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KG 2025 - Project Report

Sport Facilities and Transportation

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1 Introduction

The present document aims to provide a detailed report of the project developed following the iTelos methodology.

The main theme on which the entire project is based concerns Sports Facilities and the Transportation connected to them.

The report is structured to describe:

- Section 2: Definition of the project's purpose and its domain of interest.
High level description of the project's development and related information gathering, based on the Produce role's objectives.
- Section 3, 4, 5: The description of the iTelos process phases and their activities, divided by knowledge and data layer activities, as well as the evaluation of the resources produced in terms of fit for the chosen purpose.
- Section 6: The description of the evaluation criteria and metrics applied to the project's final outcome.
- Section 7: The description of the metadata produced for all (and all kind of) the resources handled and generated by the iTelos process, while executing the project.
- Section 8: Conclusions and open issues summary.

2 Purpose Definition

This section outlines the main purpose on which the entire project is based.

The following definitions are provided:

- **Informal Purpose:** a general description of the purpose of this project in natural language that defines the objective for which the iTelos methodology is applied.
The *Domain of Interest* of the entire project is extrapolated from this definition.
- **Formal Purpose:** defines various activities that allow the Informal Purpose to be formalized, in order to extract and describe the requirements that will be used in the subsequent phases of the project's implementation.

2.1 Informal Purpose

This section introduces the *Informal Purpose*, which outlines the project's area of interest.

The purpose of this project is to engineer a Knowledge Graph which models various sport facilities and the ways and means to commute to-and-from such facilities within a territory.

The geographic area covered is Trentino, a region in northern Italy, while the time frame considered in the project focuses on current or at least more recent data.

The implementation of this project will allow a simple but effective overview of the sports facilities in Trentino, how to reach them and whether they are easily accessible.

2.2 Formal Purpose

This section introduces the *Formal Purpose* of the project, which consists of the following activities:

- Personas & Scenarios Definition
- Competency Questions Definition
- Concepts Identification
- ER Modelling

2.2.1 Personas & Scenarios

This activity defines the actors considered for the project, describing the characteristics of each of them and matching them to the different spatial and temporal contexts specified in the *Domain of Interest*.

For this project, four different actors have been hypothesized:

Actor 1

Information	
ID	1
Age	14
Sex	M
Occ.	Student
Driver	✗
Sport	Football Swimming

Differentiator

Actor 1 is a 14-year-old middle school student who plays soccer and swims. He lives in Stenico, where public transportation is very limited compared to the regional capital or other locations. He plays soccer twice a week and swims only once a week.

Technological Resources

PC, Smartphone

Needs

Autonomy, Safety

Purposes

Actor 1 would like to have more choices when it comes to transportation.

Actor 2

Information	
ID	2
Age	18
Sex	F
Occ.	Student
Driver	✗
Sport	Volleyball

Differentiator

Actor 2 is an 18-year-old girl who lives in Rovereto. She plays volleyball semi-professionally, training four times a week plus matches on weekends.

Technological Resources

PC, Smartphone, SmartWatch, Tablet

Needs

Comfort, Safety, Security, Work

Purposes

Living in a big city, *Actor 2* would like to have transport timetables as she is concerned about her safety at night.

Actor 3

Information	
ID	3
Age	24
Sex	M
Occ.	Student
Driver	✓
Sport	Gym

Differentiator

Actor 3 is a 24-year-old university student who studies in the city center of Trento but lives outside the city. After classes, he goes to the gym in the industrial area of Trento every day. *Actor 3* has a driver's license but does not have his own vehicle.

Technological Resources

PC, Smartphone

Needs

Financial, Habit, Time

Purposes

Actor 3 would like to move house as it is difficult for him to get around.

Actor 4

Information	
ID	4
Age	49
Sex	M
Occ.	Bus Driver
Driver	✓
Sport	Padel Gym

Differentiator

Actor 4 is a 49-year-old bus driver who lives in Cavalese. He drives the route connecting Trento with Val di Fiemme, covering many kilometers every day. Actor 4 tries to go to the gym several times a week, while on weekends he plays padel.

Technological Resources

Smartphone

Needs

Energy, Time

Purposes

Actor 4 would like an app to book padel courts at the weekend.

The following scenarios have been formalized for the respective actors:

Scenario 1



I would like to move house because where I currently live is not well connected to the city's various public transport services. Every day I have to change at least three means of transportation to reach the city center and the places where I practice my hobbies. Unfortunately, housing prices near these locations are very high and I cannot afford them. It would be enough for me to find a house near the industrial area, as that part is well connected to everything.

Scenario 2



Because of my job, I spend a lot of time on the road every day. This drains my energy and prevents me from enjoying my hobbies as much as I would like. Furthermore, when I do manage to find time to relax, I can't find places where I can enjoy my favorite pastimes. It would be nice to have a way to organize myself in advance.

Scenario 3



I exercise almost every day, and sometimes our training sessions end very late. I often have to take the bus home, and at certain times of day, let's say it's not very pleasant, especially in winter when it gets dark early. I always try to arrange for someone to pick me up or give me a lift, but unfortunately this is not always possible. Therefore, it would be nice to have better planning of the various transport timetables, so that can be sure of arriving at the stops on time and not having to wait alone.

Scenario 4



I play a lot of sports, but unfortunately I live in a small mountain village and to get to the various training locations I have to organize myself very well to arrive on time. All of this is very tiring and is taking away from my study time. I hope that sooner or later they will be able to increase the number of buses that pass through the village or even build new sports centers near me.

2.2.2 Competency Question Definition

This section defines the *Competency Questions* (CQs), which are a list of questions in natural language.

Each question represents a possible need or problem that must be addressed within the final KG, and each of these questions is linked to a Person in a specific Scenario.

For this project, the following Competency Questions were defined:

1. Where are the main sports facilities located in Trentino?
2. What sports can be practiced at each sports facility?
3. What is the capacity (number of seats) of each sports facility?
4. Which sports facilities are currently open, closed, or undergoing renovation?
5. Which sports facilities regularly host a specific team or association?
6. Which sports facilities require reservations?
7. Which sports facilities are accessible to people with disabilities?
8. What additional services does a sports facility offer?
9. Which public transport options are available to reach a specific sports facility?
10. What is the closest public transport stop to a sports facility?
11. What is the average travel time by public transport to a facility?
12. Are there bike paths connecting a sports facility to the rest of the city?
13. Which sports facilities are located near a specific urban area?
14. How can I travel from my town to a ski resort using public transportation?
15. Which sports venues are accessible by bike or on foot?
16. Are there any sports facilities that are difficult to access due to limited transportation?
17. What are the opening and closing times of sports facilities?

2.2.3 Concepts Identification

The third activity is *Concept Identification*.

From the Competency Questions formalized in the previous section, all concepts that identify the entities (and their properties) that will be modeled within the final KG are extracted.

Scenarios	Personas	CQs	Entities	Properties	Focus
1	3	9, 10, 11, 13, 15, 16	Sport Facility	id, name, type, address, city, capacity, status, accessibility, timetable, walk_by	Contextual
-	-	-	Bus	id, code, capacity, accessibility, status, alimentation, year	Core
-	-	-	Bus Stop	id, name, address, city, coverage, shelter, information_table	Core
-	-	-	Bike	id, code, capacity, accessibility, status, type	Core
-	-	-	Route	id_route, duration, length, timetable	Core
2	4	2, 3, 4, 6, 8, 11, 17	Service	id, name, type, description, timetable, cost, status	Common
-	-	-	App	id, name, version, developer, o_s, type	Common
-	-	-	Reservation	id, date, time, number_people, status, payment	Common
3	2	5, 8, 9, 10, 13, 17	Train	id, code, capacity, accessibility, status, coaches_number, type, construction_year	Core
-	-	-	Train Station	id, name, address, city, coverage, waiting_room, parking_spots	Core
-	-	-	Team	id, name, type, foundation_year, athlete_number, president	Common
-	-	-	Sport	name, type, equipment, players_number	Contextual
-	-	-	Athlete	code, name, age, sex, occupation, driver	Core
4	1	1, 2, 4, 9, 10, 11, 16	Stop	id, name, address, city, coverage	Contextual
-	-	-	Means of Transport	id, code, capacity, accessibility, status	Contextual

Table I: Identifying Entity Types

Scenarios	Personas	CQs	Common Entities	Core Entities	Contextual Entities
1	3	Which public transport options are available to reach a specific sports facility?			Sport Facility
1	3	What is the closest public transport stop to a sports facility?		Bus Stop	Sport Facility
1	3	What is the average travel time by public transport to a facility?		Bus Stop, Route	Sport Facility
1	3	Which sports facilities are located near a specific urban area?		Bus Stop, Route	Sport Facility
1	3	Which sports venues are accessible by bike or on foot?		Bus Stop, Route, Bike	Sport Facility
1	3	Are there any sports facilities that are difficult to access due to limited transportation?		Bus Stop, Route, Bike	Sport Facility
2	4	What sports can be practiced at each sports facility?		Bus Stop, Route, Bike	Sport Facility
2	4	What is the capacity (number of seats) of each sports facility?		Bus Stop, Route, Bike	Sport Facility
2	4	Which sports facilities are currently open, closed, or undergoing renovation?		Bus Stop, Route, Bike	Sport Facility
2	4	Which sports facilities require reservations?	Reservation	Bus Stop, Route, Bike	Sport Facility
2	4	What additional services does a sports facility offer?	Reservation, Service, App	Bus Stop, Route, Bike	Sport Facility
2	4	What is the average travel time by public transport to a facility?	Reservation, Service, App	Bus Stop, Route, Bike	Sport Facility
2	4	Quali sono gli orari di apertura e chiusura degli impianti sportivi?	Reservation, Service, App	Bus Stop, Route, Bike	Sport Facility

3	2	Which sports facilities regularly host a specific team or association?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete	Sport Facility, Sport
3	2	What additional services does a sports facility offer?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete	Sport Facility, Sport
3	2	Which public transport options are available to reach a specific sports facility?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train	Sport Facility, Sport
3	2	What is the closest public transport stop to a sports facility?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport
3	2	Which sports facilities are located near a specific urban area?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport
3	2	What are the opening and closing times of sports facilities?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport
4	1	Where are the main sports facilities located in Trentino?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport
4	1	What sports can be practiced at each sports facility?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport
4	1	Which sports facilities are currently open, closed, or undergoing renovation?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport
4	1	Which public transport options are available to reach a specific sports facility?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport, Means of Transport
4	1	What is the closest public transport stop to a sports facility?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport, Means of Transport, Stop
4	1	What is the average travel time by public transport to a facility?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport, Means of Transport, Stop
4	1	Are there any sports facilities that are difficult to access due to limited transportation?	Reservation, Service, App, Team	Bus Stop, Route, Bike, Athlete, Train, Train Station	Sport Facility, Sport, Means of Transport, Stop

Table II: Concept Identification Focus

2.2.4 ER Modelling

The fourth activity is *ER Modelling*.

The goal of this section is to finalize the definition of the *Formal Purpose* by modelling an ER model using the concepts representing ETypes and properties.

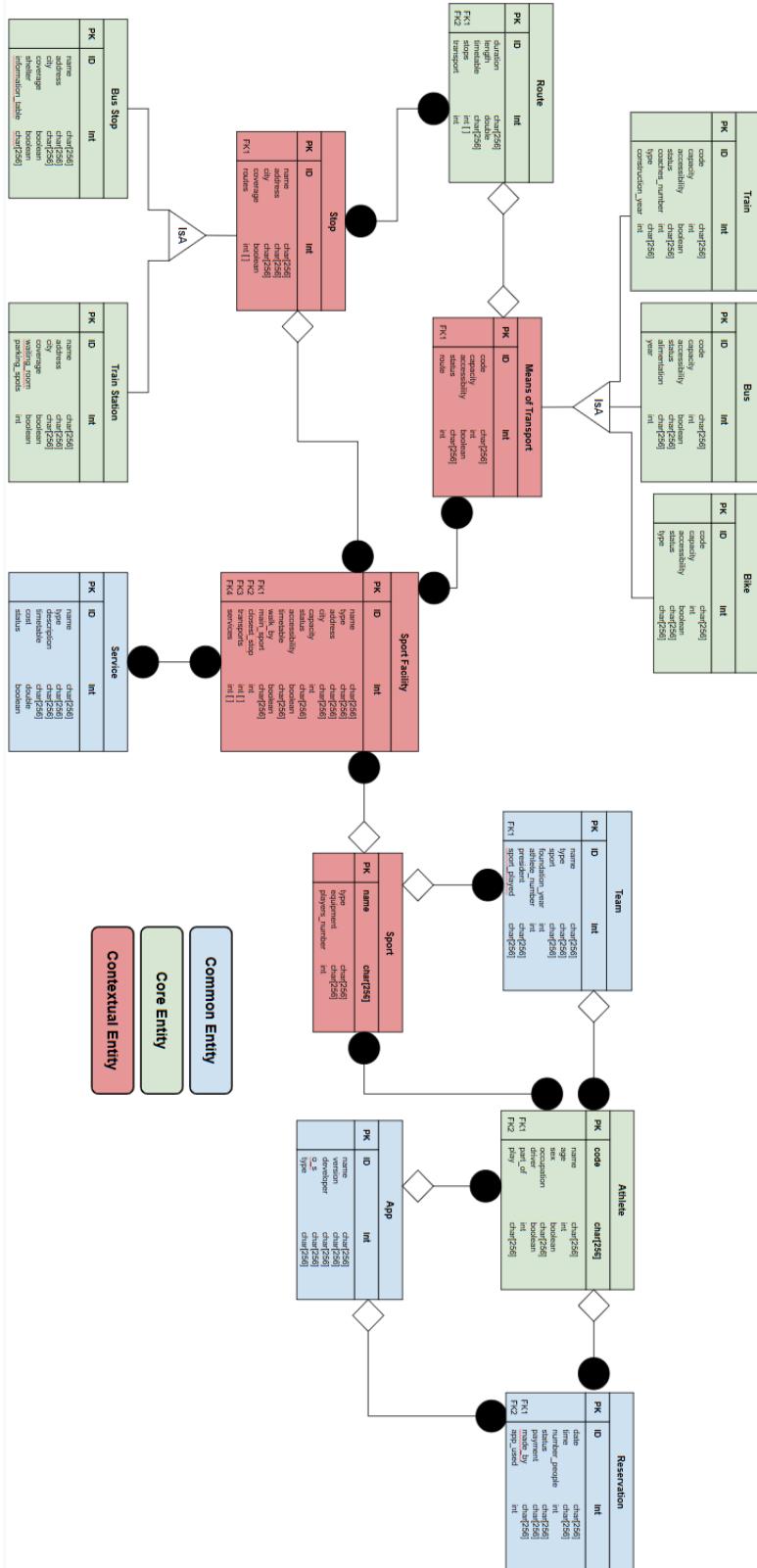


Image I: Informal ER Model

2.3 Information Gathering

This section focuses on collecting all the resources and data required for the construction of the final KG.

In this phase, the collected datasets are also improved in terms of quality and reusability, reducing noise.

The first activity in this section aims to identify and access all the necessary information. For this project, the following datasets were downloaded (the geographical area of reference is Trentino):

- Sport Facilities: downloaded from [Overpass Turbo](#)
- Road Network: [Carte della Provincia Autonoma di Trento](#)
- Bus Routes (urban and suburban): downloaded from [OpenData](#)
- Bus Stops (urban and suburban): downloaded from [OpenData](#)
- Railway Network: downloaded from [Carte della Provincia Autonoma di Trento](#)
- Train Routes (regional): downloaded from [Overpass Turbo](#)
- Train Stations: downloaded from [OpenData Trentino](#)
- Cycle and Pedestrian Network: downloaded from [Carte della Provincia Autonoma di Trento](#) and from the [Geocatalogo della Provincia autonoma di Trento](#)
- Sports Associations: downloaded from [Agenzia per la Coesione Sociale](#)

Each of these datasets was then converted into a .csv file, so that all the attributes of each defined entity could be identified.

Specifically, the following attributes are defined:

- **Identifying Attributes:** they're the unique data elements that distinguish and disambiguate one instance of an entity type from another. In short, they're data fields that provide unique identity to each entity instance
- **Descriptive Attributes:** they're the key facts or characteristics that describe an entity type. In short, they're direct answers sought about the entity itself, not its relationships.

Entity	Primary	Secondary
Sport Facility	alphanumeric string id	name of the sport facility
Bus Roads	integer id	
Bus Lines (urban and extraurban)	alphanumeric string id	
Bus Stops (urban and extraurban)	alphanumeric string id	
Train Railway	integer id	
Train Lines	alphanumeric string id	name of the line
Train Stations	alphanumeric string id	name of the station
Bike Lines	integer id	route name
Associations	name of the association/team	

Table III: ER Identifying Attributes Definition

2.3.1 sport_facilities.csv

Attributes	Description
<i>sportfacility_city</i>	city of the sport facility
<i>sportfacility_address</i>	address of the sport facility
<i>sportfacility_type</i>	type of the sport facility
<i>sportfacility_status</i>	status of the sport facility
<i>sportfacility_capacity</i>	capacity of the sport facility
<i>sportfacility_accessibility</i>	accessibility of the sport facility
<i>sportfacility_timetable</i>	time table of the sport facility
<i>sportfacility_walkby</i>	accessibility on foot of the sport facility

Table IV: sport_facilities

2.3.2 bus_roads.csv

Attributes	Description
<i>road_type</i>	type of the road
<i>road_description</i>	description of the road
<i>road_notes</i>	notes about the road
<i>road_speedlimit</i>	speed limit of the road

Table V: bus_roads

2.3.3 Bus Lines (urban and suburban)

Attributes	Description
<i>busline_length</i>	length of the bus line
<i>busline_time</i>	travel time of the bus line
<i>busline_routenumber</i>	route number of the bus line
<i>busline_calendar</i>	calendar of the bus line
<i>busline_stops</i>	stops of the bus line
<i>busline_stopstime</i>	stop schedule of the bus line
<i>busline_wheelchairboarding</i>	access for the wheelchairs

Table VI: bus_lines_#

2.3.4 Bus Stops (urban and suburban)

Attributes	Description
<i>stop_name</i>	name of the stop
<i>stop_address</i>	address of the stop
<i>stop_city</i>	city of the stop
<i>stop_coverage</i>	coverage of the stop
<i>stop_description</i>	description of the stop
<i>stop_wheelchairboarding</i>	access for the wheelchairs

Table VII: bus_stops_#

2.3.5 train_railway.csv

Attributes	Description
<i>railway_type</i>	type of the railway
<i>railway_description</i>	description of the railway
<i>railway_notes</i>	notes about the railway
<i>railway_voltage</i>	voltage of the railway

Table VIII: train_railway

2.3.6 train_lines.csv

Attributes	Description
<i>trainline_length</i>	length of the trainline
<i>trainline_time</i>	travel time of the trainline
<i>trainline_bridge</i>	bridge/s of the trainline
<i>trainline_covered</i>	coverage of the trainline
<i>trainline_electrified</i>	electronic alimentation of the trainline
<i>trainline_maxspeed</i>	trainline max speed

Table IX: train_lines

2.3.7 train_stations.csv

Attributes	Description
<i>station_name</i>	name of the station
<i>station_address</i>	address of the station
<i>station_city</i>	city of the station
<i>station_coverage</i>	coverage of the station
<i>station_manager</i>	manager of the station
<i>station_railway</i>	railway of the station

Table X: train_stations

2.3.8 bike_lines.csv

Attributes	Description
<i>bikeline_type</i>	type of the bike line
<i>bikeline_description</i>	description of the bike line
<i>bikeline_notes</i>	notes about the bike line
<i>bikeline_level</i>	level of the bike line
<i>bikeline_position</i>	position of the bike line
<i>bikeline_manager</i>	manager of the bike line
<i>bikeline_flooring</i>	flooring of the bike line

Table XI: bike_lines

2.3.9 sport_associations.csv

Attributes	Description
<i>sportassociation_address</i>	address of the sport association
<i>sportassociation_postcode</i>	postcode number of the sport association
<i>sportassociation_city</i>	city of the sport association
<i>sportassociation_type</i>	type of the sport association
<i>sportassociation.foundationyear</i>	foundation year of the sport association
<i>sportassociation_president</i>	president of the sport association
<i>sportassociation_category</i>	category of the sport association

Table XII: sport_associations

3 Language Definition

This activity process aims at defining the purpose-specific domain language resource for the current iTelos execution.

Based on the results of the *Purpose Definition* and requirements analysis, a set of relevant terms was collected to describe sports facilities, associated services, and urban and extra-urban transport systems.

The terms collected were analyzed to identify domain classes, relationships, and descriptive properties.

At this stage, language normalization was also performed, eliminating ambiguities and synonyms to ensure consistent representation of the same concepts throughout the project.

Subsequently, the identified concepts were compared with the existing *Language Teleontology* (LTLO).

Classes	Object Properties	Data Properties
sport_facility bus_road train_railway stop bus_stop (urban and suburban) train_station mean_of_transport bike bus train route bike_line bus_line (urban and suburban) train_line association athlete service app reservation sport	is_a has_sportfacility has_sport has_meanoftransport has_stop has_service has_route has_association has_athlete has_app has_reservation has_path	id name code address city postcode type status description category capacity accessibility length time notes timetable equipment coverage president age sex occupation driver cost players_number foundation_year walk_by

Table XIII: Language Teleontology (LTLO)

Each term was evaluated: if already present in the LTLO, it was aligned with the formalized concept, while new concepts were added consistently within the teleontological hierarchy.

This *Concept Alignment* process ensures that the project terminology is formally defined and compatible with the iTelos methodology.

At the end of this phase, the LTLO.owl file was created using *Protégé*, containing all the classes, properties, and relationships that make up the project language.

This resource represents the formal basis for the next phase, *Knowledge Definition*, in which the elements of knowledge actually needed to model the domain will be identified.

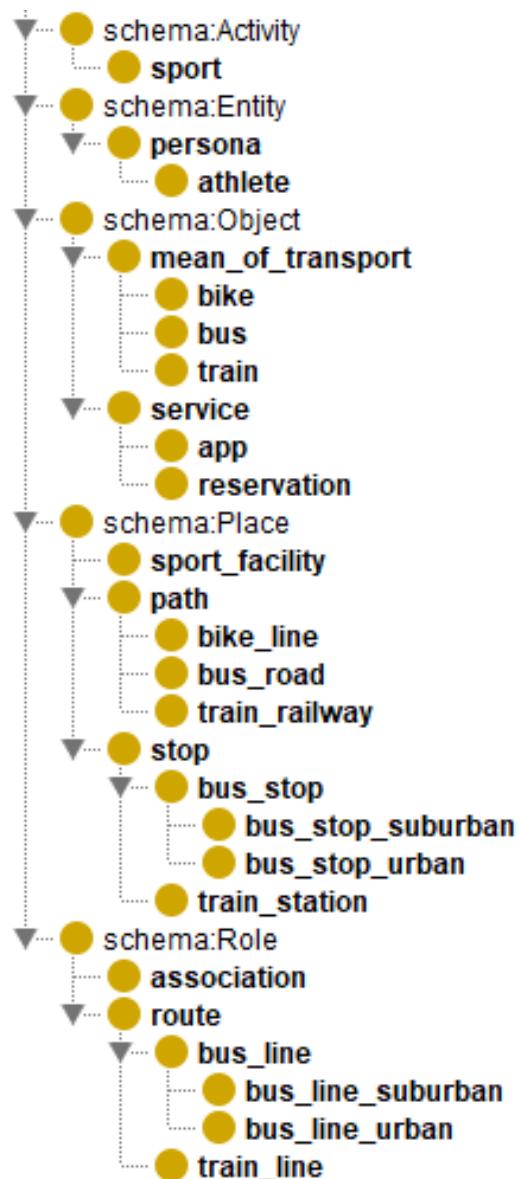


Image II: LTLO in Protégé

4 Knowledge Definition

The *Knowledge Definition* phase aims to precisely define the knowledge that the Knowledge Graph must represent.

Starting from the results of the *Purpose Definition* and *Language Definition* phases, we identified the entities relevant to the domain of sports facilities and transportation, their main properties, and the relationships between them.

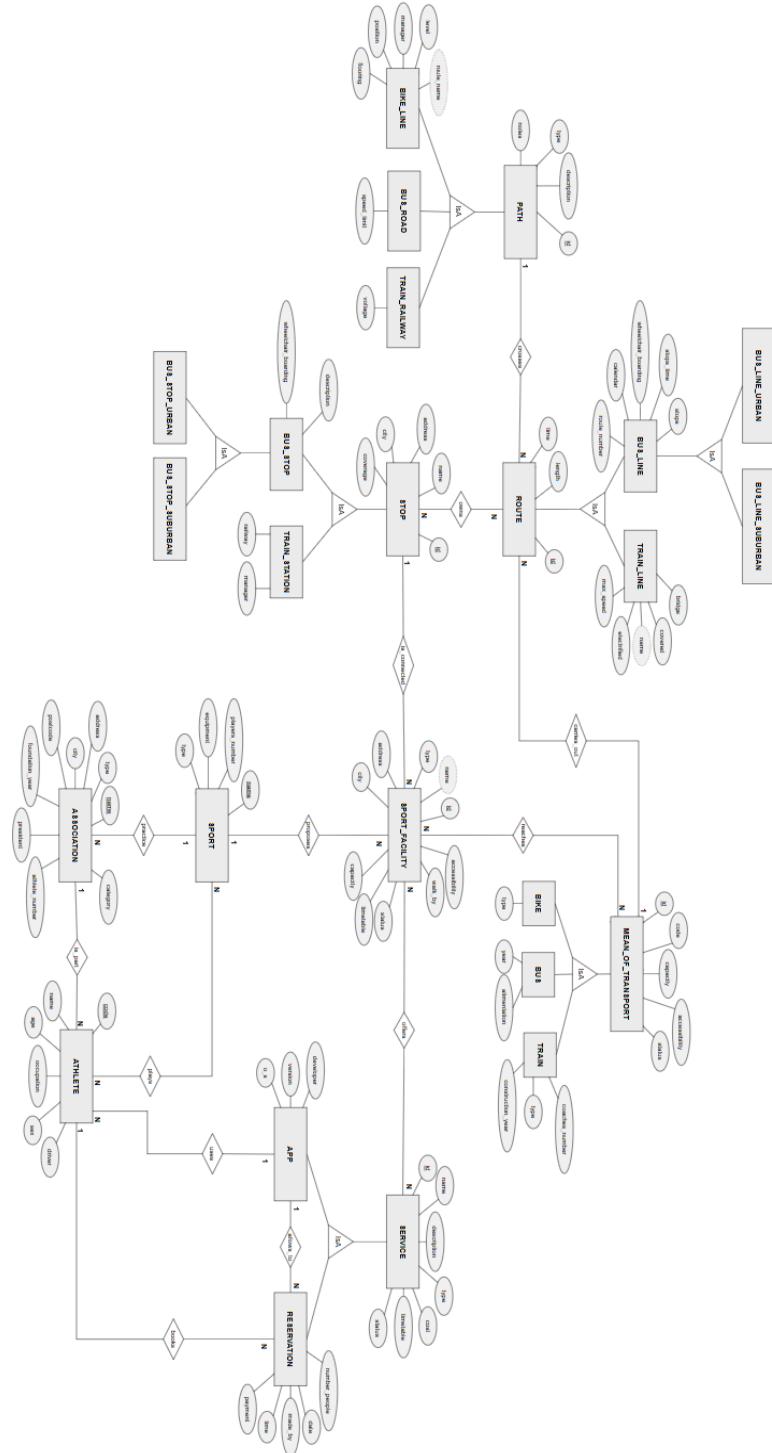


Image III: EER Model

In this phase, we also analyzed existing knowledge models (KSMs), such as ontologies in the domains of transportation, geolocation, and sports infrastructure, with the aim of reusing established classes, properties, and patterns.

By selecting and composing these ontological fragments, we built the project's *Knowledge Teleontology* (KTLO), a modular ontology that formally represents the knowledge domain.

Module	Classes	Object Properties
Infrastructure	sport_facility path stop	has_sportfacility has_meanoftransport has_route has_stop is_a
Transport	mean_of_transport route	has_sportfacility has_meanoftransport has_route has_path has_stop is_a
Actor	association persona	has_sport has_athlete has_association has_app has_reservation
Activity	service sport	has_sportfacility has_athlete has_association is_as

Table XIV: Knowledge Teleontology (KTLO)

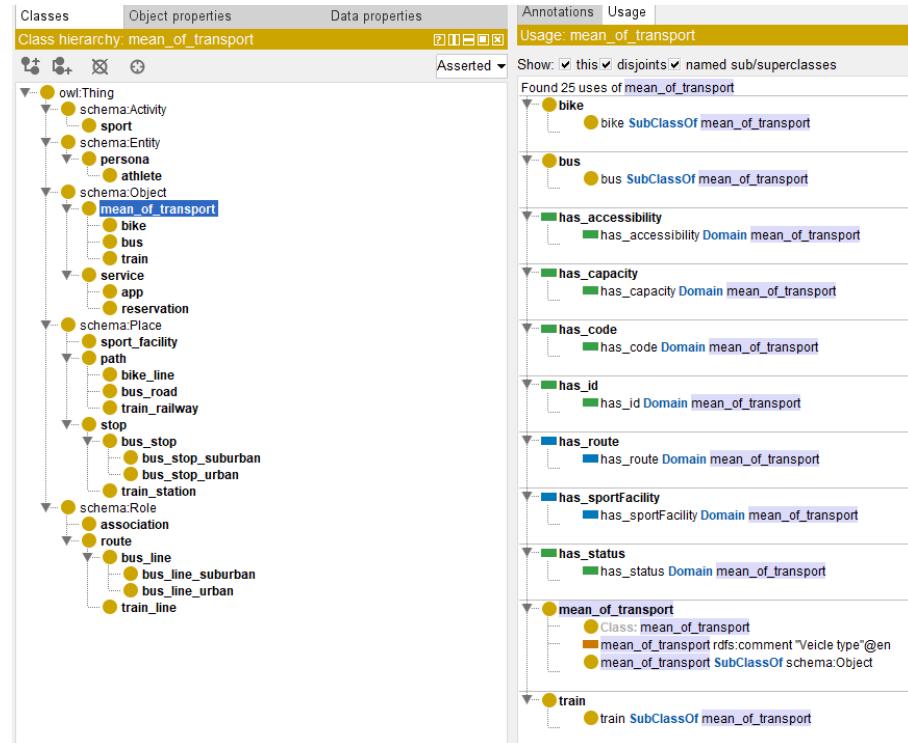


Image IV: Knowledge Teleontology (KTLO) in Protégé

Subsequently, alignment with the iTelos conceptual scheme was carried out, mapping the entities identified in the fundamental categories of the framework (Entity, Object, Activity, Place, Time, Role).

This step ensures consistency with the methodology and complete coverage of the *Competency Questions* formulated in the previous phase.

Entity	Category	Motivation
sport_facility	Place	physical structure
mean_of_transport	Object	physical transportation
path	Place	physical link
route	Role	working connection
stop	Place	physical stop
sport	Activity	abstract activity
association	Role	group that practices sports
persona	Entity	physical person
service	Object	part of the facility

Table XV: Schema Alignment iTelos

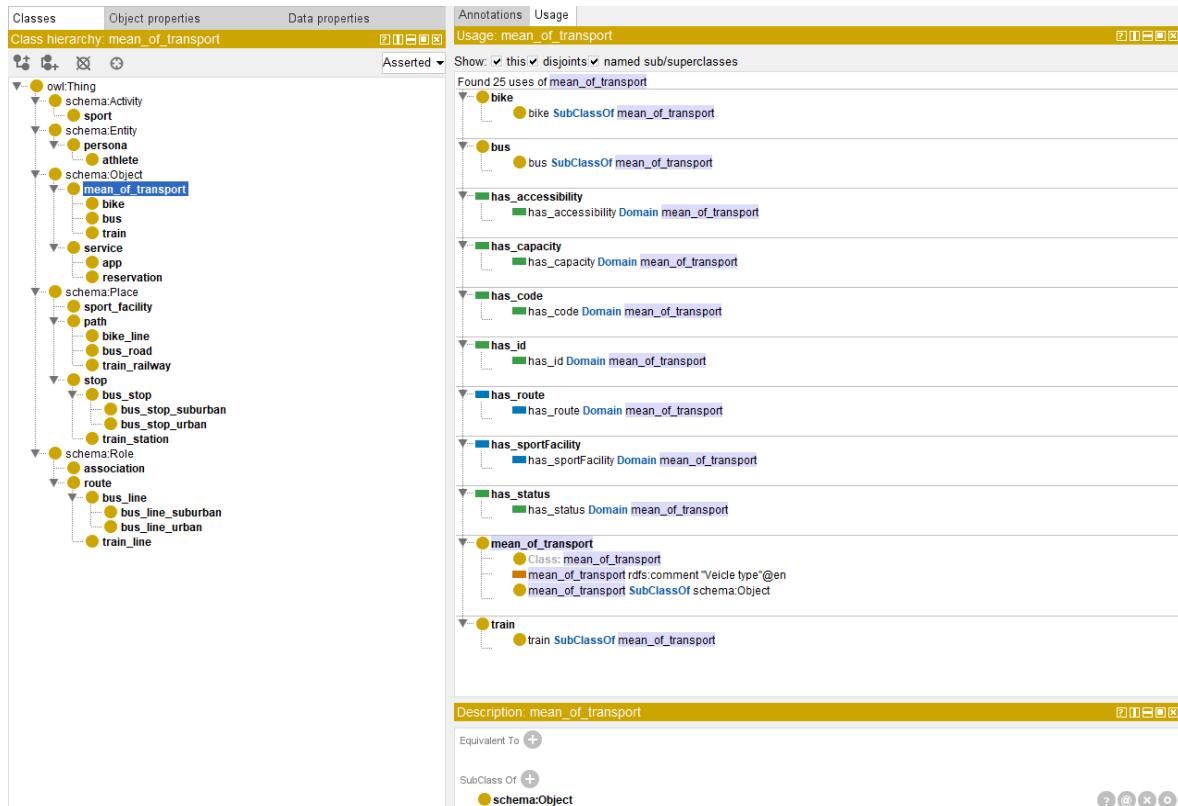


Image V: Teleology

These elements form the formal basis for the subsequent *Entity Definition* phase and guide the construction of the final Knowledge Graph.

5 Entity Definition

The *Entity Definition* phase aims to precisely identify the entities that will populate the Knowledge Graph and establish how they will be extracted from the available datasets.

This phase follows the results of the *Knowledge Definition* phase and is divided into three sub-phases:

- *Entity Matching*
- *Entity Identification*
- *Entity Mapping*

In the *Entity Matching* step, all the datasets available for the project were analyzed, such as data on sports facilities, urban and extra-urban public transport datasets, lists of sports associations, and other territorial data.

From each dataset, candidate entities were identified, i.e., possible classes that represent useful information with respect to the objective of the Knowledge Graph.

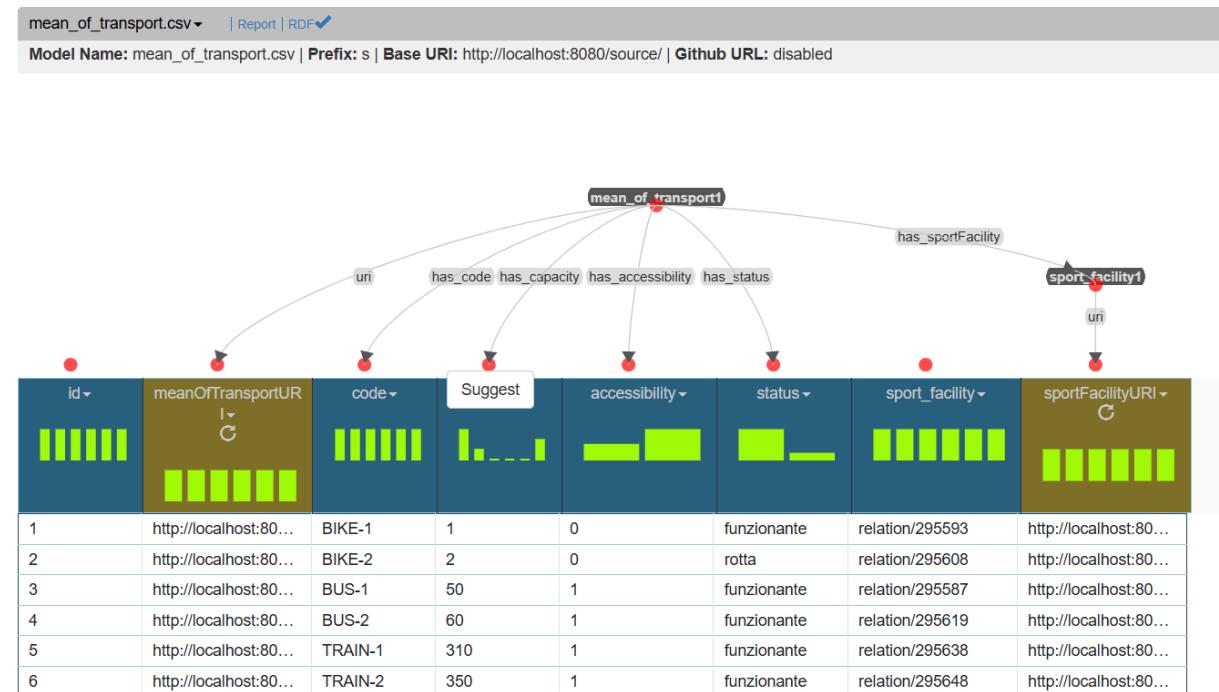


Image VI: Entity Mapping of Mean of Transport

In the *Entity Identification* step, the candidate entities were evaluated, consolidated, and organized.

Some entities were confirmed, others merged, and still others divided into subclasses when necessary (for example, distinguishing between bus stops and train stations).

For each entity, a description, main attributes, and internal hierarchies were defined, thus obtaining the final list of entities in the Knowledge Graph.

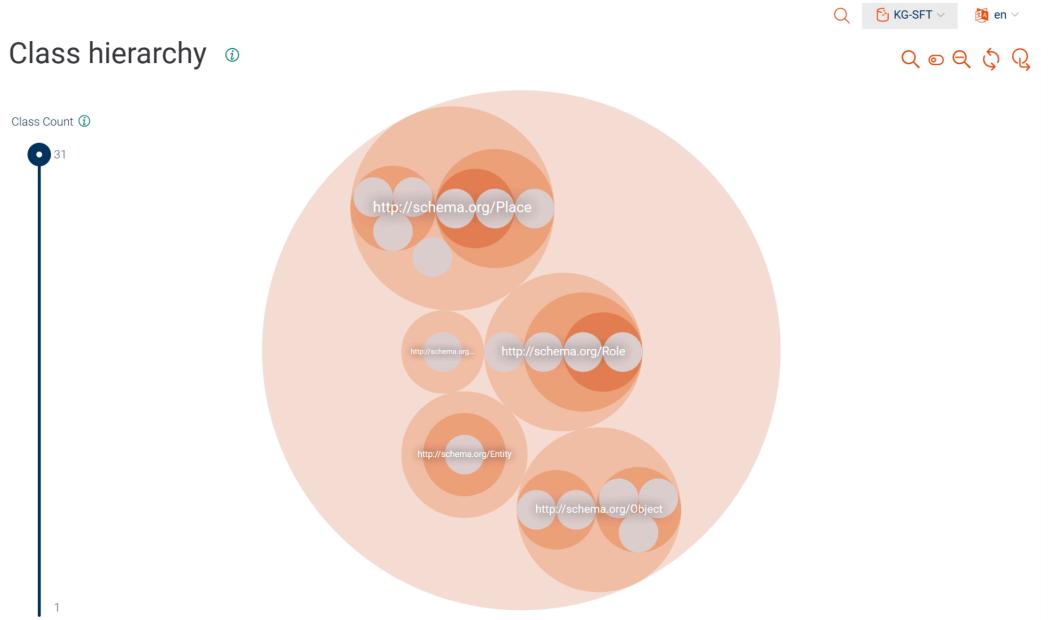


Image VII: Class Hierarchy in GraphDB

Finally, in the *Entity Mapping* step, the link between each entity and the actual datasets was defined.

The fields of the datasets that populate the entity attributes were identified, building mapping tables that allow raw data to be transformed into instances consistent with the ontological model.

This step allows us to establish how data will be extracted, integrated, and loaded into the Knowledge Graph.

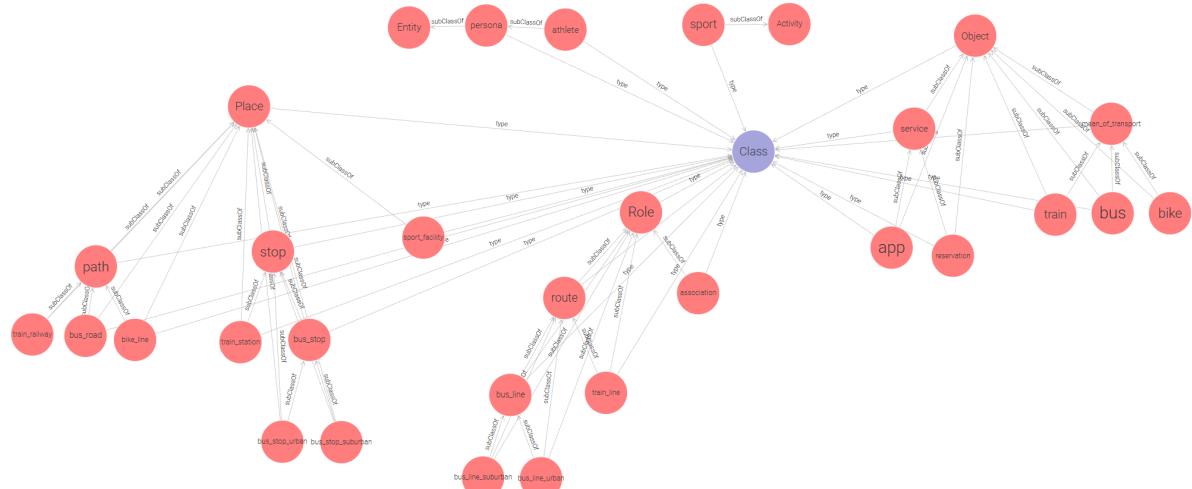


Image VIII: Visualization Diagram in GraphDB

These elements form the operational basis for creating instances and building the Knowledge Graph in the next phase.

```
COMPETENCY QUESTIONS (NATURAL LANGUAGE) TO COMPETENCY QUERIES (SPARQL)
-----
PREFIX sft: <http://www.semanticweb.org/KG-SFT#>
-----

CQ1. Where are the main sports facilities located in Trentino?

SELECT
  (REPLACE(STR(?sport_facility), "http://localhost:8080/source/SportFacility/", "") AS ?id)
  ?city ?address
WHERE {
  ?sport_facility a sft:sport_facility ;
    sft:has_city ?city ;
    sft:has_address ?address .
}

CQ2. What sports can be practiced at each sports facility?

SELECT
  (REPLACE(STR(?sport_facility), "http://localhost:8080/source/SportFacility/", "") AS ?id)
  (REPLACE(STR(?sport), "http://localhost:8080/source/Sport/", "") AS ?sport_name)
WHERE {
  ?sport_facility a sft:sport_facility ;
    sft:has_sport ?sport .
}

CQ3. What is the capacity (number of seats) of each sports facility?
```

Image IX: CQs in Sparql

6 Evaluation

Following the definition of the purpose, language, knowledge, and entities of the Knowledge Graph, the *Evaluation* phase was carried out according to the iTelos methodology.

The objective of the evaluation is to verify the extent to which the work carried out is consistent with the requirements defined by the *Competency Questions* and with the reference terminology of the *Language Teleontology*.

6.1 Purpose Evaluation

For the *Purpose Evaluation*, the skills required by the CQs were compared with the available datasets.

Both the coverage of the CQs with respect to the datasets and the coverage of the dataset with respect to the CQs were calculated in order to verify that the data used are necessary, sufficient, and relevant to the purpose of the project.

Competency Question Number	Competency Question	Requirement	Entity	Property	Dataset	Dataset Field	Present	Notes
1	Where are the main sports facilities located in Trentino?	sport facility name	Sport Facility	name	sport_facilities.csv	name	Y	
1	Where are the main sports facilities located in Trentino?	sport facility address	Sport Facility	address	sport_facilities.csv	address	Y	
1	Where are the main sports facilities located in Trentino?	sport facility city	Sport Facility	city	sport_facilities.csv	city	Y	
2	What sports can be practiced at each sports facility?	type of the sport facility (e.g. gym, stadium)	Sport Facility	type_structure	sport_facilities.csv	type	Y	
2	What sports can be practiced at each sports facility?	sport name	Sport	name	missing	N	Missing dataset	
2	What sports can be practiced at each sports facility?	equipment of the sport	Sport	equipment	missing	N	Missing dataset	
3	What is the capacity (number of seats) of each sport facility?	capacity of the sport facility	Sport Facility	capacity	sport_facilities.csv	capacity	Y	
4	Which sports facilities are currently open, closed, or undergoing renovation?	status of the sport facility	Sport Facility	status	sport_facilities.csv	status	Y	Field not complete
5	Which sports facilities regularly host a specific team or association?	association name	Association	name	sport_associations.csv	name	Y	
5	Which sports facilities regularly host a specific team or association?	type of the association (e.g. association, team)	Association	type	sport_associations.csv	type	Y	
6	Which sports facilities require reservation?	reservation id	Reservation	id	missing	N	Missing dataset	
6	Which sports facilities require reservation?	number of people for the reservation	Reservation	number_people	missing	N	Missing dataset	
7	Which sports facilities are accessible to people with disabilities?	accessibility of the sport facility	Sport Facility	accessibility	sport_facilities.csv	accessibility	Y	Field not complete
7	Which sports facilities are accessible to people with disabilities?	accessibility by foot of the sport facility	Sport Facility	walk_accessibility	sport_facilities.csv	walk_by	Y	Field not complete
8	What additional services does a sports facility offer?	service name	Service	name	missing	N	Missing dataset	
9	Which public transport options are available to reach a specific sports facility?	mean of transport id	Mean of Transport	id	unfilled	id	Y	
9	Which public transport options are available to reach a specific sports facility?	route id	Route	id	unfilled	id	Y	
9	Which public transport options are available to reach a specific sports facility?	stop name	Stop	name	unfilled	name	Y	
10	What is the closest public transport stop to a sport facility?	duration of the route	Route	duration_time	unfilled	time	Y	Field not complete
11	What is the average travel time by public transport to a facility?	description of the bike line	Bike Line	description	unfilled	description	Y	
12	Are there bike paths connecting a sports facility near a specific urban area?	description of the path	Path	description	unfilled	description	Y	
13	Which sports facilities are located near a specific urban area?	description of the path	Path	description	unfilled	description	Y	
14	How many bike paths are available for public transportation?	mean of transport id	Mean of Transport	id	unfilled	id	Y	
14	How can I travel from my town to a ski resort using public transportation?	route id	Route	id	unfilled	id	Y	
14	How can I travel from my town to a ski resort using public transportation?	path id	Path	id	unfilled	id	Y	
15	Which sports venues are accessible by bike or on foot?	notes about the path	Path	notes	unfilled	notes	Y	
15	Which sports venues are accessible by bike or on foot?	flooring of the bike line	Bike Line	flooring	unfilled	flooring	Y	Field not complete
16	Are there any sports facilities that are difficult to access due to limited transportation?	route id	Route	id	unfilled	id	Y	
16	Are there any sports facilities that are difficult to access due to limited transportation?	wheelchair accessibility for the bus stop	Bus Stop	wheelchair_accessibility	unfilled	wheelchair_boarding	Y	
17	What are the opening and closing times of sports facilities?	timetable of the sport facility	Sport Facility	timetable	sport_facilities.csv	timetable	Y	Field not complete

Image X: CQs vs. Dataset (DS) Coverage

Metrics:

- CQ1 requires 3 fields, 3 present → CQ1 Coverage = 3/3 = 100%
- CQ2 requires 3 fields, 1 present → CQ2 Coverage = 1/3 = 33.3%
- CQ3 requires 1 fields, 1 present → CQ3 Coverage = 1/1 = 100%
- CQ4 requires 1 fields, 1 present → CQ4 Coverage = 1/1 = 100%
- CQ5 requires 2 fields, 2 present → CQ5 Coverage = 2/2 = 100%
- CQ6 requires 2 fields, 0 present → CQ6 Coverage = 0/2 = 0%
- CQ7 requires 2 fields, 2 present → CQ7 Coverage = 2/2 = 100%
- CQ8 requires 1 fields, 0 present → CQ8 Coverage = 0/1 = 0%
- CQ9 requires 2 fields, 2 present → CQ9 Coverage = 2/2 = 100%
- CQ10 requires 1 fields, 1 present → CQ10 Coverage = 1/1 = 100%
- CQ11 requires 1 fields, 1 present → CQ11 Coverage = 1/1 = 100%
- CQ12 requires 1 fields, 1 present → CQ12 Coverage = 1/1 = 100%
- CQ13 requires 1 fields, 1 present → CQ13 Coverage = 1/1 = 100%
- CQ14 requires 3 fields, 3 present → CQ14 Coverage = 3/3 = 100%
- CQ15 requires 2 fields, 2 present → CQ15 Coverage = 2/2 = 100%
- CQ16 requires 2 fields, 2 present → CQ16 Coverage = 2/2 = 100%
- CQ17 requires 1 fields, 1 present → CQ17 Coverage = 1/1 = 100%

Aggregate: 24/29 = 0.828 = 82.8%

6.2 Language Evaluation

For *Language Evaluation*, the domain terms were compared with the *Language Teleontology* (LTLO).

Coverage metrics were calculated for entity-type terms, object properties, and data properties, verifying that the designed terminology adequately represented the necessary concepts.

Term	Type	Aligned	URI	Notes
Sport Facility	class	Y	ltlo:sport_facility	
Path	class	Y	ltlo:path	
Stop	class	Y	ltlo:stop	
Mean of Transport	class	Y	ltlo:mean_of_transport	
Route	class	Y	ltlo:route	
Association	class	Y	ltlo:association	
Athlete	class	N	ltlo:athlete	Not required in CQs
Service	class	Y	ltlo:service	
App	class	N	ltlo:app	Not required in CQs
Reservation	class	Y	ltlo:reservation	
Sport	class	Y	ltlo:sport	
Is a	object property	Y	ltlo:is_a	
Has sport facility	object property	Y	ltlo:has_sportfacility	
Has sport	object property	Y	ltlo:has_sport	
Has mean of transport	object property	Y	ltlo:has_meanoftransport	
Has stop	object property	Y	ltlo:has_stop	
Has service	object property	Y	ltlo:has_service	
Has route	object property	Y	ltlo:has_route	
Has association	object property	Y	ltlo:has_association	
Has athlete	object property	N	ltlo:has_athlete	Not required in CQs
Has app	object property	N	ltlo:has_app	Not required in CQs
Has reservation	object property	Y	ltlo:has_reservation	
Has path	object property	Y	ltlo:has_path	
ID	data property	Y	ltlo:id	
Name	data property	Y	ltlo:name	
Code	data property	Y	ltlo:code	
Address	data property	Y	ltlo:address	
City	data property	Y	ltlo:city	
Postcode	data property	Y	ltlo:postcode	
Type	data property	Y	ltlo:type	
Status	data property	Y	ltlo:status	
Description	data property	Y	ltlo:description	
Category	data property	Y	ltlo:category	
Capacity	data property	Y	ltlo:capacity	
Accessibility	data property	Y	ltlo:accessibility	
Length	data property	Y	ltlo:length	
Time	data property	Y	ltlo:time	
Notes	data property	Y	ltlo:notes	
Timetable	data property	Y	ltlo:timetable	
Equipment	data property	Y	ltlo:equipment	
Coverage	data property	Y	ltlo:coverage	
President	data property	Y	ltlo:president	
Age	data property	N	ltlo:age	Not required in CQs
Sex	data property	N	ltlo:sex	Not required in CQs
Occupation	data property	N	ltlo:occupation	Not required in CQs
Driver	data property	N	ltlo:driver	Not required in CQs
Cost	data property	Y	ltlo:cost	
Players Number	data property	Y	ltlo:players_number	
Foundation Year	data property	Y	ltlo:foundation_year	
Walk Rv	data property	Y	ltlo:walk_rv	

Image XI: Language Coverage

Entity Coverage: 9/11 = 0.818 = 81.8%

Object Property Coverage: 10/12 = 0.833 = 83.3%

Data Property Coverage: 23/27 = 0.852 = 85.2%

6.3 Knowledge Evaluation

Knowledge Evaluation verified the completeness of the Teleology by comparing the required *Knowledge Atoms* (entities, object properties, data properties) with the elements actually modeled.

Again, coverage metrics were calculated to assess the alignment between necessary knowledge and modeled knowledge.

KATOM	Label	Type	Aligned	URI	Notes
K1	Sport Facility	entity	Y	teo:sport_facility	OK
K2	Path	entity	Y	teo:path	OK
K3	Stop	entity	Y	teo:stop	OK
K4	Mean of Transport	entity	Y	teo:mean_of_transport	OK
K5	Route	entity	Y	teo:route	OK
K6	Association	entity	Y	teo:association	OK
K7	Athlete	entity	Y	teo:athlete	OK
K8	Service	entity	Y	teo:service	OK
K9	App	entity	Y	teo:app	OK
K10	Reservation	entity	Y	teo:reservation	OK
K11	Sport	entity	Y	teo_sport	OK
K12	Is a	object property	Y	teo:is_a	OK
K13	Has sport facility	object property	Y	teo:has_sportfacility	OK
K14	Has sport	object property	Y	teo:has_sport	OK
K15	Has mean of transport	object property	Y	teo:has_meanoftransport	OK
K16	Has stop	object property	Y	teo:has_stop	OK
K17	Has service	object property	Y	teo:has_service	OK
K18	Has route	object property	Y	teo:has_route	OK
K19	Has association	object property	Y	teo:has_association	OK
K20	Has athlete	object property	Y	teo:has_athlete	OK
K21	Has app	object property	Y	teo:has_app	OK
K22	Has reservation	object property	Y	teo:has_reservation	OK
K23	Has path	object property	Y	teo:has_path	OK
K24	ID	data property	Y	teo:has_id	OK
K25	Name	data property	Y	teo:has_name	OK
K26	Code	data property	Y	teo:has_code	OK
K27	Address	data property	Y	teo:has_address	OK
K28	City	data property	Y	teo:has_city	OK
K29	Postcode	data property	Y	teo:has_postcode	OK
K30	Type	data property	Y	teo:has_type	OK
K31	Status	data property	Y	teo:has_status	OK
K32	Description	data property	Y	teo:has_description	OK
K33	Category	data property	Y	teo:has_category	OK
K34	Capacity	data property	Y	teo:has_capacity	OK
K35	Accessibility	data property	Y	teo:has_accessibility	OK
K36	Length	data property	Y	teo:has_length	OK
K37	Time	data property	Y	teo:has_time	OK
K38	Notes	data property	Y	teo:has_notes	OK
K39	Timetable	data property	Y	teo:has_timetable	OK
K40	Equipment	data property	Y	teo:has_equipment	OK
K41	Coverage	data property	Y	teo:has_coverage	OK
K42	President	data property	Y	teo:has_president	OK
K43	Age	data property	Y	teo:has_age	OK
K44	Sex	data property	Y	teo:has_sex	OK
K45	Occupation	data property	Y	teo:has_occupation	OK
K46	Driver	data property	Y	teo:has_driver	OK
K47	Cost	data property	Y	teo:has_cost	OK
K48	Players Number	data property	Y	teo:has_players_number	OK
K49	Foundation Year	data property	Y	teo:has.foundation_year	OK
K50	Walk By	data property	Y	teo:has_walk_by	OK

Image XII: Knowledge Coverage

Entity Coverage: 11/11 = 1 = 100%

Object Property Coverage: 12/12 = 1 = 100%

Data Property Coverage: 27/27 = 1 = 100%

6.4 Entity Evaluation

Finally, in *Entity Evaluation*, the quality and compatibility of the datasets were analyzed, identifying and descriptive attributes, verifying the presence of overlapping entities, and choosing the most appropriate strategy for data integration.

The sparsity of the resulting KG was also calculated to measure its completeness.

The following entities and their respective attributes were taken into consideration:

- *Association* (dataset sport_associations.csv): name, type, address, city, postcode, foundation_year, president, players_number, category
- *Sport Facility* (dataset sport_facilities.csv): id, name, type, address, city, capacity, timetable, status, accessibility, walk_by
- *Bike Line* (dataset bike_lines.csv): id, description, type, notes, route_name, level, manager, position, flooring
- *Bus Roads* (dataset bus_roads.csv): id, description, type, notes, speed_limit
- *Train Railway* (dataset train_railway.csv): id, description, type, notes, voltage
- *Bus Stop Urban* (dataset bus_stops_urban.csv): id, name, address, city, coverage, description, wheelchair_boarding
- *Bus Stop Suburban* (dataset bus_stops_suburban.csv): id, name, address, city, coverage, description, wheelchair_boarding
- *Train Station* (dataset train_stations.csv): id, name, address, city, coverage, railway, manager
- *Bus Line Urban* (dataset bus_lines_urban.csv): id, length, time, stops, stops_time, wheelchair_boarding, calendar, route_number
- *Bus Line Suburban* (dataset bus_lines_suburban.csv): id, length, time, stops, stops_time, wheelchair_boarding, calendar, route_number
- *Train Line* (dataset train_lines.csv): id, length, time, bridge, covered, name, electrified, max_speed

No overlap analysis was performed for the *Association* and *Sport Facility* entities, while the following studies were carried out for the other entities:

Attribute	D1: bike_lines.csv	D2: bus_roads.csv	D3: train_railway.csv	Same concept?	Notes
id	✓	✓	✓	YES	Same meaning
description	✓	✓	✓	YES	Same meaning
type	✓	✓	✓	YES	Same meaning
notes	✓	✓	✓	YES	Same meaning
route_name	✓	✗	✗	NO	Only in D1
level	✓	✗	✗	NO	Only in D1
manager	✓	✗	✗	NO	Only in D1
position	✓	✗	✗	NO	Only in D1
flooring	✓	✗	✗	NO	Only in D1

Table XVI: Bike Line, Bus Roads and Train Railway

Attribute	D1: bus_stops_urban.csv	D2: bus_stops_suburban	D3: train_stations.csv	Same concept?	Notes
id	✓	✓	✓	YES	Same meaning
name	✓	✓	✓	YES	Same meaning
address	✓	✓	✓	YES	Same meaning
city	✓	✓	✓	YES	Same meaning
coverage	✓	✓	✓	YES	Same meaning
description	✓	✓	✗	NO	Only in D1 and D2
wheelchair_boarding	✓	✓	✗	NO	Only in D1 and D2

Table XVII: Bus Stop Urban, Bus Stop Suburban and Train Station

Attribute	D1: bus_lines_urban.csv	D2: bus_lines_suburban	D3: train_lines.csv	Same concept?	Notes
id	✓	✓	✓	YES	Same meaning
length	✓	✓	✓	YES	Same meaning
time	✓	✓	✓	YES	Same meaning
stops	✓	✓	✗	NO	Only in D1 and D2
stops_time	✓	✓	✗	NO	Only in D1 and D2
calendar	✓	✓	✗	NO	Only in D1 and D2
route-number	✓	✓	✗	NO	Only in D1 and D2
wheelchair_boarding	✓	✓	✗	NO	Only in D1 and D2

Table XVIII: Bus Line Urban, Bus Line Suburban and Train Line

After comparing the various attributes of the analyzed datasets, an overlap analysis was performed and, subsequently, the databases were all unified using intelligent merge (strategy 3), producing the following tables:

- *bus_stop*: from TABLE XVII the data regarding *id*, *name*, *address*, *city*, *coverage*, *description* and *wheelchair_boarding* for datasets D1 and D2 have been inserted
- *bus_line*: from TABLE XVIII the data regarding *id*, *length*, *time*, *stops*, *stops_time*, *calendar*, *route_number* and *wheelchair_boarding* for datasets D1 and D2 have been inserted

- *path*: from TABLE XVI the data regarding *id*, *description*, *type* and *notes* for datasets D1, D2 and D3 have been inserted
- *stop*: from TABLE XVII the data regarding *id*, *name*, *address*, *city* and *coverage* for datasets D1, D2 and D3 have been inserted
- *route*: from TABLE XVIII the data regarding *id*, *length* and *time* for datasets D1, D2 and D3 have been inserted

For the *route* and *path* datasets, the data merge produced tables with no empty cells, so the final *sparsity* calculation for these 2 is 0%.

As for the *stop* dataset, the merge generated a table with 2948 empty cells out of a total of 29372 cells, and therefore the final *sparsity* calculation has a value of approximately 10%, a very acceptable value by iTelos standards.

For each of these three tables, a column has been added that identifies the object's instance type.

For example, for the *path* table, the *path_type* column has been added, which distinguishes the following values:

- *train railway*
- *bus road*
- *bike line*

path.csv | Report | RDF ✓

Model Name: path.csv | Prefix: s | Base URI: http://localhost:8080/source/ | Github URL: disabled

id	pathURI	description	type	notes	route	routeURI	path_type
3723356	http://localhost:80...	Verona - Brennero	ESISTENTE	Stato=ESISTENTE Fer_id=1 Nome=Verona - Brennero	way/198323...	http://localhost:80...	train railway
3723356	http://localhost:80...	Verona - Brennero	ESISTENTE	Stato=ESISTENTE Fer_id=1 Nome=Verona - Brennero	way/228688...	http://localhost:80...	train railway
3723356	http://localhost:80...	Scali - Binari morti	ESISTENTE	Stato=ESISTENTE Fer_id=0 Nome=Scali - Binari morti	way/228688...	http://localhost:80...	train railway

Image XIII: *Path* merged table in Karma

route.csv | Report | RDF ✓

Model Name: route.csv | Prefix: s | Base URI: http://localhost:8080/source/ | Github URL: disabled

	id	routeURI	length	time	path	pathURI	stop	stopURI	mean_of_transport	meanOfTransportURI	route_type
1	http://localhost:80...	53	47	2771674	http://localhost:80...	477	http://localhost:80...	6	http://localhost:80...	bus line urban	
2	http://localhost:80...	10	21	2775863	http://localhost:80...	297	http://localhost:80...	6	http://localhost:80...	bus line urban	
3	http://localhost:80...	28	20	2774147	http://localhost:80...	912	http://localhost:80...	6	http://localhost:80...	bus line urban	
4	http://localhost:80...	34	14	2774921	http://localhost:80...	177	http://localhost:80...	6	http://localhost:80...	bus line urban	
5	http://localhost:80...	75	45	2774714	http://localhost:80...	916	http://localhost:80...	5	http://localhost:80...	bus line urban	
6	http://localhost:80...	36	41	2771912	http://localhost:80...	949	http://localhost:80...	2	http://localhost:80...	bus line urban	
7	http://localhost:80...	23	22	2773343	http://localhost:80...	625	http://localhost:80...	1	http://localhost:80...	bus line urban	
8	http://localhost:80...	10	39	2772527	http://localhost:80...	1089	http://localhost:80...	1	http://localhost:80...	bus line urban	

Image XIV: Route merged table in Karma

stop.csv | Report | R2RML Model | RDF ✓

Model Name: stop.csv | Prefix: s | Base URI: http://localhost:8080/source/ | Github URL: disabled

	id	stopURI	name	address	city	coverage	route	routeURI	sport_facility	sportFacilityURI	stop_type
4	http://localhost:80...	Ponte	Avisio,,46.134568,...	4,22220z,Lamar	1	34	http://localhost:80...	way/66345986	http://localhost:80...	http://localhost:80...	bus stop urban
5	http://localhost:80...	85	Bivio	5,28060z,Sp	0	31	http://localhost:80...	way/66345987	http://localhost:80...	http://localhost:80...	bus stop urban
6	http://localhost:80...	Bollerì,46.102457...		7,24405z,Maso	1	35	http://localhost:80...	way/66345988	http://localhost:80...	http://localhost:80...	bus stop urban

Image XV: Stop merged table in Karma

7 Metadata

At the same time, the *Metadata Production* phase was carried out, during which the following were produced:

- *Language Metadata*, which formally describe the terms of the domain
- *Knowledge Metadata*, which document the structure of the KG (entities, properties, and roles)
- *KG Project Metadata*, necessary for the LiveKnowledge catalog and for the complete traceability of the project

These elements guarantee the transparency, reusability, and quality of the Knowledge Graph and constitute the final documentary basis of the project.

Namespace	This is the fully annotated Sport Facilities and Transportation Namespace
Resources	sft_Itlo.xlsx
Version	This is the file representing the Sport Facilities and Transportation (sft) namespace v1.3
Prefix	sft
Publisher	KnowDive Group
Annotator	Lorenzo Zappacosta
Owner	KnowDive Group
License	CC0
Other Namespace Reused	schema.org
Generation DateTime	2025-11-30T15:24:00
Language	en
Translators	M. Vettori, L. Zappacosta
Keywords	sport, transportation
DatDomain	Society&Territory
Validator	Fausto Giunchiglia, Mayukh Bagchi
Reference (Tele)ontology	KnowDive Group
Reference UKC Version	to be added
Project Page	Sport Facilities and Transportation
Type	Namespace

Image XVI: Language Metadata

Schema	A teleontology developed based on data from various dataset about Trentino
Resources	KG-Teleology.owl
DatKeyword	The OWL RDF/XML distribution of the sft Teleontology
DatPublisher	transportation
DatDomain	KnowDive Group
DatCreator	Society&Territory
DatPublicationTimeStamp	M. Vettori, L. Zappacosta
DatLanguage	Unknown
DatVersion	en
LKDAType	v2.4
DatOwner	Teleontology
DatLevel	KnowDive Group
DatLicense	Knowledge Level(L3-4)
Type	CC0
	Schema

Image XVII: Knowledge Metadata

	The Sport Facilities and Transportation github link provides the access to all the projects developed during the edition 2025/2026 of the Knowledge Graph academic course (University of Trento, DISI department).
Resources	Sport Facilities and Transportation
License	CC0
Category	Sport, Transportation
Maintainer	L. Zappacosta
Maintainer Email	lorenzo.zappacosta@studenti.unitn.it
Author(s)	Manuel Vettori Lorenzo Zappacosta
Author(s) Email	manuel.vettori@studenti.unitn.it lorenzo.zappacosta@studenti.unitn.it
Tags	kg, sport, transportation, trentino
Publication Date	2025-11-10

Image XVIII: KG Project Metadata

8 Open Issues

This project has provided a fairly detailed overview of the connections between the various sports facilities and the public transport associated with them in Trentino.

The data has been downloaded from specialized online catalogs and modified according to our needs and it has enabled the creation of a Knowledge Graph showing the network between the entities and associations identified during the project.

Future developments could include:

- integration of more detailed data (e.g., geographical coordinates, updated timetables, etc.)
 - design of new entities for better connections (e.g. cars as a means of transport, additional services, hierarchy of sports facilities, etc.)
 - expansion of the project's scope (e.g. Northern Italy)
 - updating of the data used

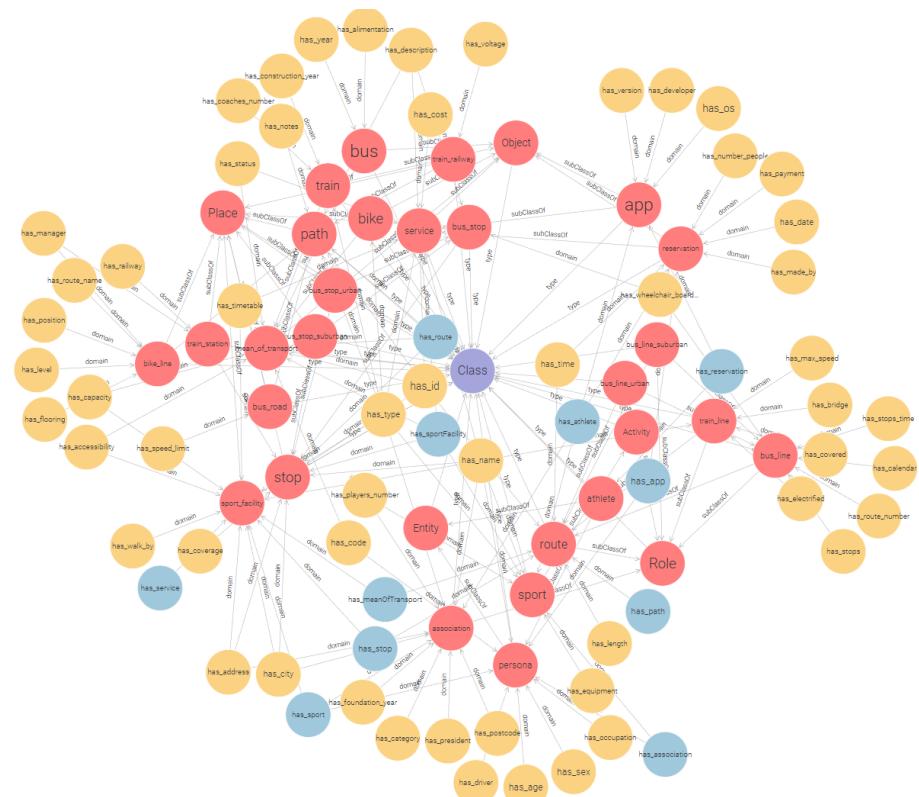


Image XIX: Complete Knowledge Graph SFT in GraphDB

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