
- **Primary Scenario:** Scenario 4

5.3 Competency Questions (CQs)

The following competency questions were developed based on the personas and scenarios defined above:

5.3.1 Entity Identification and Basic Information

CQ1: What is the registration number of a legal entity given its name?

CQ2: What is the registration date of a specific legal entity?

CQ3: What is the legal form (Хэлбэр) of a given company?

CQ4: What is the type (Төрөл) classification of a legal entity?

CQ5: What is the registered address of a legal entity?

5.3.2 Ownership and Shareholder Information

CQ6: Who are all the shareholders and members of a specific legal entity?

CQ7: What is the classification (Ангилал) of each shareholder in a company?

CQ8: Which country does each shareholder belong to?

CQ9: What is the gender distribution of shareholders in a given company?

CQ10: When was each shareholder registered as a member of the company?

CQ11: Which companies share common shareholders?

CQ12: What legal entities does a specific individual hold shares in?

5.3.3 Management and Representation Authority

CQ13: Who are the officials authorized to represent a company without power of attorney?

CQ14: What position does each authorized representative hold?

CQ15: Which companies does a specific individual have authority to represent?

CQ16: Are there individuals who serve as authorized representatives in multiple companies?

CQ17: What is the registration date of each authorized representative's appointment?

5.3.4 Ultimate Beneficial Ownership

CQ18: Who are the ultimate beneficial owners of a specific legal entity?

CQ19: What is the classification of each ultimate beneficial owner?

CQ20: Which companies share the same ultimate beneficial owner?

CQ21: For a given individual, in which companies are they listed as an ultimate beneficial owner?

CQ22: Which companies lack complete ultimate beneficial owner information?

5.3.5 Business Activities

CQ23: What are the registered business activities of a legal entity?

CQ24: What is the status (active/inactive) of each business activity?

CQ25: Which companies operate in the same business sector?

CQ26: When was a specific business activity registered for a company?

5.3.6 Corporate Restructuring and History

CQ27: Has a legal entity undergone any organizational restructuring?

CQ28: What was the previous name of a restructured company?

CQ29: What type of restructuring occurred (merger, division, transformation)?

CQ30: What is the chronological history of changes for a given company?

5.3.7 Network Analysis and Cross-Entity Queries

CQ31: What is the network of companies connected through shared ownership?

CQ32: Which individuals appear in multiple roles (shareholder, official, beneficial owner) across different companies?

CQ33: What is the degree of separation between two legal entities through ownership or management relationships?

CQ34: Which clusters of companies exhibit patterns of coordinated control?

5.4 Concepts Identification

Based on the scenarios, personas, and competency questions, the following concepts have been identified and classified according to their popularity and relevance to the project purpose.

5.4.1 High Popularity Concepts (Core Entities)

Concept (English)	Concept (Mongolian)	Description
Legal Entity	Хуулийн этгээд	The primary entity representing registered companies and organizations
Person	Хүн	Individual persons who can be shareholders, officials, or beneficial owners
Shareholder/Member	Хувьцаа эзэмшигч/Гишүүн	Persons or entities holding ownership stakes
Authorized Representative	Итгэмжлэлгүй төлөөлөгч	Officials with authority to represent without power of attorney
Ultimate Beneficial Owner	Эцсийн өмчлөгч	The final natural person who ultimately owns or controls the entity

5.4.2 Medium Popularity Concepts (Supporting Entities)

Concept (English)	Concept (Mongolian)	Description
Business Activity	Үйл ажиллагааны чиглэл	Types of business operations registered for an entity
Position/Title	Албан тушаал	Official positions held by authorized representatives
Legal Form	Хэлбэр	The legal structure type of the entity (LLC, JSC, etc.)
Entity Type	Төрөл	Classification type of the legal entity

Concept (English)	Concept (Mongolian)	Description
Country	Улс	Country of origin for foreign shareholders

5.4.3 Low Popularity Concepts (Contextual Information)

Concept (English)	Concept (Mongolian)	Description
Restructuring Event	Өөрчлөлт	Corporate reorganization events
Address	Хаяг	Physical location of the legal entity
Classification	Ангилал	Category classification for shareholders and beneficial owners
Activity Status	Төлөв	Current status of business activities

5.4.4 Property Identification

Property (English)	Property (Mongolian)	Data Type	Applies To
Registration Number	Регистрийн дугаар	Number	Legal Entity
Name	Оноосон нэр	String	Legal Entity
Registration Date	Бүртгэсэн огноо	Date	Multiple entities
First Name	Нэр	String	Person
Patronymic	Эцэг/эх/-ийн нэр	String	Person
Gender	Хүйс	String	Person
Country Name	Улсын нэр	String	Person
Position Title	Албан тушаал	String	Authorized Representative
Activity Direction	Үйл ажиллагааны чиглэл	String	Business Activity
Status	Төлөв	String	Business Activity

Property (English)	Property (Mongolian)	Data Type	Applies To
Restructuring Type	Өөрчлөгдөн зохион байгуулсан хэлбэр	String	Restructuring Event
Previous Name	Өөрчлөлтийн өмнөх оноосон нэр	String	Restructuring Event
Change Notes	Өөрчлөлтийн тэмдэглэл	String	Restructuring Event

5.5 ER Model Definition

Based on the concepts and properties identified above, the following Entity-Relationship model has been designed to represent the purpose of the Knowledge Graph.

5.5.1 Entity Descriptions

LegalEntity - The central entity representing registered legal entities in Mongolia.

- Primary Key: registrationNumber
- Attributes: name, registrationDate, legalForm, entityType, address

Person - Represents natural persons who participate in legal entities.

- Attributes: firstName, patronymic, gender, countryName

BusinessActivity - Represents registered business activity directions.

- Attributes: activityDirection, status, registrationDate

Position - Represents official positions/titles.

- Attributes: positionTitle

RestructuringEvent - Represents corporate reorganization events.

- Attributes: restructuringType, registrationDate, previousName, changeNotes

5.5.2 Relationship Descriptions

Relationship	From Entity	To Entity	Cardinality	Attributes
hasShareholder	LegalEntity	Person	1:N	classification, registrationDate
hasAuthorizedRep	LegalEntity	Person	1:N	position, registrationDate
hasBeneficialOwner	LegalEntity	Person	1:N	classification, registrationDate
hasActivity	LegalEntity	BusinessActivity	1:N	-
hasRestructuring	LegalEntity	RestructuringEvent	1:N	-
holdsPosition	Person	Position	N:M	-

5.5.3 ER Diagram

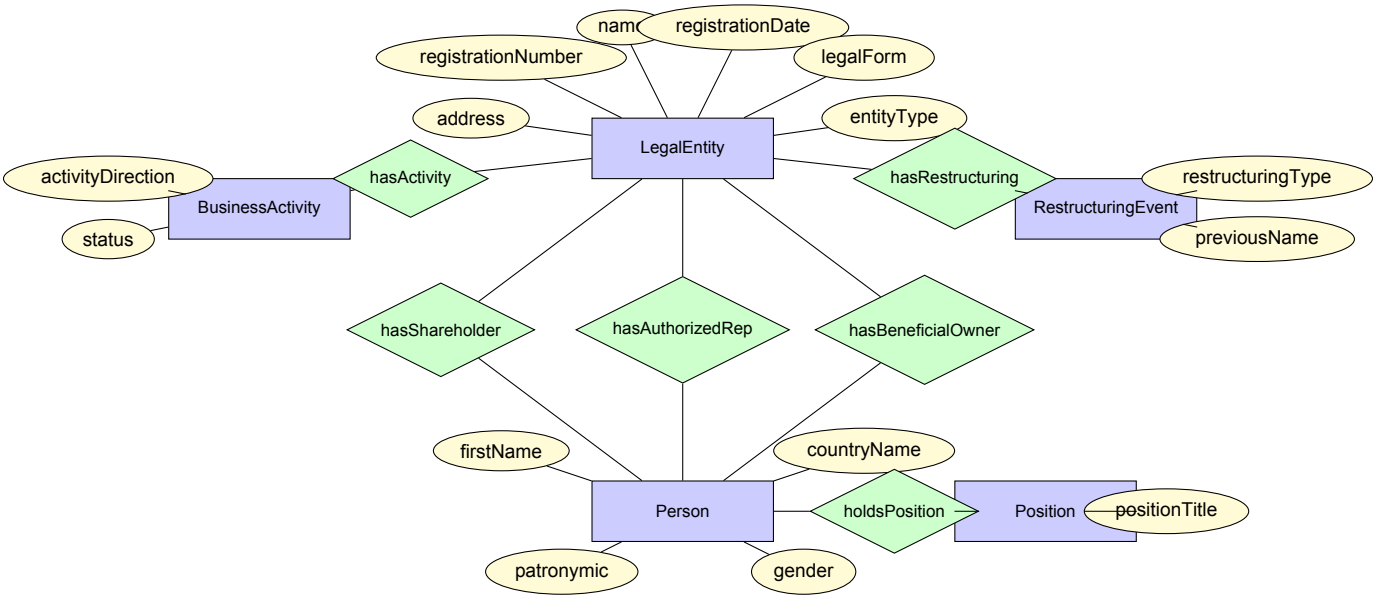

Figure 1: Entity-Relationship Diagram for Mongolian Legal Entities Knowledge Graph

5.6 Design Decisions and Rationale

5.6.1 Strengths of the Proposed Model

1. **Comprehensive Coverage**: The model captures all key aspects of the source data, including ownership, management, beneficial ownership, business activities, and corporate history.

2. **Network Analysis Support**: The design enables complex graph queries to identify relationships between entities and persons across multiple companies, supporting the investigative and analytical use cases identified in the scenarios.
3. **Temporal Tracking**: Registration dates are captured for all major relationships, enabling historical analysis and change tracking.
4. **Flexibility for Extension**: The model can be extended to incorporate Mongolian Stock Exchange data through additional entities and relationships without major restructuring.

5.6.2 Limitations and Trade-offs

1. **Person Identification**: The source data does not include unique identifiers for persons, making it challenging to definitively link the same individual across different roles and companies. Name-based matching may be required.
2. **Ownership Percentages**: The current data format does not explicitly include shareholding percentages, which limits quantitative ownership analysis.
3. **Historical Completeness**: Changes in shareholders, officials, and beneficial owners over time are not fully captured in the source data structure, limiting historical analysis capabilities.

5.6.3 Alternative Approaches Considered

1. **Single Person Entity vs. Role-Specific Entities**: We considered creating separate entities for Shareholders, Officials, and Beneficial Owners. However, the unified Person entity was chosen to better support network analysis and identify individuals appearing in multiple roles.
2. **Address as Entity vs. Attribute**: Address could be modeled as a separate entity to enable geographic analysis. This was deferred to keep the initial model simpler, but remains a candidate for future extension.

6 Information Gathering

This section aims at reporting the execution of the activities involved in the Information Gathering iTelos phase. In this section are described both the resourced selected, and the sources from which such a resources have been retrieved.

Information Gathering sub activities:

- The iTelos data Producer, in this phase, aims at collecting ”informal” resources from sources with an higher level of heterogeneity. The resources collected by the producer process are not compliant with the iTelos quality and reusability guidelines. Those are the resources that the producer will transform into quality resources at the end of the process.
  - Knowledge layer:
    - Sources description
    - Informal resources collection and scraping;
    - Informal resources classification over common, core and contextual
  - Data layer:
    - Sources description
    - Resources collection and scraping;
    - Resources classification over common, core and contextual

The report of the work done during the first phase of the methodology, has to includes also the description of the different choices made, with their strong and weak points. In other words the report should provide to the reader, a clear description of the reasoning conducted by all the different team members.

7 Language Definition

This section is dedicated to the description of the Language Definition phase. Like in the previous section, it aims to describe the different sub activities performed by all the team members, as well as the phase outcomes produced.

Language Definition sub activities:

- The iTelos data Producer, in this phase, aims at fixing the language (concepts and words) used to represent the information required to satisfy the project purpose. Moreover, in this phase, the resources collected are filtered to remove noisy resources, which are not useful to satisfy the project purpose. With this objectives, the knowledge and data resources are handled in this phase following the below activities:
  - Concept identification
  - UKC alignment
  - Dataset filtering

The report of the work done during this phase of the methodology, has to includes also the description of the different choices made, with their strong and weak points. In other words the report should provide to the reader, a clear description of the reasoning conducted by all the different team members.

8 Knowledge Definition

This section is dedicated to the description of the Knowledge Definition phase. Like in the previous section, it aims to describe the different sub activities performed by all the team members, as well as the phase outcomes produced.

Knowledge Definition sub activities:

- The iTelos data Producer, in this phase, aims at defining the knowledge structure of the information to be considered to satisfy the project purpose. More in details, the producer process, in this phase, aims at defining the knowledge structure for each dataset (thus for each entity and properties) to be formalize, singularly. The data within such datasets, are then aligned with the structure d knowledge. The above objectives should be described by the following activities.
  - Teleology definition
  - Teleontology definition
  - Dataset cleaning and formatting

The report of the work done during this phase of the methodology, has to includes also the description of the different choices made, with their strong and weak points. In other words the report should provide to the reader, a clear description of the reasoning conducted by all the different team members.

9 Data Definition

This section is dedicated to the description of the Data Definition phase. Like in the previous section, it aims to describe the different sub activities performed by all the team members, as well as the phase outcomes produced. In this phase the knowledge and data layers, composing the final KG, are merged to form a single data structure. The obtained result is a structured Knowledge Graph including both the two layers, and implicitly the language layer composed by the concepts and terms adopted to define the KG's teleontology.

Data Definition sub activities:

- The iTelos data Producer, in this phase, aims at merging the knowledge layer of a single dataset with the data values present within such a dataset, for each dataset collected. During this operation, the Producer has to consider the identification of the entities within each datasets, and, if different representation of the same entity exist, the Producer has to merge them. The above objectives should be described by the following activities.
  - Entity identification
  - Data mapping

The report of the work done during this phase of the methodology, has to includes also the description of the different choices made, with their strong and weak points. In other words the report should provide to the reader, a clear description of the reasoning conducted by all the different team members.

10 Evaluation

This section aims at describing the evaluation performed at the end of the whole process (producer plus consumer) over the final outcome of the iTelos methodology. More in details, this section as to report:

- the final Knowledge Graph information statistics (like, number of etypes and properties, number of entities for each etype, and so on).
- Knowledge layer evaluation: the results of the application of the evaluation metrics applied over the knowledge layer of the final KG.
- Data layer evaluation: the results of the application of the evaluation metrics applied over the data layer of the final KG.
- Query execution: the description of the competency queries executed over the final KG in order to test the suitability of the KG to satisfy the project purpose.

11 Metadata Definition

In this section the report collects the definitions of all the metadata defined for the different resources produced along the whole process (producer and consumer). The metadata defined in this phase describes both the final outcome of the project, and the intermediate

outcome of each phase.

The definition of the metadata, is crucial to enable the distribution (sharing) of the resource produced. For this reason it is important to describe also where such metadata will be published to distribute the resources it describes (for example the DataScientia catalogs).

In particular the structure of this section is organized as follows, with the objective to describe the metadata relative to all the type of resources produced by the project.

- Language resources metadata description
- Knowledge resources metadata description
- Data resources metadata description

12 Open Issues

This section concludes the current document with final conclusions regarding the quality of the process and final outcome, and the description of the issues that (for lack of time or any other cause) remained open.

- Did the project respect the scheduling expected in the beginning ?
- Are the final results able to satisfy the initial Purpose ?
  - If no, or not entirely, why ? which parts of the Purpose have not been covered ?

Moreover, this section aims to summarize the most relevant issues/problems remained open along the iTelos process. The description of open issues has to provide a clear explanation about the problems, the approaches adopted while trying to solve them and, eventually, any proposed solution that has not been applied.

- which are the issues remained open at the end of the project ?