IMPRO Improving the information base and optimising service solutions to support social welfare & healthcare reform

Christmas seminar on geoinformation and health services 2018

Modeling time and travel costs for treatment of chronic diseases

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strategic RESEARCH

Background

- Patients' time and travel costs associated with receiving healthcare services are often ignored in economic evaluations, even though they are critical to both society and patients
  - It has been shown that these costs should be included in the economic assessments of interventions that require regular monitoring and traveling

- Revealed healthcare accessibility can be modeled and measured as travel time, distance or monetary cost by combining patient register data and GIS-methods
  - My aim is to develop a georeferenced cost model that could be applied to multiple areas and diseases
  - I also seek to provide relevant information for healthcare planning about interventions that reduce traveling and costs

- **Publications from this topic:**

  1) Aapeli Leminen, Markku Tykkyläinen, Tiina Laatikainen, Self-monitoring induced savings on type 2 diabetes patients' travel and healthcare costs, International Journal of Medical Informatics, Volume 115, 2018.

  2) Currently in the works: Patients' time and travel costs in the treatment of atrial fibrillation: Savings achievable with the shift from warfarin to new oral anticoagulants (work title)

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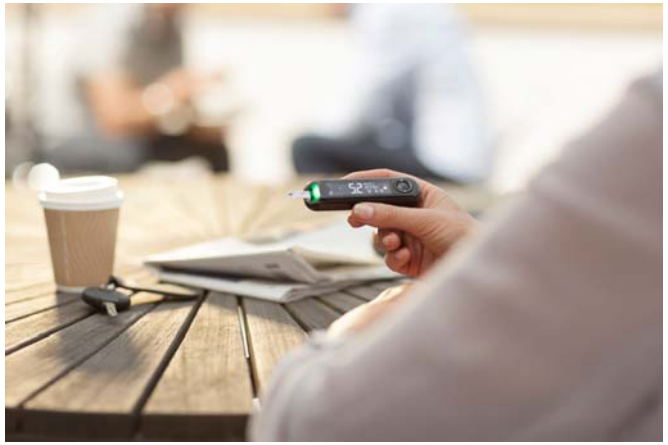
Study settings in the healthcare district of Siun Sote in North Karelia Finland

Study 1 – Type 2 diabetes (T2D):

- In follow-up of type 2 diabetes, hemoglobin A1c (HbA1c) and low density lipoprotein (LDL) are measured regularly

→ 2-6 healthcare visits per year

– **What is the cost of measurements, traveling and time loss?**



→ Part of the measurements and patient's trips could be replaced with self-monitoring

– **How large are the self-monitoring induced savings on patients' travel and healthcare costs when half of the measurements/ visits are replaced with self-measurements?**

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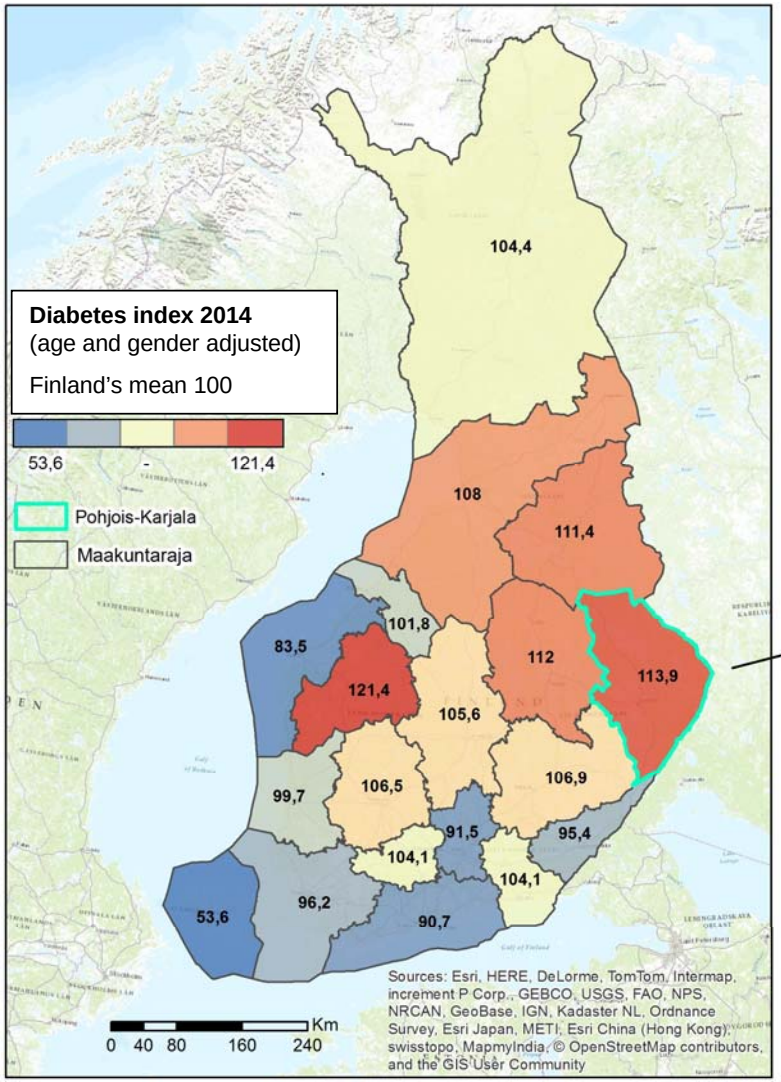
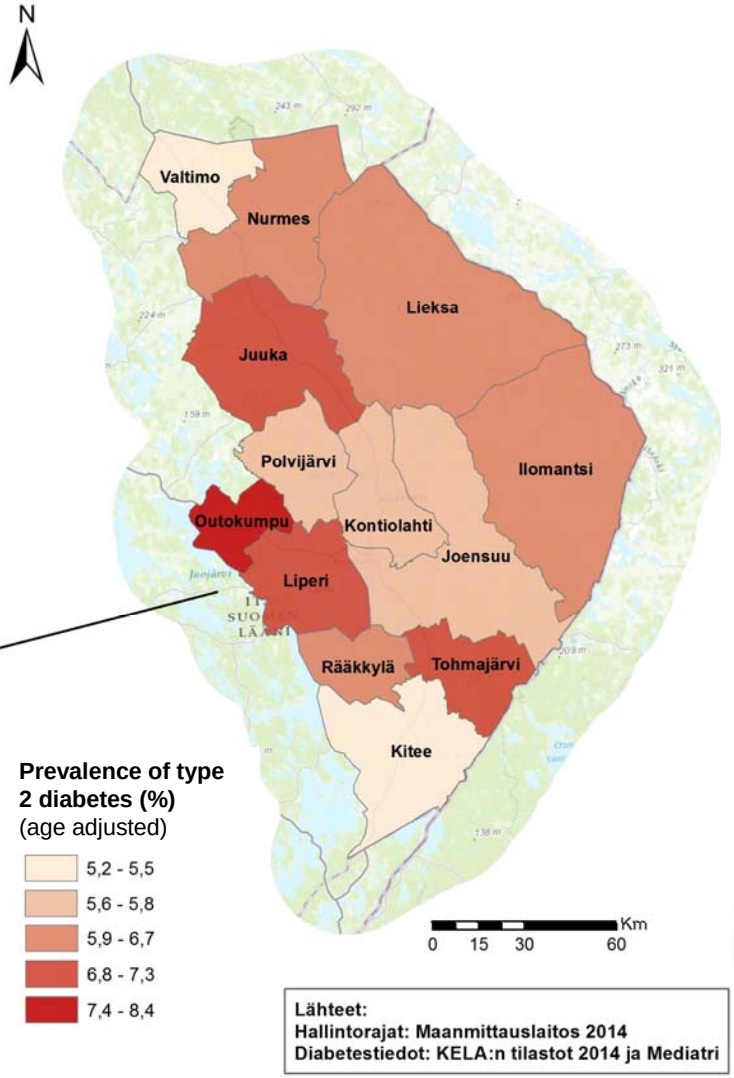
Study 1

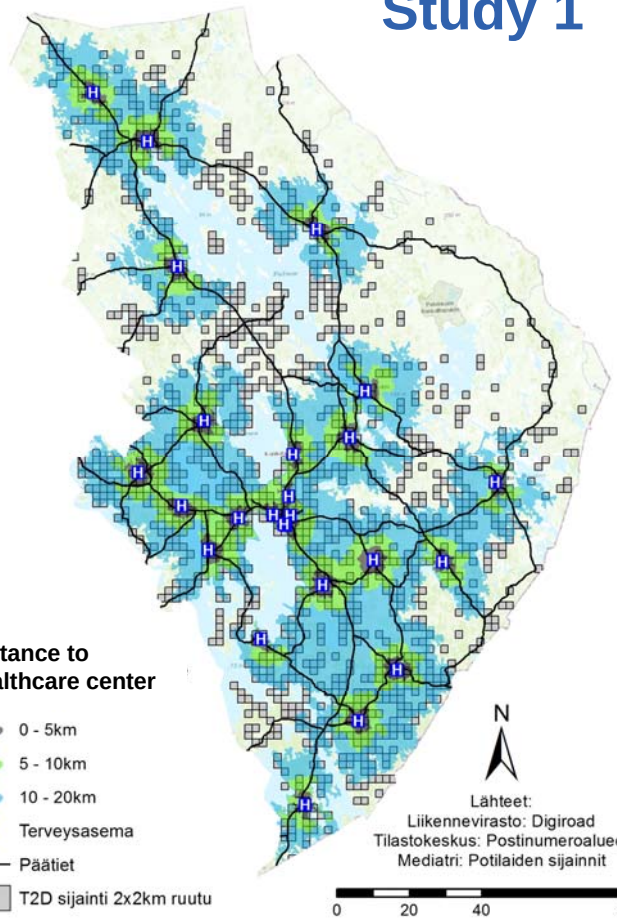




Prevalence of type 2 diabetes (%)
(age adjusted)

- 5,2 - 5,5
- 5,6 - 5,8
- 5,9 - 6,7
- 6,8 - 7,3
- 7,4 - 8,4

Lähteet:
Hallintorajat: Maanmittauslaitos 2014
Diabetestiedot: KELA:n tilastot 2014 ja Mediatri



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Study 2 – Atrial fibrillation (AF):

•The primary form of anticoagulation therapy for atrial fibrillation, warfarin (sold under brand names Marevan and Coumadin), is associated with serious adverse drug events, such as blood cloth and bleeding, so it requires regular monitoring

- Patients travel to a clinic/laboratory for a blood test that measures the international normalized ratio (INR)

  → In Finland on average 15 visits per year

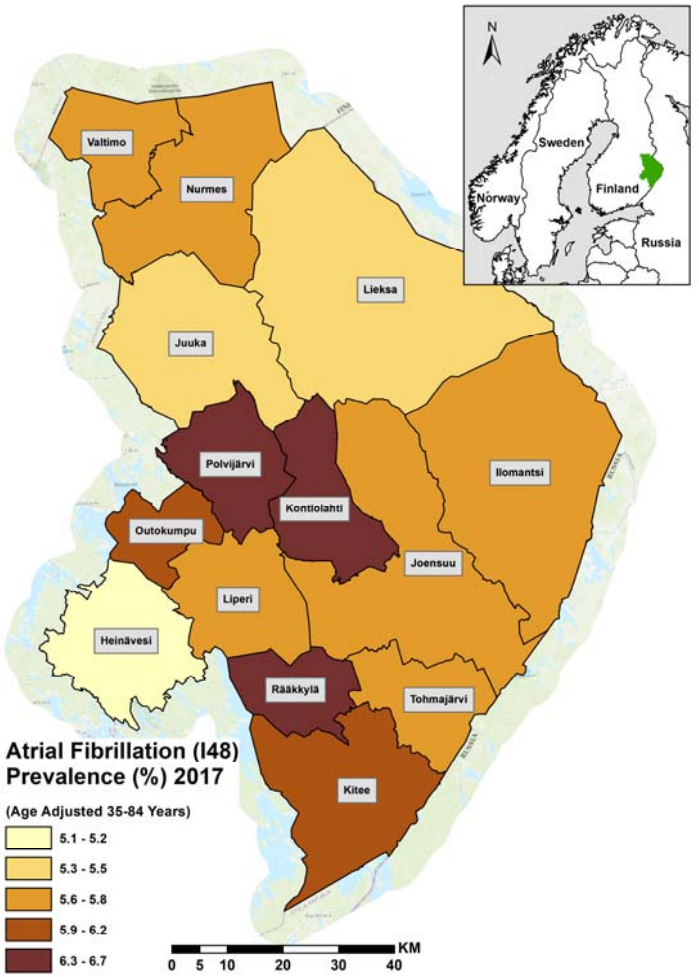
  – What is the share of time and travel costs in the total costs of warfarin therapy?

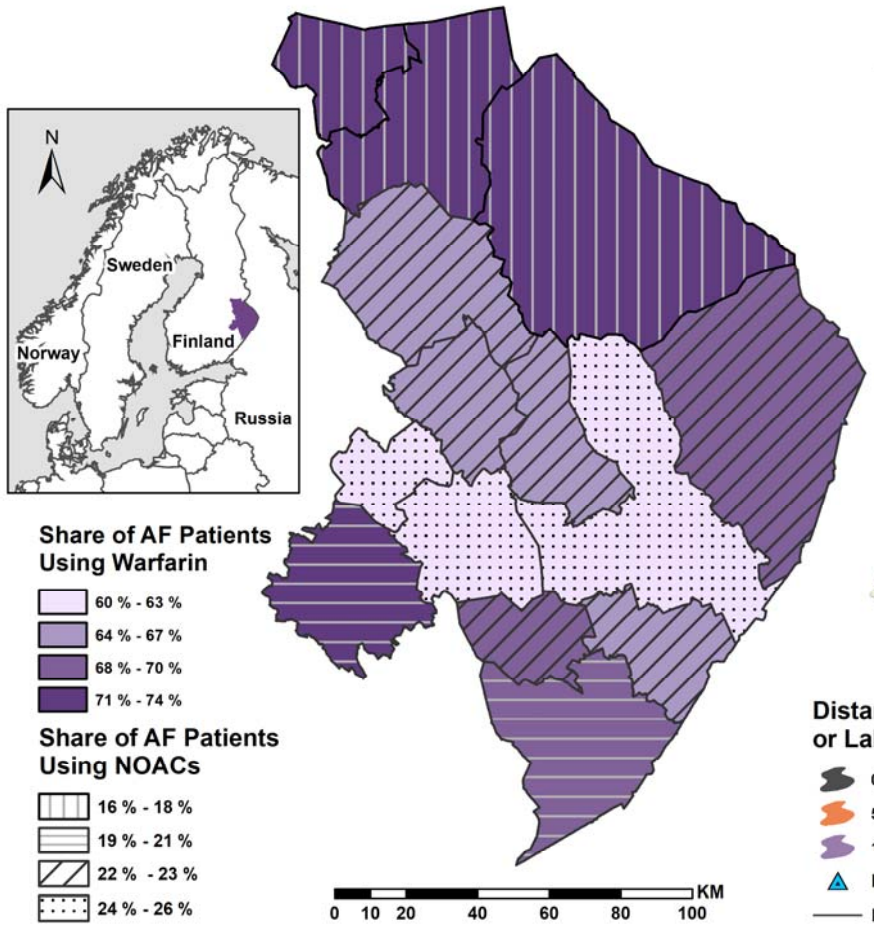
- Warfarin could be replaced with comparably effective new oral anticoagulants (NOAC) that are more expensive but do not require any INR monitoring

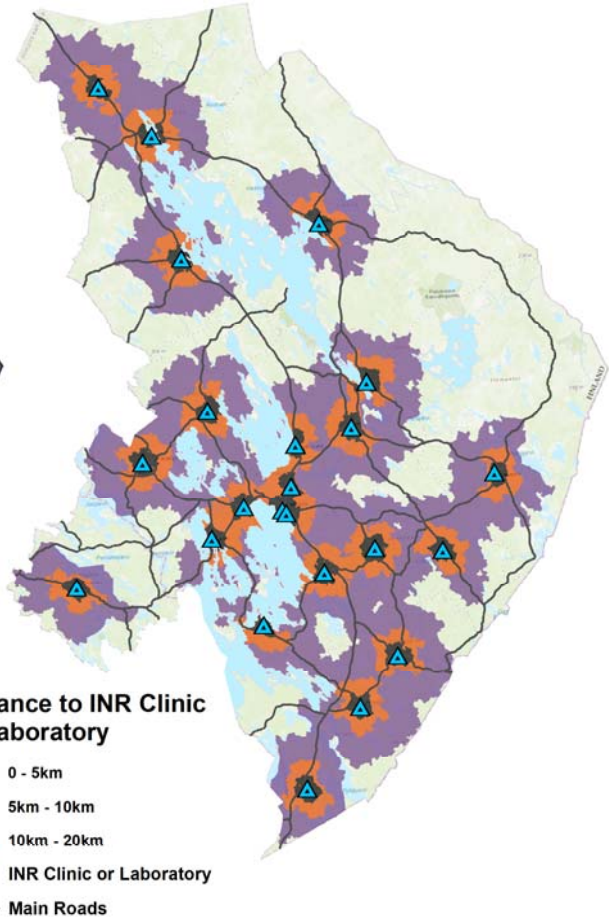
  → More expensive medication but no monitoring related time and travel costs

  – Does replacing warfarin with NOACs induce any savings in the total societal costs of the antiocoagulation management?

Study 2







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Data

- Real-world patient data from the regional patient database (Mediatri) of healthcare district of Siun Sote in North Karelia Finland
  - ❖ Data of gender, age, domicile, diagnoses, laboratory results, prescriptions and healthcare service visits etc. between 2011-2018
  - ❖ **Study 1:** 10 204 patients with type 2 diabetes (ICD-10 code E11) from 2012
  - ❖ **Study 2:** 7436 patients with atrial fibrillation (ICD-10 code I48) from 2017
  - Geocoding with patient home addresses using Digitransit geocoding API in QGIS-software (for example 98.9% success rate, n=7355 for study 2)
  - The used clinic/laboratory and the number and type of healthcare visits per year are known
- Clinic and laboratory locations
- Digital road network data based on Digiroad from Finnish Transport Agency
  - Used to calculate travel time and travel distance
- Zip code area-level income data
  - Used in the valuation of travel time

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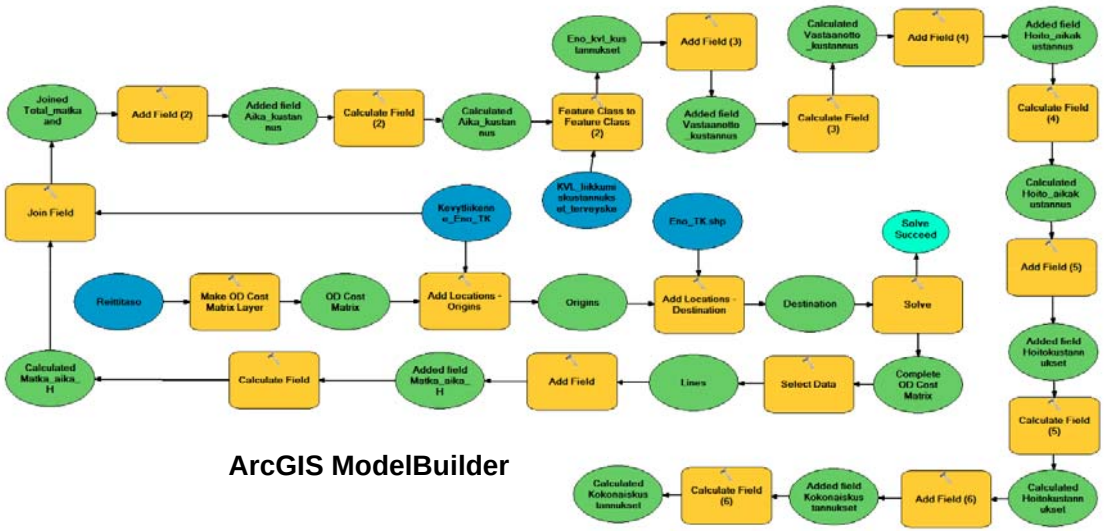
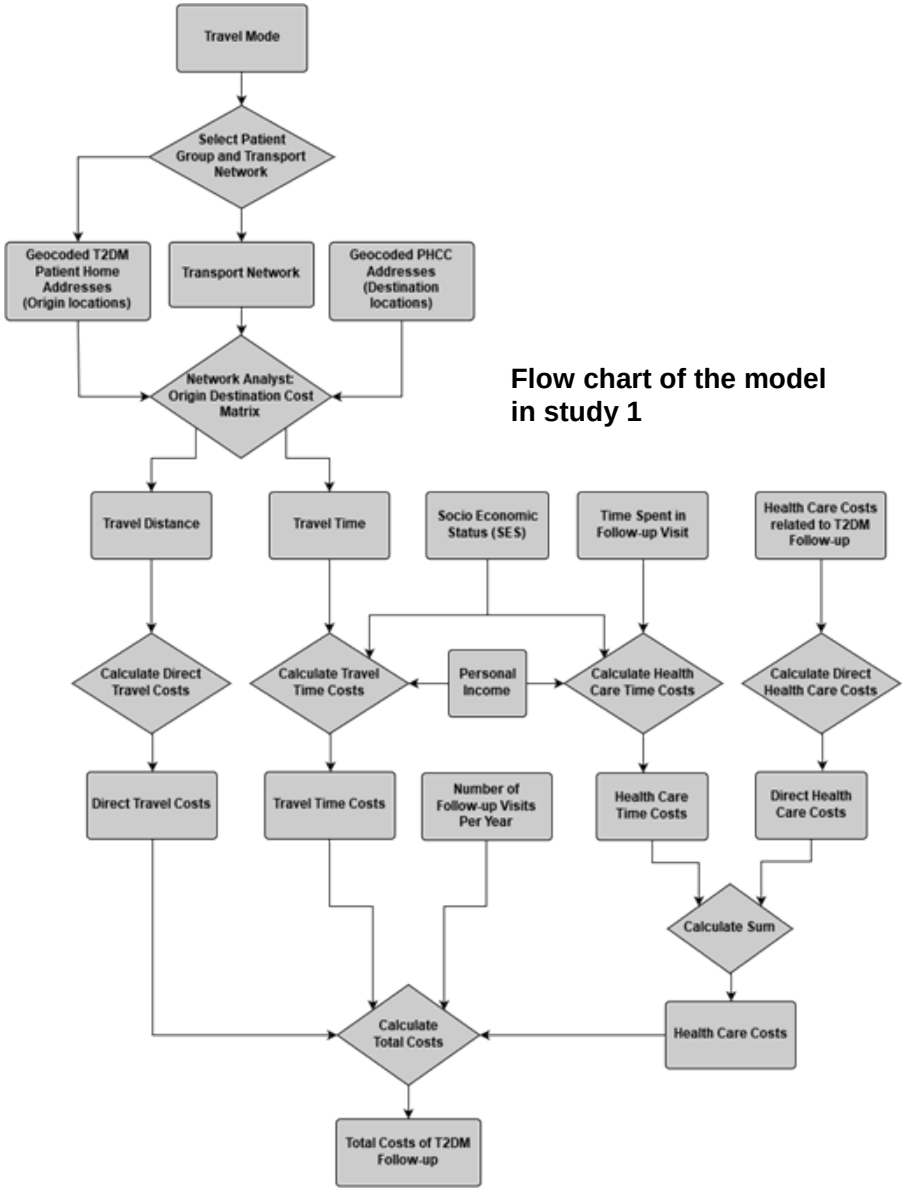
Methods – The cost model

- Georeferenced cost model consists of healthcare related costs as well as time and travel costs
  - **Study 1**: Esri ArcGIS ModelBuilder
  - **Study 2**: Network analysis with Esri ArcGIS Pro and final model in Microsoft Excel



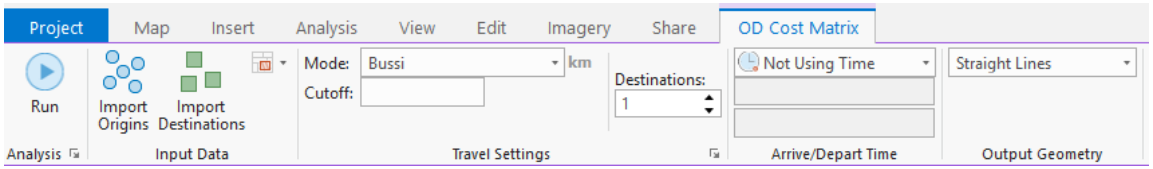
ArcGIS ModelBuilder

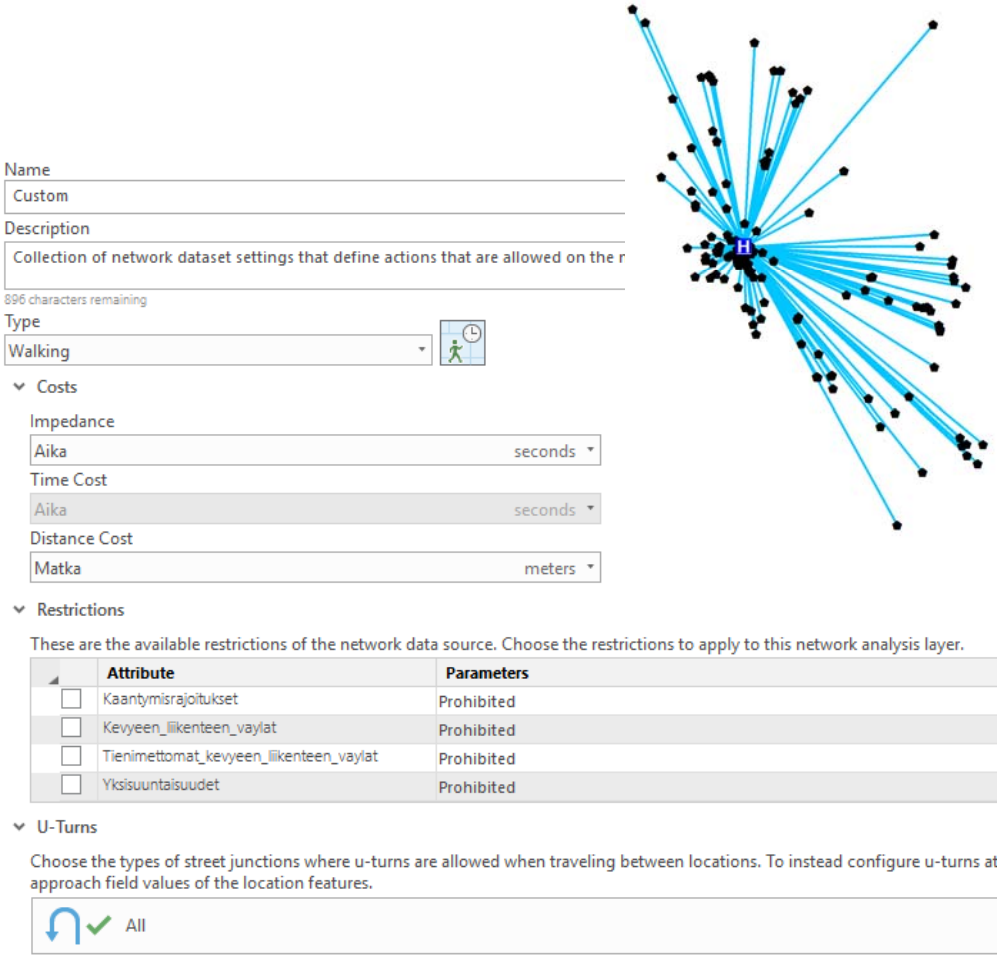


Flow chart of the model in study 1

Methods - Network Analysis

- Origin-Destination (OD) Cost Matrix in ArcGIS
  - Travel time and distance between patient home addresses and clinics/laboratories based on the fastest routes along road network
    - → Converted as monetary costs in the cost model
      - Travel time is valued based on hourly income
        - 100 % for working age patients and 35 % for retired patients (the sensitivity of the results tested also with 20 % and 50 %)
  - Travel modes: private car, taxi, bus, walking



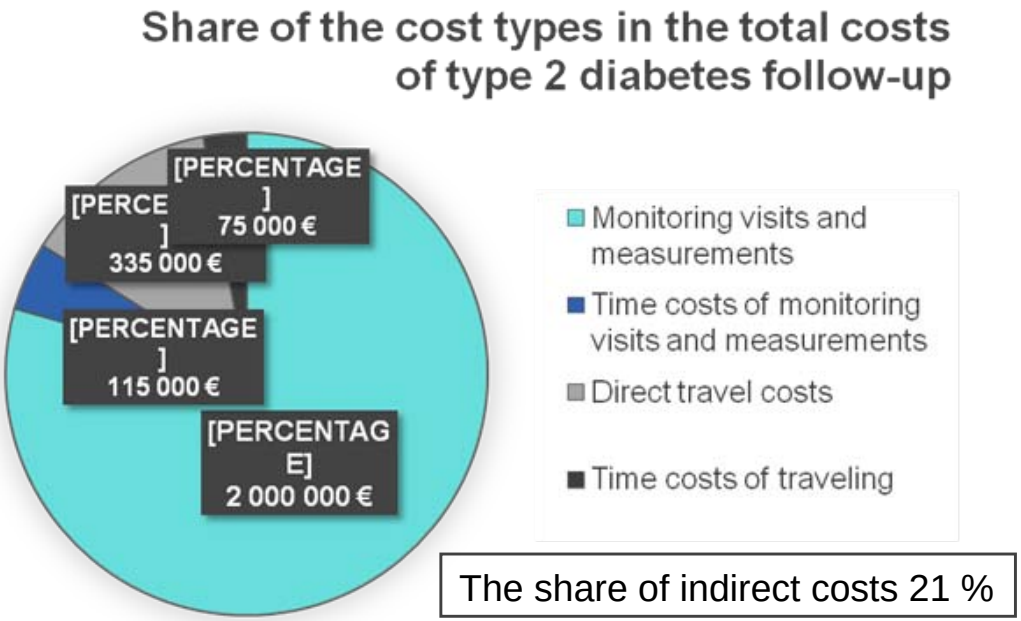


Results – Study 1

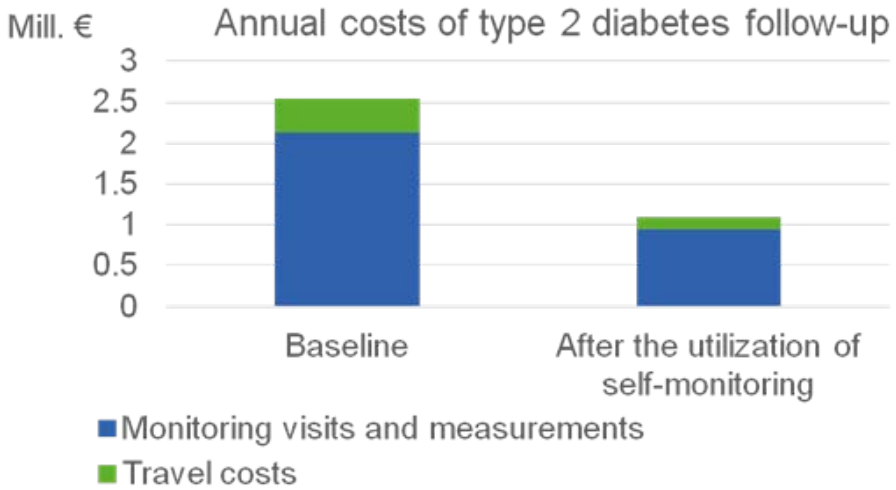
- Annual cost of HbA1c monitoring in T2D follow-up in North Karelia ~2.5 mill. € (2012)
  - On average 280 € per patient
  - On average 78 € per monitoring visit
  - Average annual travel costs 45 € per patient

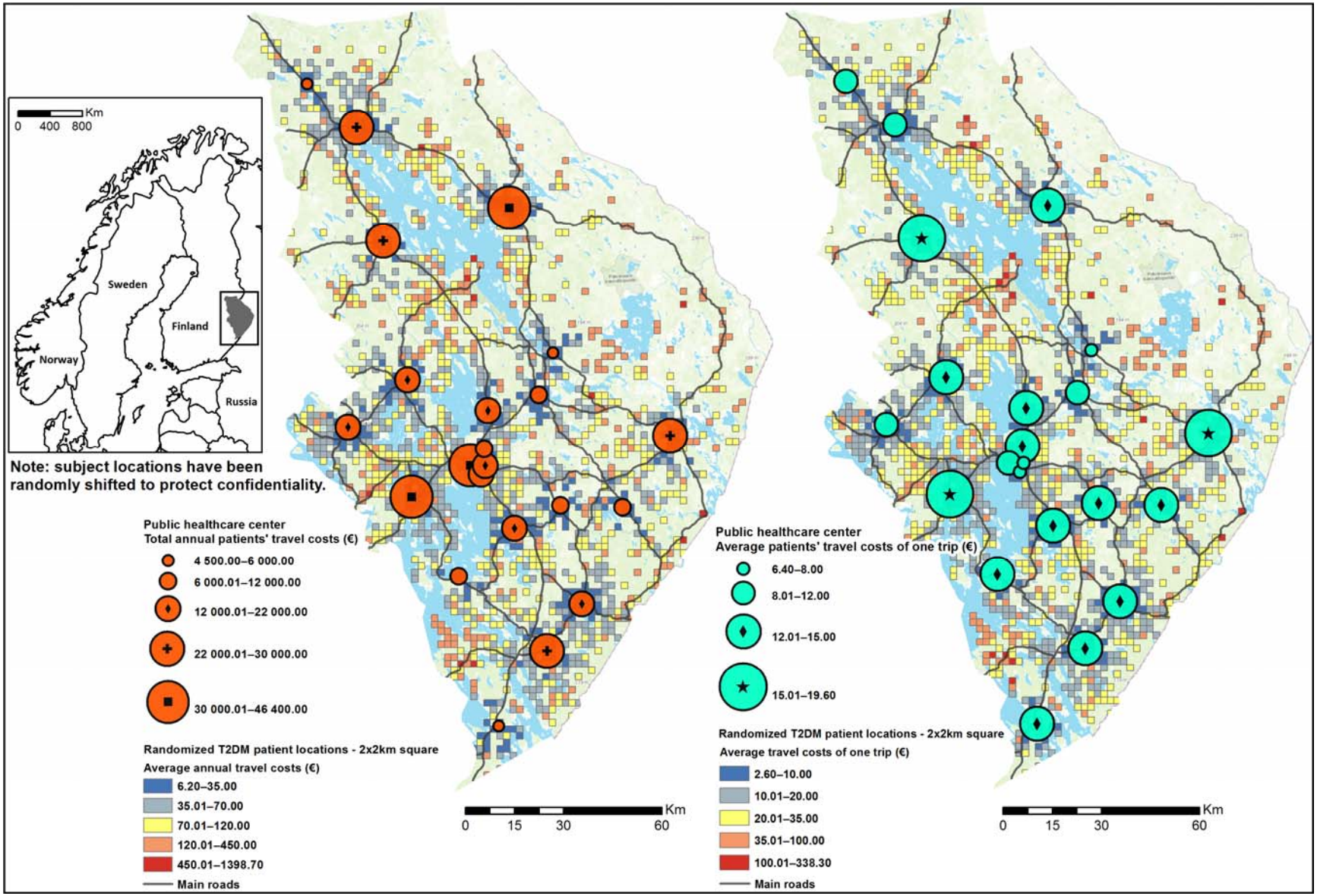
Savings achievable with self-monitoring:

- Annual total costs ~2.5 mill. € → ~1.1 mill. € – **57 % savings**
  - Per patient 280 € → **121 €**
- Annual travel costs 410 000 € → 150 000 € – **63 % savings**
  - Per patient 45 € → **17 €**



The share of indirect costs 21 %




Km
0 400 800
Sweden
Finland
Norway
Russia
Note: subject locations have been randomly shifted to protect confidentiality.
Public healthcare center
Total annual patients' travel costs (€)
4 500.00–6 000.00
6 000.01–12 000.00
12 000.01–22 000.00
22 000.01–30 000.00
30 000.01–46 400.00
Randomized T2DM patient locations - 2x2km square
Average annual travel costs (€)
6.20–35.00
35.01–70.00
70.01–120.00
120.01–450.00
450.01–1398.70
Main roads
Km
0 15 30 60
Public healthcare center
Average patients' travel costs of one trip (€)
6.40–8.00
8.01–12.00
12.01–15.00
15.01–19.60
Randomized T2DM patient locations - 2x2km square
Average travel costs of one trip (€)
2.60–10.00
10.01–20.00
20.01–35.00
35.01–100.00
100.01–338.30
Main roads
Km
0 15 30 60

Results – Study 2

- Annual cost of INR monitoring in warfarin therapy in North Karelia ~4,05 mill. € (2017)
  - On average 835 € per patient
  - On average 52 € per monitoring visit
  - Average annual travel costs 207 € per patient
  - The Indirect costs (time and travel costs) constitute 26.6 % of the total societal costs of warfarin therapy

- Savings achievable with the shift from warfarin to new oral anticoagulants:
  - The total societal cost of anticoagulation management increases 1.8 % with current drug retail prices (excl. VAT) in Finland
  - When measured with drug wholesale prices (the price of drugs from the distributor) the total societal cost decreases 13.6 %

  → Societal savings possible with retail prices after the new drugs become more common and their price starts to decrease

  → Meanwhile, from the patient's perspective the shift is beneficial as it eliminates the burden of traveling and troublesome dosage adjustment of warfarin

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Thank you!