Dipartimento di Ingegneria e Scienza dell'Informazione

– KnowDive Group –

KGE 2024 - HealthRoute Trentino

Project Report

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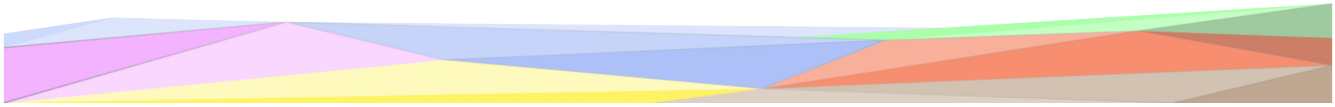

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Revision History:

Revision	Date	Author	Description of Changes
0.1	October 16, 2024	Alice Massacci	Document created
1.0	October 19, 2024	Alice Massacci	Informal Purpose & DoI
1.1	October 26, 2024	Alice Massacci	Activity 1: Personas & Scenarios definition
1.2	October 27, 2024	Alice Massacci	Activity 2: Competency Questions definition
1.3	October 27, 2024	Alice Massacci	Activity 3: Concepts Identification
1.4	October 30, 2024	Alice Massacci	Purpose Definition completed

1 Introduction

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.

2 Purpose Definition

2.1 Informal Purpose

The **HealthRoute Trentino** project aims to develop a Knowledge Graph (KG) that provides seamless access to up-to-date information about Healthcare Facilities across the Trentino Province, along with their integration into the public transportation network. The KG will empower users—whether healthcare professionals or patients—to easily locate medical services (e.g., hospitals, pharmacies, medical centers) and discover the most efficient transit routes to access them. The system aims to streamline healthcare access and improve overall coordination between health services and transportation options.

The informal purpose can be stated as: *"A KG that helps users quickly find healthcare facilities/services in Trentino and determine how to reach them efficiently using public transportation, based on their location and transport data."*

The KG should be capable of answering complex queries like "Which hospital can I reach by bus within 30 minutes from my current location?" or "Which pharmacies are accessible via public transport in the evening?" The KG will integrate static transportation data from different sources with healthcare facilities and synthetic user data, and will serve as a foundation for web or smartphone applications that assist users in planning trips to healthcare facilities based on real-time schedules, transportation options, and user location.

2.2 Domain of Interest (DoI)

The DoI for this project is bounded in space and time:

- Space: autonomous province of Trentino.
- Time: To ensure practical applicability, the project will utilize current public transportation data from the year 2024.

These boundaries ensure that the project operates within a realistic and usable framework for public transportation information.

2.3 Purpose Definition – Activities

Once the informal purpose and DoI are defined, the iTelos methodology moves to formalization of the initial purpose statement into a purpose-specific Entity-Relationship (ER) model. Purpose formulation involves four key Activities:

- Personas & Scenarios definition
- Competency Questions definition
- Concepts Identification
- ER modeling

2.3.1 Activity 1: Personas & Scenarios definition

To guide the design and development of the KG, a set of personas—fictional representations of different end-user types with specific needs and objectives—and scenarios have been defined. These scenarios cover a variety of transportation and healthcare-related challenges, ensuring coverage of rush hour demands, working days and holidays. By framing the project through these user-centered examples, the practical applications of the HealthRoute Trentino KG are demonstrated.

Scenarios

Working Day (Monday to Friday) – Morning (S1)
On a typical weekday morning in Trento, between 7 a.m. and 12 p.m., the city is bustling with activity as residents commute to work and students head to school. The public transport system runs at full capacity. Buses, trams, and trains operate frequently to accommodate the surge in passengers, with most routes servicing both urban and suburban areas. Healthcare workers–doctors, nurses, and administrative staff–rely heavily on public transport to reach hospitals, clinics, and medical centers on time to start their shifts. Patients, especially those with scheduled appointments, also need reliable transportation.

Nighttime Travel (S2)
It's late at night in Trento, between 12 a.m. and 6 a.m. The city is quiet, with most residents at home and businesses closed, except for emergency services like hospitals. Public transportation services are limited, with only a few night buses running. Passengers needing to travel during these hours, such as night-shift workers, may experience longer waiting times and fewer route options.

Weekend Reduced Service (S3)
On weekends, especially Sundays, Trento slows down as businesses close. Public transportation runs on reduced schedules, with fewer buses and trains in operation. Hospitals and essential services remain open.

Heavy Rain (S4)
It's raining heavily, and streets are slick with water, making outdoor travel less appealing. Fewer people are

walking outside, opting instead for the warmth and shelter of public transportation. Buses are more crowded than usual. The weather conditions also slow down traffic. Passengers face longer waiting times and a slower commute.

Strike Day (S5)
On strike days, both buses and trains can be delayed or cancelled altogether, creating significant disruptions for commuters. People who rely solely on public transportation face difficulties, as they might be unable to get to work, miss important meetings, or face long delays.

Traffic Disruption Due to Construction Work (S6)
Ongoing construction work on a major road in Trento has caused significant delays throughout the city. Public buses are forced to take alternative routes, resulting in longer travel times for passengers who might miss connections or arrive late at their destinations. The detours also add extra pressure on already busy streets.

Personas

Stefania (P1): Stefania is a 36-year-old social worker living in Borgo Valsugana. She frequently visits nursing homes and hospitals as part of her job. Stefania also has to manage her own health, picking up prescriptions for thyroid medication and visiting her endocrinologist in Trento.

Riccardo (P2): Riccardo is a 45-year-old IT consultant from Pergine Valsugana. After suffering a minor heart attack a year ago, he became committed to improving his health through regular cardiovascular check-ups and a strict fitness routine. He prefers using public transportation to reduce stress and improve his health further, often combining his trips with walks in the local parks. He also suffers from seasonal allergies and regularly visits the local pharmacy during spring and summer to buy antihistamines and nasal sprays. Riccardo often schedules his trips to the pharmacy for early morning to avoid the intense heat in the summer.

Elena (P3): Elena is a 38-year-old teacher living in Rovereto. She has asthma and needs regular check-ups with a pulmonologist. When the weather is favorable, Elena uses her scooter to travel to her appointments. However, during colder months or when her asthma flares up, she relies on public transportation for her commutes. Her appointments are often scheduled for the early morning, during the busy weekday rush hours.

Chiara (P4): Chiara is a 29-year-old nurse working at a hospital in Trento. She is often on rotating shifts, including nights and weekends. Her day shifts run from 7 am to 3 pm, while night shifts run from 11 pm to 7 am. In addition to her regular duties, Chiara is part of a professional development program that requires her to travel to different healthcare facilities across the region. She mentors new nurses and attends training sessions and seminars to stay updated on the latest medical practices. Chiara often relies on public transport for her commutes.

Edoardo (P5): Edoardo is a 50-year-old man who lives in Caldonazzo and works in Trento. Due to his job as a restaurant manager, Edoardo often works late into the night. He has chronic insomnia and sometimes needs to visit the pharmacy after work to get over-the-counter sleep aids. Since he doesn't drive, Edoardo depends on late-night bus services and 24-hour pharmacies to manage his condition without having to take time off work.

2.3.2 Activity 2: Competency Questions (CQs) definition

- **CQ-1 (P1-S5)**: Stefania has a busy Monday morning with back-to-back appointments at two nursing homes, but a public transport strike has been announced. a) Which train/bus lines does she rely on for her appointments? b) Are they affected by the strike?
- **CQ-2 (P1-S1)**: Stefania has a morning visit scheduled at a nursing home in Trento at 11:00 a.m.
  a) What is the most efficient public transportation route for her to arrive at the nursing home on time?
  b) Is there a pharmacy within 500 meters of the final bus stop?
  c) If she leaves home at 9:30 a.m., will she have sufficient time to stop by the pharmacy to buy her thyroid medications before proceeding to her appointment?
- **CQ-3 (P2-S1)**: I'ts Wednesday, Riccardo has a cardiovascular check-up scheduled for 9:00 a.m. at Ospedale Santa Chiara and plans to pick up some antihistamines beforehand.
  a) How many pharmacies are located within a 5-10 minute walk from each bus stop on his route to the hospital, and which one would be the most convenient to stop at?
  b) If he leaves home at 7:30 a.m., will he arrive on time for his appointment?
- **CQ-4 (P2-S3)**: After enjoying a walk in Parco delle Albere on a sunny Sunday afternoon, Riccardo begins experiencing allergy symptoms and needs to buy antihistamines.
  a) Is there a nearby pharmacy open on Sundays?
  b) Given the reduced weekend public transport service, what is the fastest route he can take to reach the pharmacy and then continue home?
- **CQ-5 (P3-S6)**: Elena has a morning appointment with her pulmonologist at Ospedale Santa Chiara in Trento. Due to ongoing construction on the train line between Rovereto and Trento, she must rely on replacement bus services.
  a) What is the best route for her to take?
  b) Which is the travel time using the replacement bus?
  c) If Elena's appointment is scheduled for 10:00 a.m., what time should she leave her home to catch the replacement bus and ensure she arrives on time?
- **CQ-6 (P4-S6)**: Chiara finishes her shift at Ospedale S. Camillo at 3:00 p.m. and needs to travel to Centro Medico di Rovereto for a training session at 4:30 p.m., but there is ongoing construction causing delays on the usual bus route. What alternative bus routes can she use to reach the training center on time despite the disruption?
- **CQ-7 (P4-S4)**: Chiara is finishing her night shift at the hospital at 7:00 a.m. on a rainy weekday.
  a) What public transportation options are available for her to get home after her shift?
  b) If the bus arrives but is overcrowded due to the heavy rain, how long will she have to wait for the next available bus?
- **CQ-8 (P5-S2)**: Edoardo finishes his late shift at the restaurant at 1:00 a.m. and needs to stop by a 24-hour pharmacy to pick up sleep aids. Given the limited late-night bus service, what is the quickest way for him to reach the nearest open pharmacy and then head home to Caldonazzo?

2.3.3 Activity 3: Concepts Identification

Considering the scenarios and personas involved in the CQs, the following entities and their properties can be identified:

Scenarios	Personas	CQs	Entities	Properties	Focus
1–6	1–5	1–8	End_User	id, name, gender, age, type	Contextual
1–6	1–5	1–8	Trip	id, start_time, end_time, start_point, end_point, route	Contextual
1–6	1–5	1–8	Route	id, type, provider, length, schedule	Core
1–6	1–5	1–8	Position	id, address, latitude, longitude	Contextual
1–6	1,2	2b,3a	Stop	id, name, coordinates, arrival_time, departure_time	Core
1–4	1,2,4,5	1a,2,3,4,7,8	Weekly_Schedule	id, monday, tuesday, wednesday, thursday, friday, saturday, sunday	Core
5,6	1,3,4	1b,5,6	Schedule_Exception	id, date, exception_type, affected_routes	Core
5,6	1,3,4	1b,5,6	Event	id, type, date	Core
1–6	1–5	1–8	Health_Facility	id, name, coordinates, type, access_schedule	Core
1,5,6	1–7	1,2,3,5c,6	Appointment	id, user, when, where	Contextual

Table 1: Purpose Formalization sheet

2.3.4 Activity 4: ER modeling

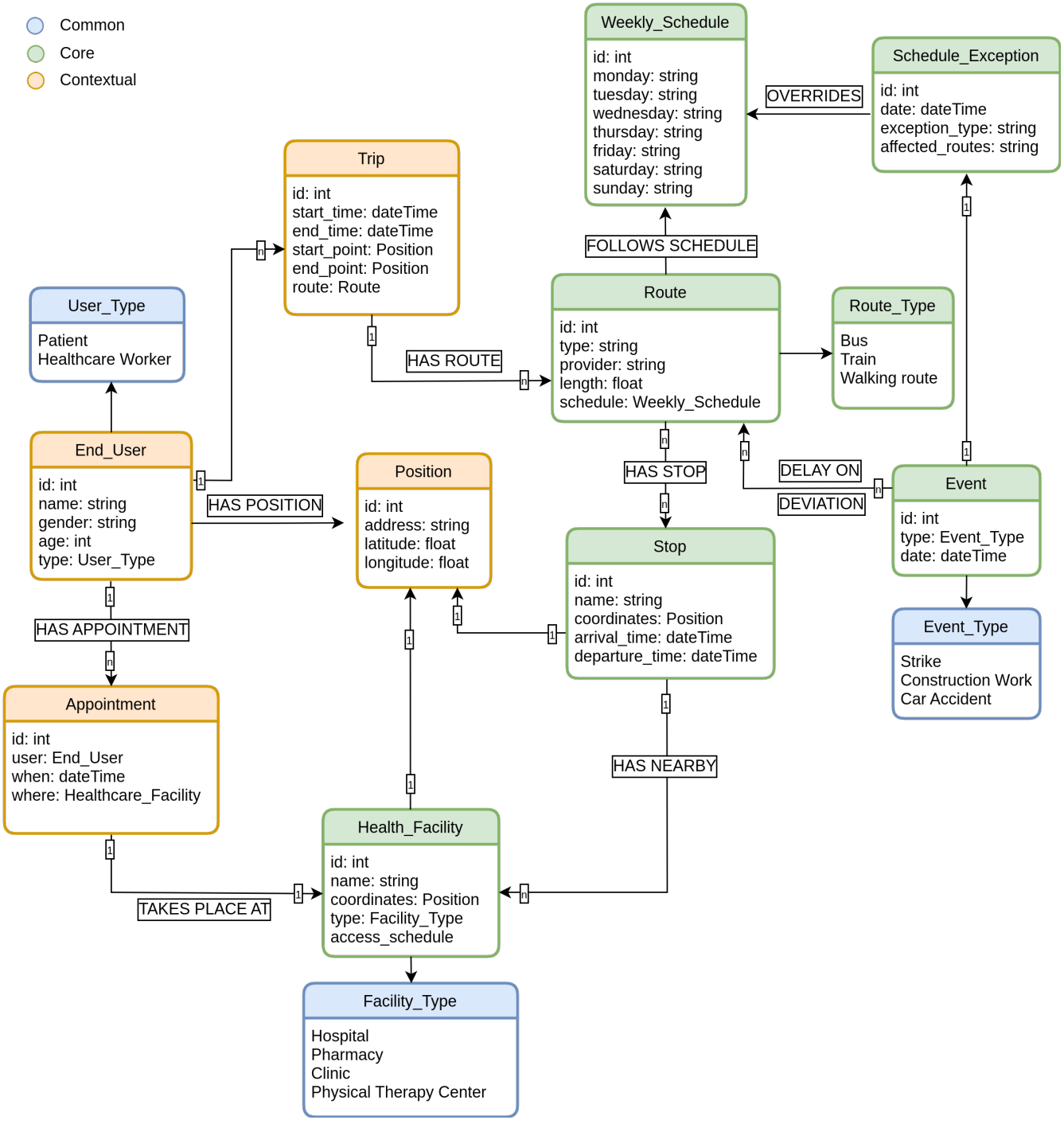

Figure 1: ER model

Each EType in the ER model has specific attributes that provide information relevant to answering CQs and fulfilling the KG's purpose.

The **End_User** EType captures individual user data and categorizes users into distinct **User_Type** groups—patients and healthcare professionals. **End_Users** are linked to the **Appointment** EType, which is key to aligning travel routes with users' healthcare schedules, supporting the KG's goal of matching users with timely travel options to and from their appointments.
Transportation-related ETypes—**Trip**, **Route**, and **Stop**—model the transportation network. A **Trip** defines a single journey taken by an **End_User** from a start point to a destination, and is served by one or more **Routes** that define the specific transit paths and schedules. This design supports queries like finding the nearest healthcare facility within a set travel time. The **Stop** EType defines precise locations along a route where users can board or exit. Each **Stop** has coordinates, scheduled arrival and departure times, and supports queries about where users can access transport, travel times, and nearby healthcare facilities.
The **Weekly_Schedule** EType defines the recurring weekly timetable for transportation services. By associating each route with its **Weekly_Schedule**, the KG can provide users with detailed timing and frequency information. Real-world schedules are subject to disruptions, and **Schedule_Exception** captures temporary changes to a regular schedule, such as delays or cancellations, caused by external occurrences (**Event** EType) such as traffic accidents, road closures, strikes. This structure allows the model to answer queries about potential disruptions.
Finally, healthcare service locations are managed through the **Health_Facility** EType, which catalogs healthcare access points—hospitals, clinics, and pharmacies—with data properties (attributes) for coordinates, facility type, and open hours.

Object properties (relationships) between ETypes have also been established. Key relationships include **HAS ROUTE** (linking a **Trip** to its **Route/s**), **FOLLOWS SCHEDULE** (associating **Route** with a **Weekly_Schedule**), and **HAS STOP** (connecting a **Route** to its **Stop** locations). Each relationship has defined cardinalities to specify how many instances of the two entities are involved. For instance, the **HAS STOP** relationship between **Route** and **Stop** typically has a many-to-many cardinality, as each route has multiple stops, and each stop may serve multiple routes. The **HAS APPOINTMENT** relationship, instead, exhibits a one-to-many cardinality, whereby an **End_User** can have multiple appointments, while each **Appointment** is associated with a single user. Defining these cardinalities ensures that the model accurately represents the complexity of real-world entities and can effectively processes user queries.