2021 ASPARi Annual Symposium

Presentations

ASPARi

Paving the way forward

UNIVERSITY OF TWENTE.

ASPARi Jaarlijkse Mini-symposium
Online op woensdag 8 december 2021

09:00	09:10	Jan van der Water (Voorzitter ASPARi)	Welkom en introductie
09:10	09:30	Babs Ernst (PDEng kandidaat)	Samen aan de weg timmeren, nieuwe lesmaterialen voor het hbo
09:30	09:50	Tim Stevering (BSc)	Hoogwaardig hergebruik van ZOAB in de praktijk
09:50	10:10	Chris vd Pol (MSc)	Circulaire Materialen als vervanging voor bitumen - Op weg naar een duurzaam asfalt bouwindustrie
10:10	10:30	Thalia Pilataxi (BSc)	Paving and Compaction Support Systems - the status of implementation worldwide
10:30	10:50	Koffie Pauze	
10:50	11:10	Dr. ir. Farid Vahdatikhaki	Pavement Lifecycle Digital Twin; building blocks, applications and road ahead
11:10	11:30	Quinshuo Shen (PDEng candidate)	Coupling PQi Process Quality indicators with Pavement Quality indicators using Machine Learning
11:30	11:50	Inga Maria Giorgadze (PDEng candidate)	A semantic enrichment of asphalt failure modes for Lifecycle Infrastructure Digital Twins
11:50	12:10	Mohammad Sadeghian (PDEng candidate)	Developing an Ontology for the Pavement Lifecycle Management
12:10	12:30	Sajad Mowlaei (PDEng candidate)	The ASPARi Compaction Simulator - first user experiences at the SOMA
12:30	13:00	Lunch	
13:00	13:30	Angie Ruiz Roblez (PhD candidate)	Enhancing stakeholders' synergies on sustainability in the asphalt road sector: a guideline for implementing innovations
13:30	14:00	Monik Pena Acosta (PhD candidate)	Study of the Urban Heat Island phenomenon from a road perspective
14:00	14:30	Denis Makarov (PhD candidate)	Towards an Autonomous Asphalt Construction Process - an overview of research results
14:30		Discussion	

ASPARi
Paving the way forward

UNIVERSITEIT TWENTE.

Timmeren aan de weg

Nieuwe lesmaterialen voor het hbo

Door Babs Ernst

ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Bouwend Nederland
de vereniging van bouw- en infrabedrijven

ASPARi
Paving the way forward

Hoe is deze weg opgebouwd?

Hoe is deze weg opgebouwd?

Zandlaag

Waarom is dit project ontstaan?

Hoe is deze weg opgebouwd?

Fundering	Wat hebben we geconstateerd?
Zandlaag	Waarom is dit project ontstaan?

Hoe is deze weg opgebouwd?

Hoe is deze weg opgebouwd?

Hoe is deze weg opgebouwd?

Hoe is deze weg opgebouwd?

Een snelle samenvatting

Een snelle samenvatting

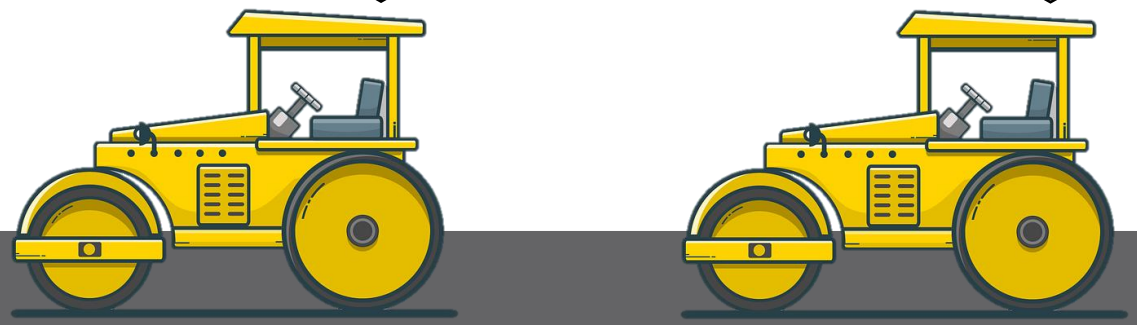
Een snelle samenvatting

Lesmaterialen hbo verouderd

Een snelle samenvatting

Lesmaterialen hbo verouderd

Veranderende eisen vanuit het werkveld



Een snelle samenvatting

Lesmaterialen hbo verouderd

Veranderende eisen vanuit het werkveld

Een sterke innovatieve industrie

De Analyse

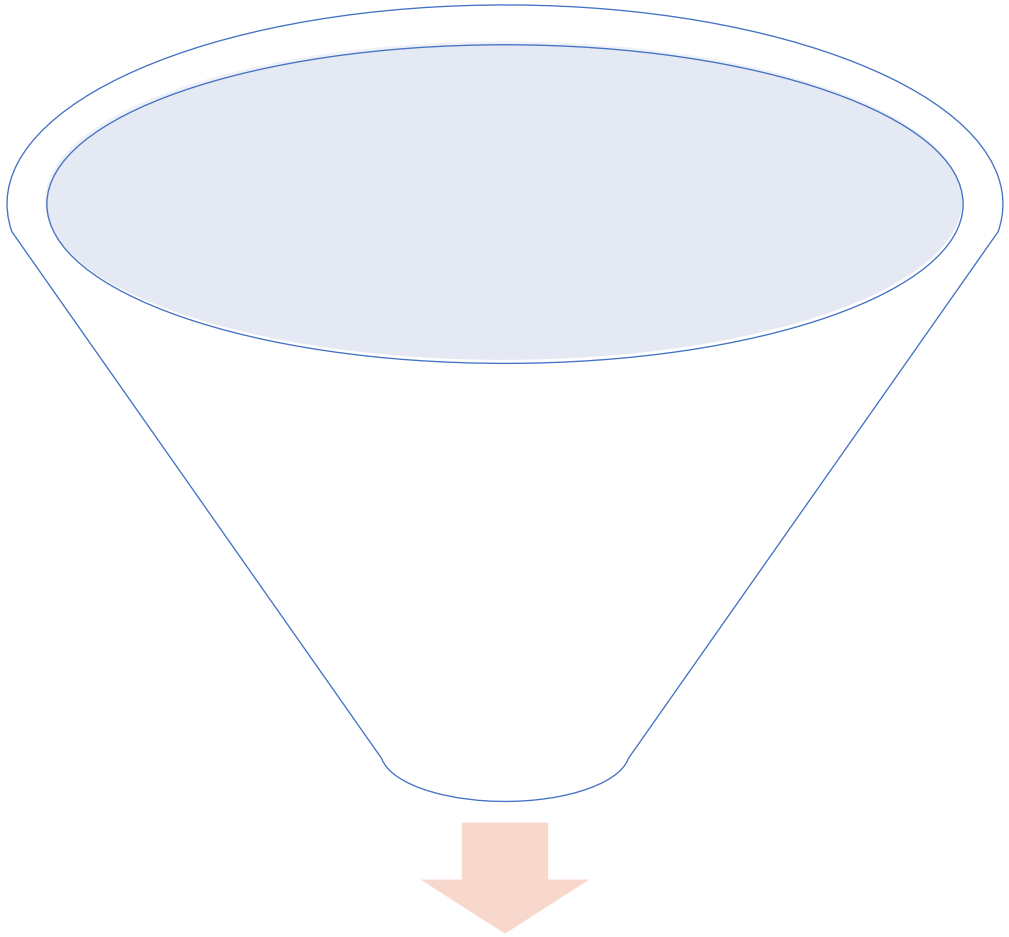
De Analyse

- Werkveld
- Onderwijsinstellingen
- Literatuur

De Analyse

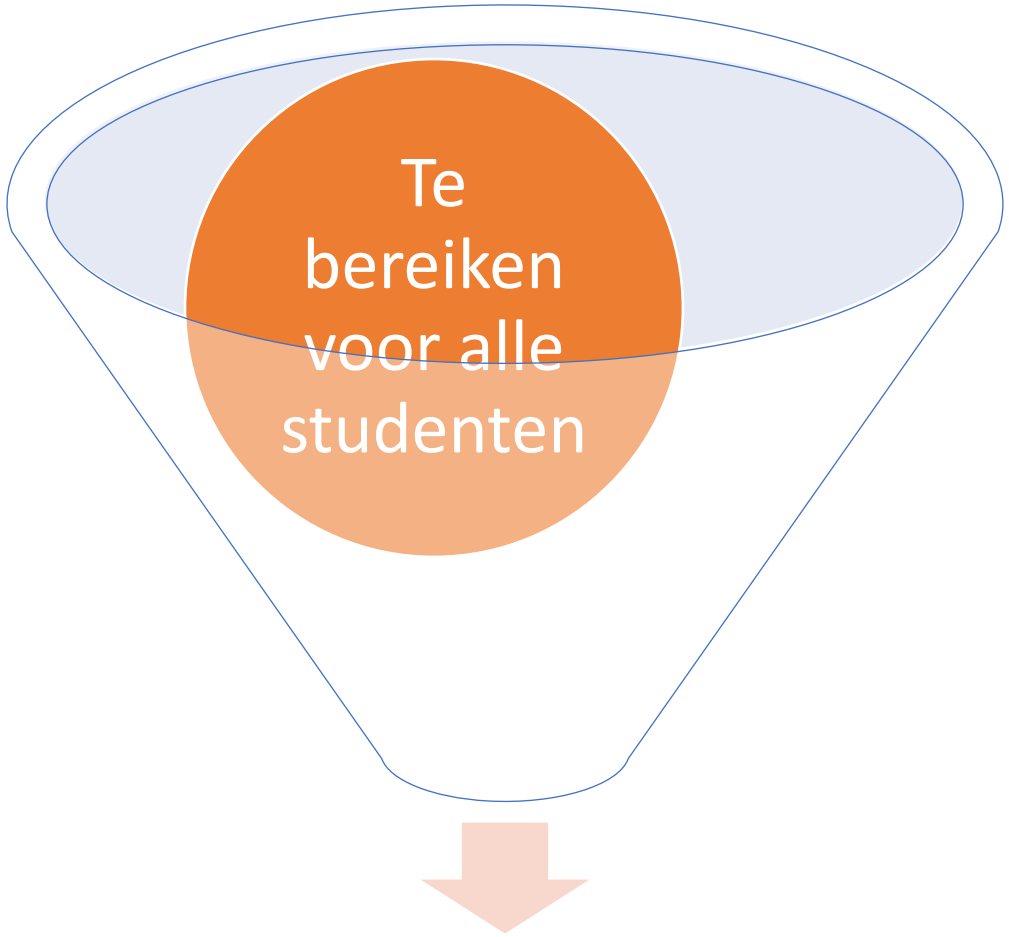
De Analyse


De ontwikkelingen van de industrie
Educatie in het onderwijs

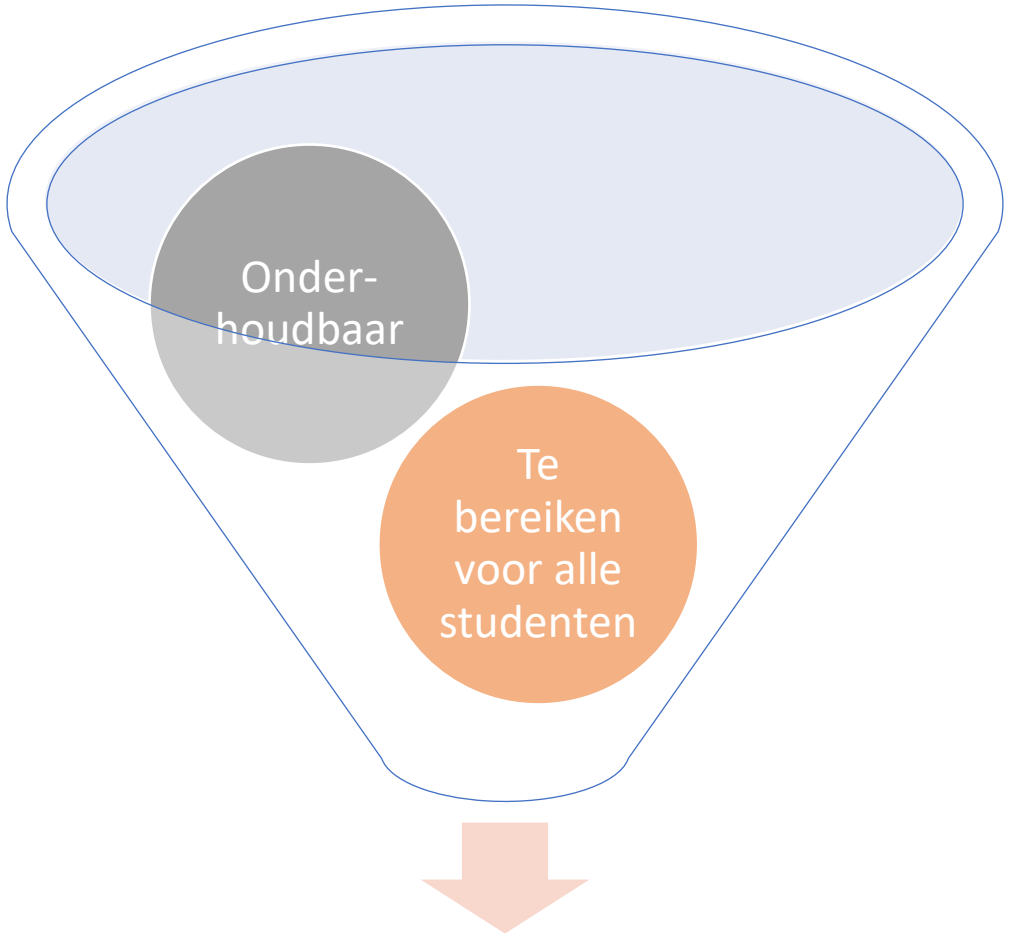


Lesmaterialen wegenbouw

Wat is er ontwikkeld?

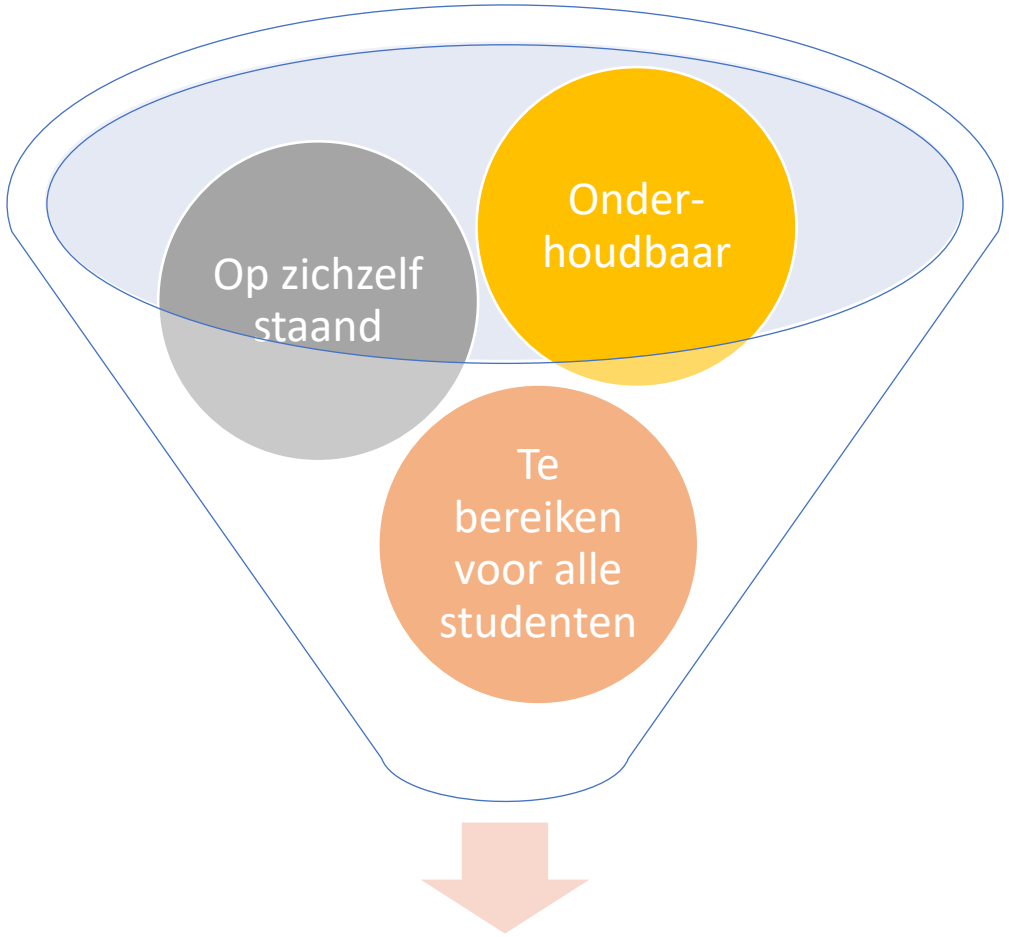


Lesmaterialen wegenbouw



Lesmaterialen wegenbouw

Wat is er ontwikkeld?



Lesmaterialen wegenbouw

Wat is er ontwikkeld?

Realiseren asfalt constructie

Marco Oosterveld

De asfaltcentrale

Alex van de Wall

Asfaltmengsels

Babs Ernst & Jeroen Besamusca

Kwaliteitsborging

Berwich Sleuer

Meten aan de weg

Seirgei Miller

Module Realiseren Asfaltconstructie | Guest (y6jrfut5qn)

- Introductie
- Logistiek
- Op de bouwplaats
- De aanleg
- De machines
- Eindopdracht Randweg Bo…

De aanleg

Introductie

In de vorige onderdelen heb je geleerd over hoe het asfalt naar de bouwplaats komt en welke voorbereidingen er getroffen moeten worden. In dit blok ga je leren over de aanleg van de weg. Aan het eind van dit onderdeel weet je alles over de verschillende lagen van de weg, verdichting en wat er belangrijk is bij deze verdichting.

Een weg aanleggen doe je niet in één keer. Een weg bestaat namelijk uit diverse lagen. In figuur 1 zie je een voorbeeld van een standaard opbouw van de weg met de meerdere lagen. Dat de weg uit lagen bestaat, heeft meerdere redenen. Voordat je hierover leest, mag je hier eerst zelf over na gaan denken.

Introductieopdracht: Waarom denk je dat de weg uit meerdere lagen bestaat?

Wat is hiermee gebeurd?

Minor, een innoverende asfaltketen

avans hogeschool

HAN_UNIVERSITY OF APPLIED SCIENCES

Toegang tot lesmaterialen om hun onderwijs te verbeteren

Wat is hiermee gebeurd?

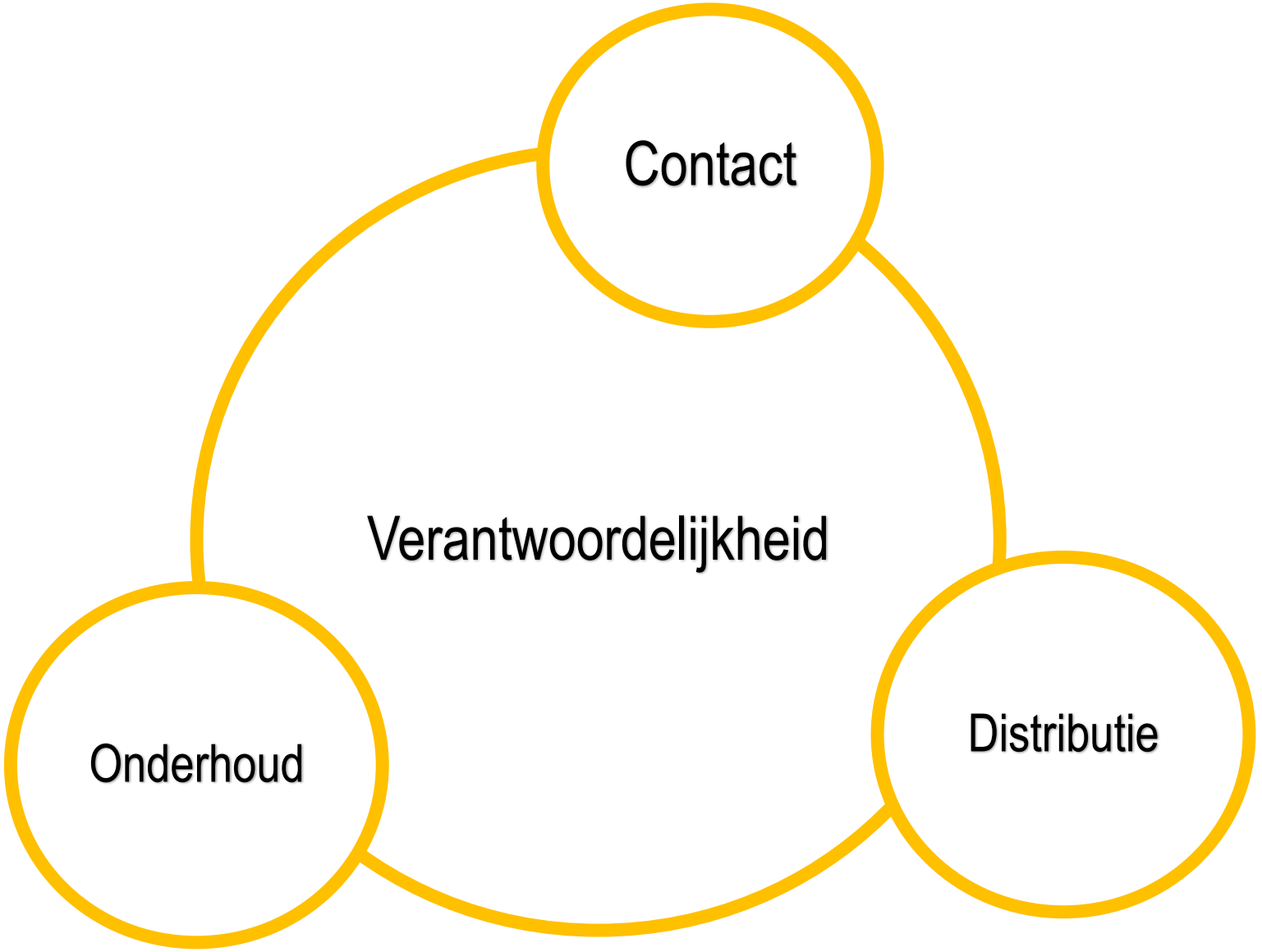
Waar zijn we nu?

Wat is hiermee gebeurd?

Waar zijn we nu?

De laatste walsgangen worden nog uitgevoerd over deze laag…

Wat is hiermee gebeurd?


Contact
Verantwoordelijkheid
Onderhoud
Distributie

Take home message…

Take home message…

Aan de weg timmeren doen we samen

Bedankt voor de aandacht

Babs Ernst

b.t.m.ernst@utwente.nl

Begeleiding door:
Seirgei Miller
André Dorée
Ron Wesseling
Wouter Heijsser

Wals door Pixabay.com

Bedankt voor de aandacht

Hoogwaardig hergebruik van ZOAB in de praktijk

Waar staan we en waar moeten we op letten?

Bachelor Thesis onderzoek
Tim Stevering
November 2020 – Februari 2021

Onder begeleiding van
Dr. S.R. Miller (UT)
Dr. R. Hofman (RWS)

Introductie

- Doel: Inzicht in problemen gerelateerd aan horizontaal hergebruik ZOAB

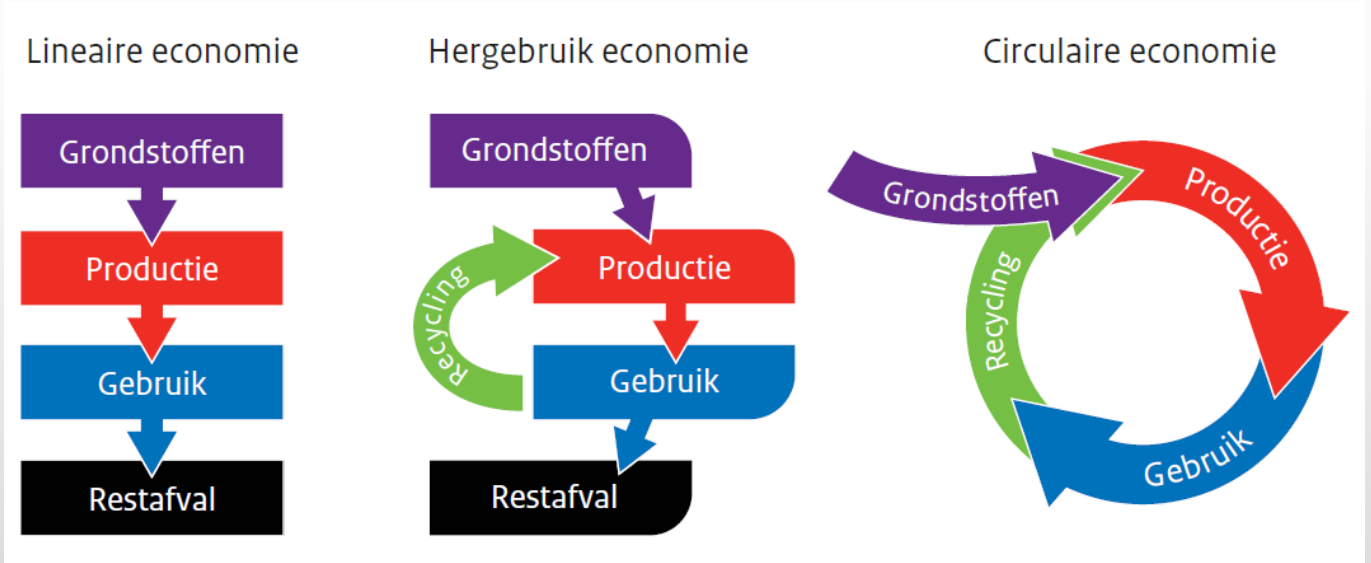
ASPARi

Paving the way forward

UNIVERSITY OF TWENTE.

Waarom?

- RWS ➔ Klimaat neutraal en circulair in 2030
- >80% toplagen RWS is ZOAB
- Potentieel tekort aan PR?



Van lineaire naar circulaire economie (IenM, 2016)

ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Hoe?

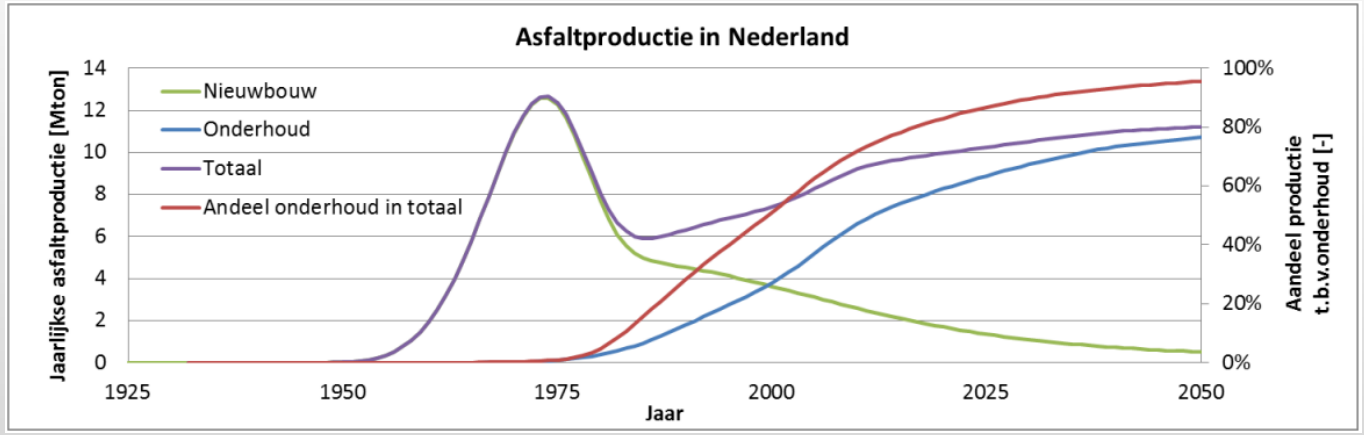
- Literatuuronderzoek, 8 interviews en 2 casestudies.

ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Wat kan volgens de literatuur?

- Asfalt met max 60% PR ➔ meer overschrijdt de emissienormen asfaltcentrales (Jacobs, Frunt & Reering, 2016)
- ≈ 60% ZOAB frees kan worden hergebruikt als PR voor ZOAB (geïnterviewden)
  - Innovaties zoals kneuzen van asfalt kunnen dit verhogen.



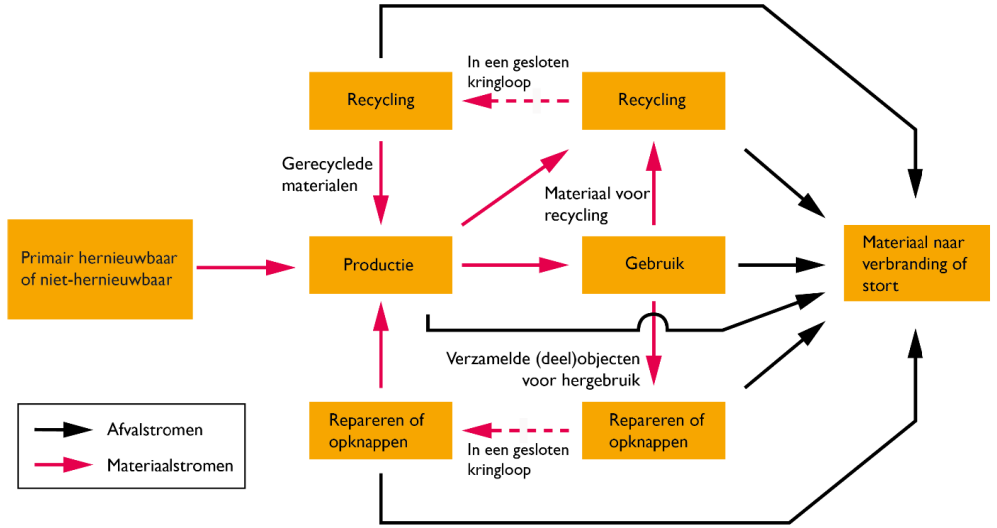
Asfalt productie in Nederland (Huurman & Demmink, 2016)

ASPARi
Paving the way forward

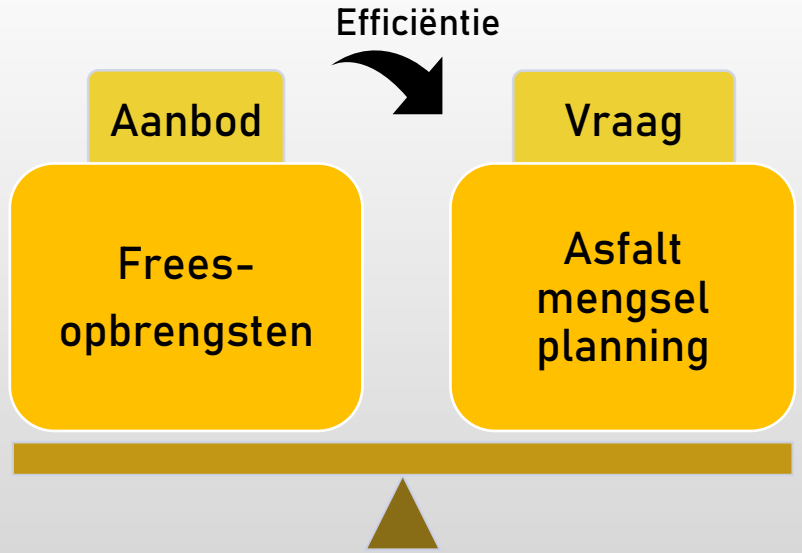
UNIVERSITY OF TWENTE.

Wat meten we?

- Materiaal balans
- Minimaliseren materiaal verlies
- Hoogwaardig hergebruik



Materiaal balans (Platform CB'23, 2020)



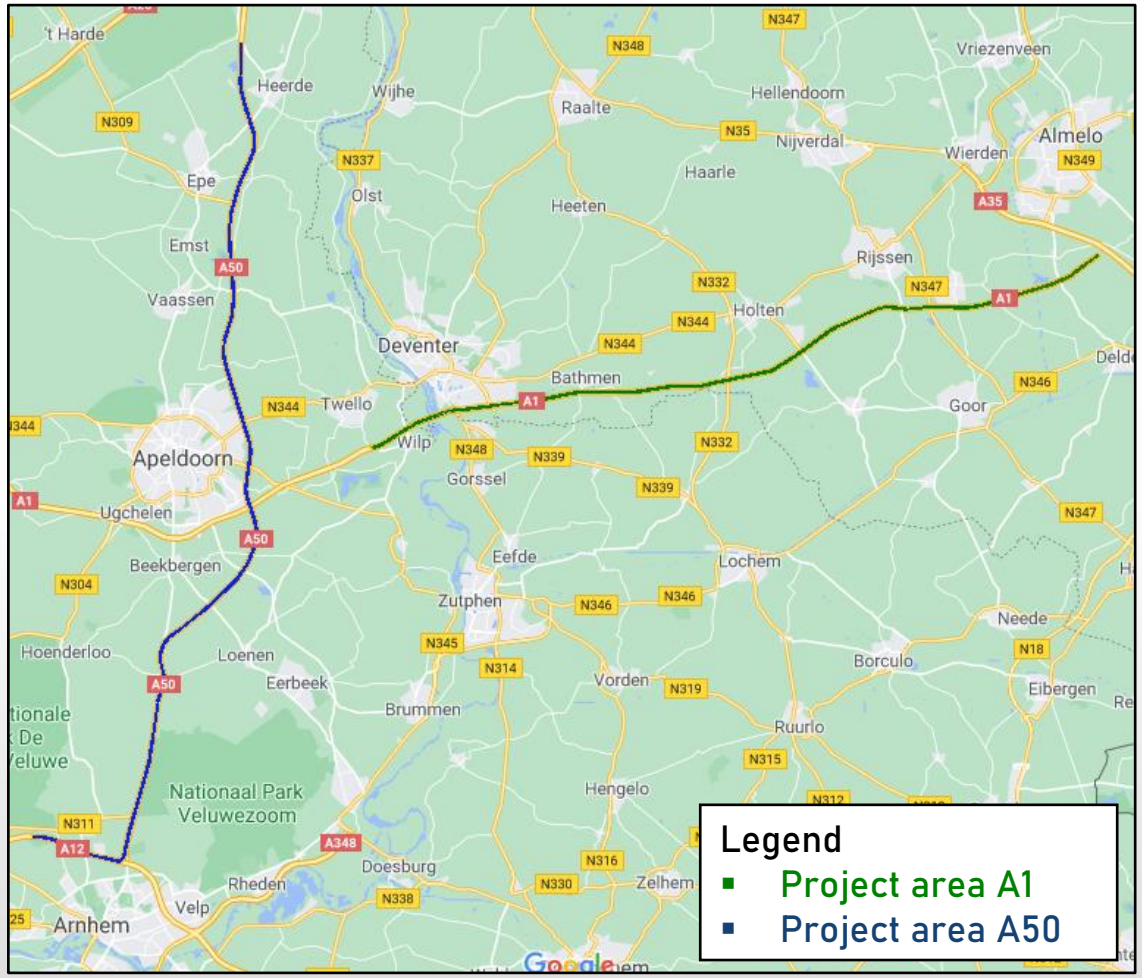
ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Waar? – Casestudies

- A1 Apeldoorn – Azelo (A1oost)
  - Uitbreiding / Verbreding
  - ≈ 40 km, 410.000 ton asfalt waarvan 135.000 ton ZOAB

- A50 Heerde – Waterberg (IGO oost)
  - Onderhoudsproject
  - ≈ 50 km, 185.000 ton asfalt waarvan 145.000 ton ZOAB



ASPARi
Paving the way forward

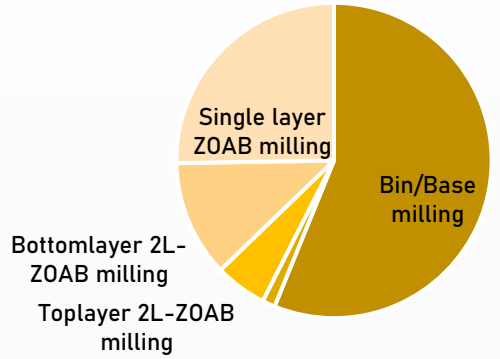
UNIVERSITY OF TWENTE.

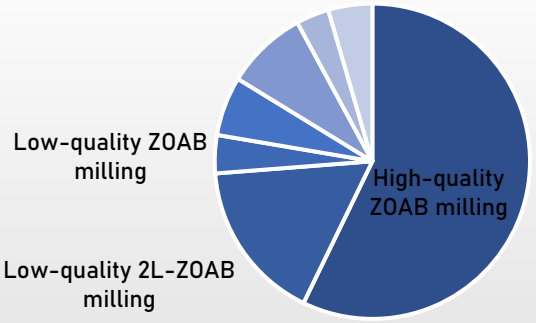
Resultaten

- A1:
  - Voornamelijk bin/base-frees
  - Aantal ton gefreesd ≈ ½ aantal ton PR gebruikt.

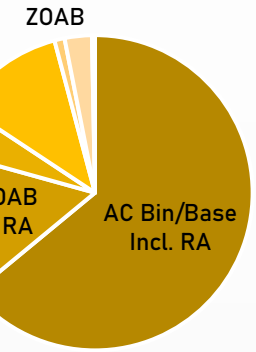
- A50:
  - Voornamelijk ZOAB-frees
  - Aantal ton gefreesd ≈ aantal ton PR gebruikt.

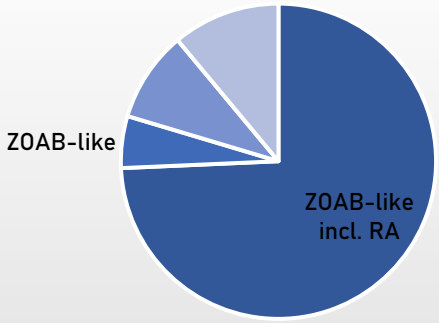
Freesopbrengsten





Asfaltmengels



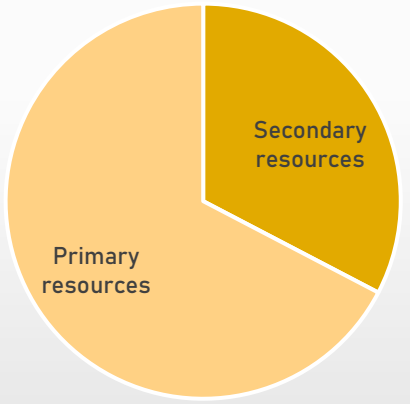


ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Resultaten A1

- ≈ 33% van nieuwe ZOAB is gerecycled
- Maar, alle PR is gebruikt binnen het project
  - Deels hoogwaardig, deels downcycled.



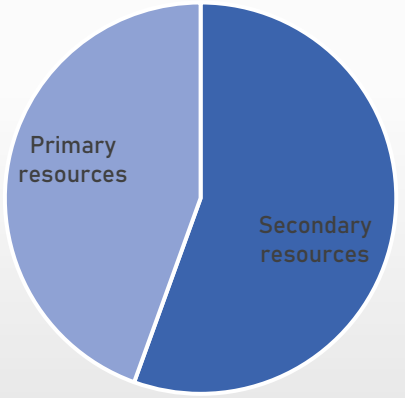
ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Resultaten A50

- ≈ 56% van nieuwe ZOAB is gerecycled
  - ZOAB mengsels met percentages tot 70% hergebruikte materialen

- Aanbod PR uit project te laag voor de vraag
  - PR uit andere projecten nodig



ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Tekort aan PR?

- Ja, te weinig PR vrijgekomen om 56% circulair ZOAB te maken
- Enkel tekort in grove fractie asfaltgranulaat
  - 5/8mm steenslag 3 & 11/16mm steenslag 3

- Kwaliteitsverlies tijdens gebruik & breken tijdens frezen.

- Overschot in andere fracties

ASPARi

Paving the way forward

UNIVERSITY OF TWENTE.

Conclusie

- Theoretisch maximum 60%, Casestudie resultaat 56%
  - Asfaltcentrales zijn bottleneck, innovaties kunnen dit omzeilen (PA-stone)
- Tekort aan PR is waargenomen,
  - Enkel de hoogwaardige grove fracties
- Tekort kan zorgen voor compromissen

ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Circulaire bitumen-vervangers

Op weg naar een duurzame wegenbouw?

GEBR. VAN DER LEE

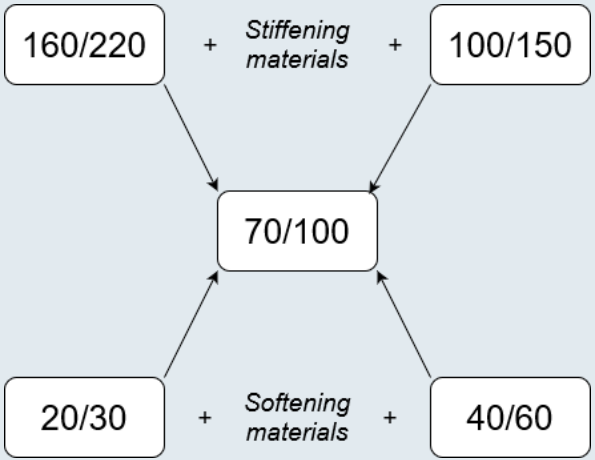
C.R. (Chris) van de Pol

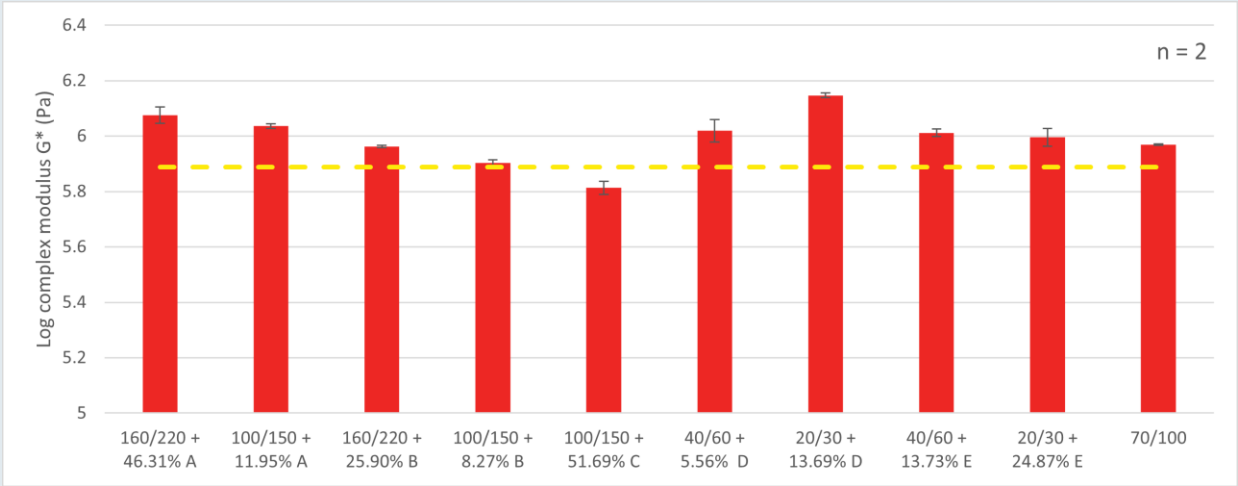
MSc. Construction Management & Engineering
University of Twente
Gebr. Van der Lee
Master thesis

ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Onderzoeksplan





A, B, C, D, E

Dynamic shear rheometer

- Stijfheid
- Fasehoek

- Vermoeiing
- Spoorvorming
- Meng- en verwerkingstemperatuur

Resultaten

Mengsels	Spoor-vorming	Elastisch herstel	**Vermoeiing**	Mengtemperatuur	Verdichtingstemperatuur	**Gewogen gemiddelde**
Gewicht	0.25	0.25	0.25	0.125	0.125	
160/220 + 46.31% A	17.1	9.4	**-15.5**	-53.2	-55.5	**-10.8**
100/150 + 11.95% A	5.3	-0.9	**1.8**	-27.9	-24.1	**-5.0**
160/220 + 25.90% B	18.3	29.6	**-16.8**	-49.8	-39.8	**-3.4**
100/150 + 8.27% B	9.8	19.6	**10.0**	0.1	-1.0	**9.7**
100/150 + 51.69% C	17.2	66.5	**82.1**	14.8	22.5	**46.1**
40/60 + 5.56% D	-11.5	-3.1	**-17.7**	21.5	28.3	**-1.8**
20/30 + 13.69% D	-81.7	-33.5	**-17.9**	46.8	44.5	**-21.9**
40/60 + 13.73% E	2.3	-8.1	**-1.6**	-2.5	1.8	**-1.9**
20/30 + 24.87% E	7.2	-0.5	**21.4**	-0.7	-4.0	**6.4**
70/100	0.0	0.0	**0.0**	0.0	0.0	**0.0**

Materiaal A: Kraft lignine

GEBR. VAN DER LEE

STORAENSO

BIOWAY

CHAPLIN

GRASFALT

Materiaal A: Kraft lignine

Mengsels	Spoorvorming	Elastisch herstel	Vermoeiing	Mengtemperatuur	Verdichtingstemperatuur
	Jnr @ 0.1kpa	R @ 0.1 kPa	Cyclussen tot falen	°C	°C
160/220 + 46.31% A	0.61	34.18	38350	169.3	159.3
100/150 + 11.95% A	1.63	26.61	272100	163.4	151.9
70/100	2.09	27.30	247700	156.9	146.2

Materiaal A: Kraft lignine

GEBR. VAN DER LEE

“Helft van bitumen vervangen door lignine”

“Lignine is op veel lagere temperaturen te produceren dan bitumen”

“Geur”??

Materiaal A: Kraft lignine

Mengsel	AC 11 Surf	
% PR	0	
% Bitumen	3.0	46%
% Lignine	2.6	
% Holle ruimte		
Bitumen & Lignine apart	10%	
Bitumen & Lignine voorgemend	9%	
Bitumen & Lignine apart + LTA	9%	

Toekomst

GEBR. VAN DER LEE

Laboratorium <> Asfaltmolen?

Hoe kan een mengsel waar het functionele bindmiddel grotendeels vervangen is door een vaste stof betere prestaties opleveren?

Paving and Compaction Support Systems – the status of implementation worldwide

Thalia Johanna Pilataxi Araujo

ASPARi

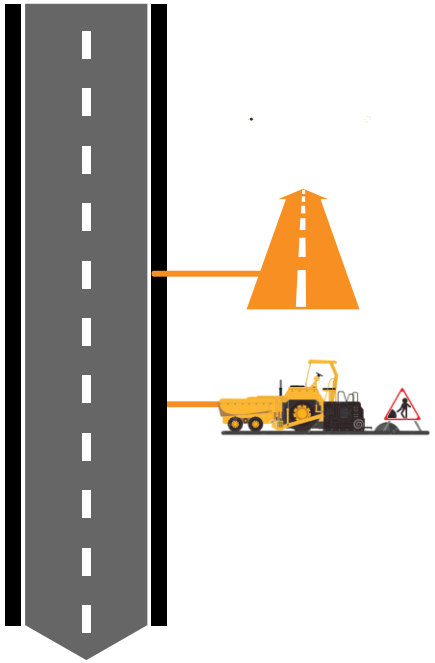
Paving the way forward

UNIVERSITY OF TWENTE.

In this presentation:

1. Introduction
2. Evolution of paving and compaction support systems
3. Guidelines and specifications for road construction
4. Enablers and barriers
5. Conclusions and recommendations
6. Questions

Introduction



Quality assessment is carried out manually and at limited spots

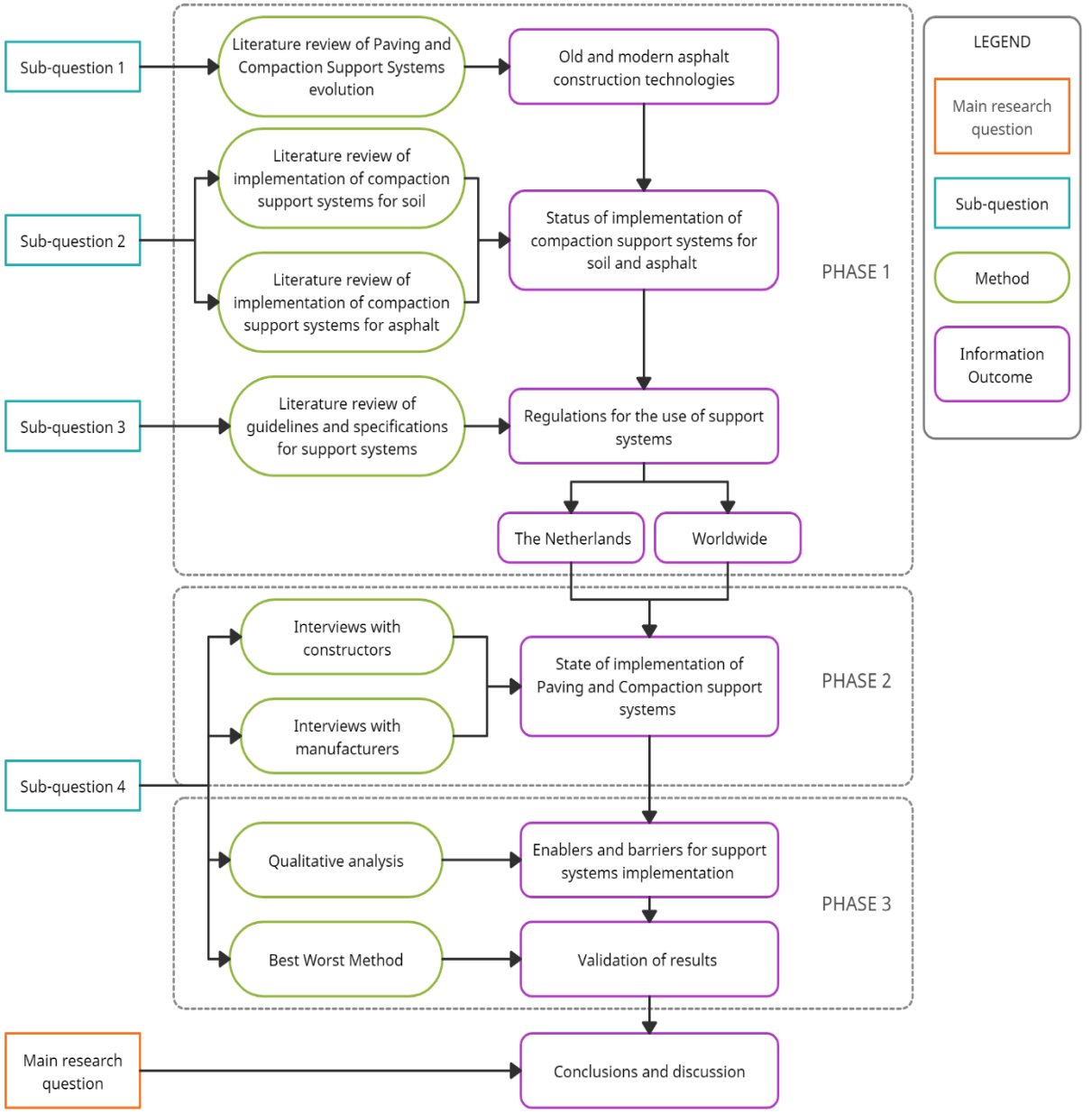
Academia and industry have developed high-tech solutions for asphalt construction

Research questions

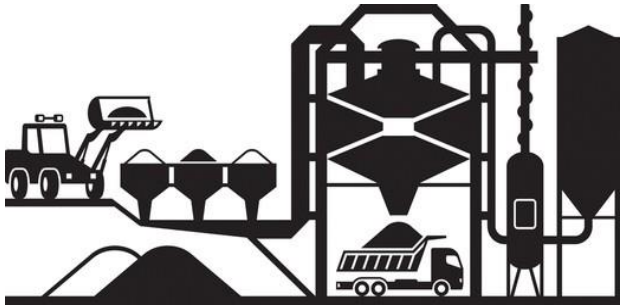
How can the implementation and adoption of paving and compaction support systems for asphalt construction be fast-tracked given current approaches in development, contractual forms and regulations?

1. How have paving and compaction support systems evolved over the years?
2. What are the differences among the implementation of support systems for soil and asphalt compaction of roads?
3. How have paving and compaction support systems been integrated into specifications and guideline documents for road construction in Europe, North America and South America?
4. What are the enablers and barriers to paving and compaction support systems becoming standard practice for road construction?

Research methods



Conventional practices for road construction

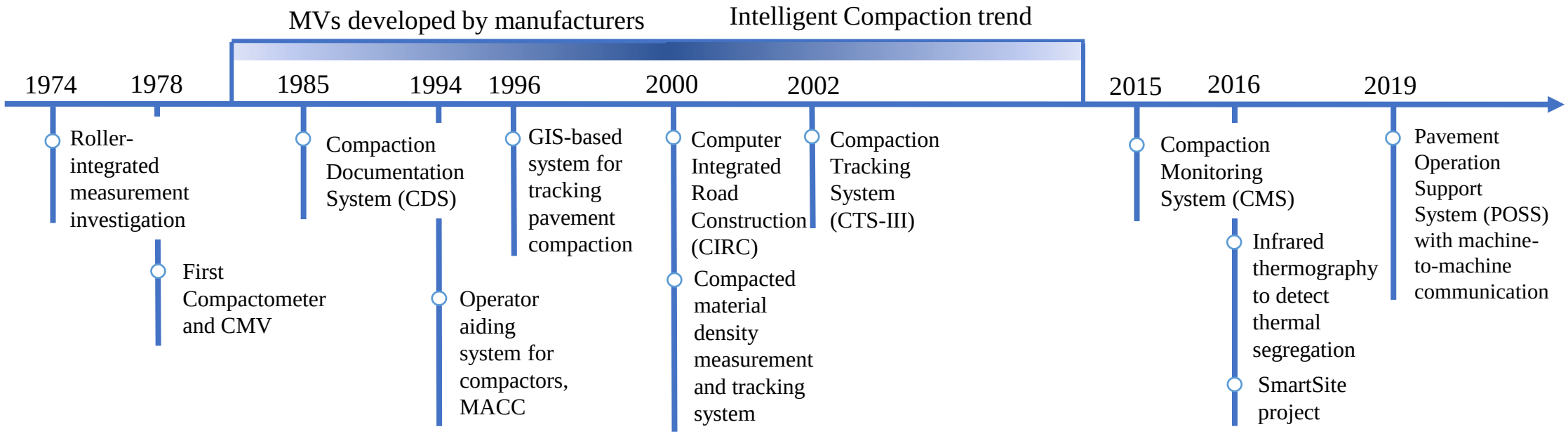


Production and transportation of asphalt mixes

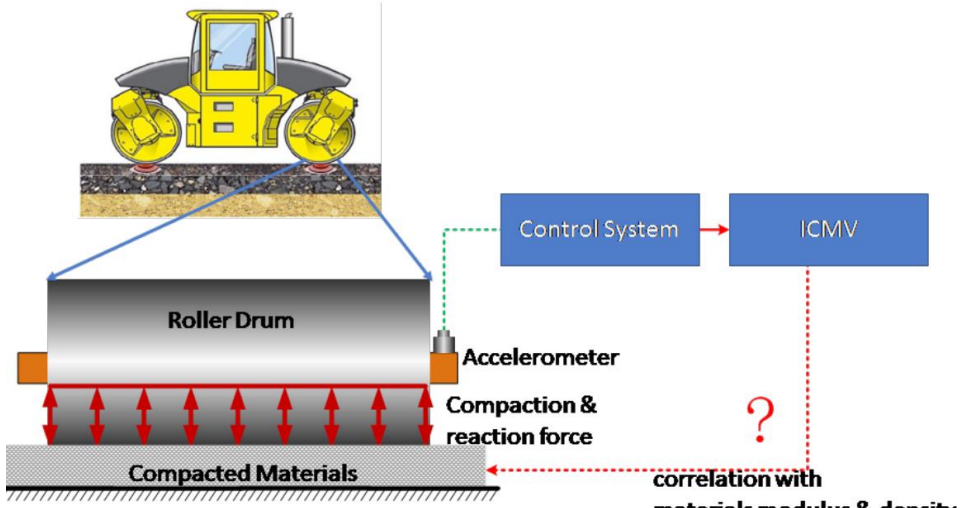
Asphalt placement and roller compaction

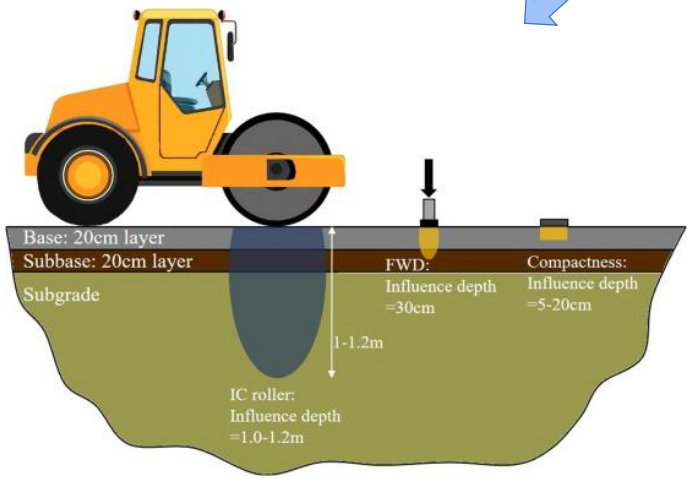
Random (spot) testing methods

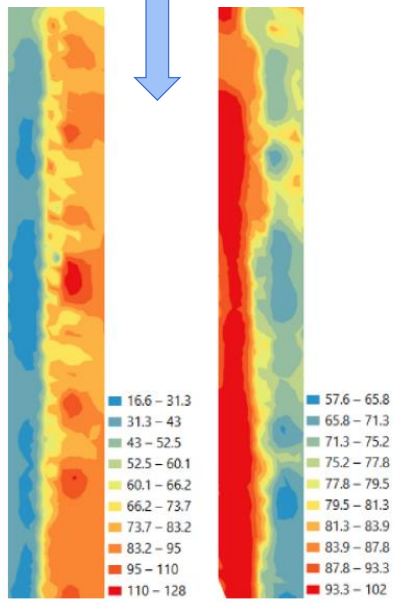
The historical track of developments in asphalt construction

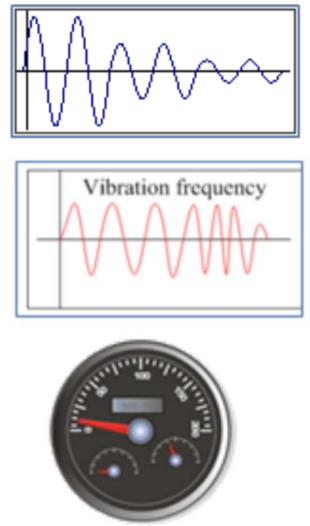


Correlation studies





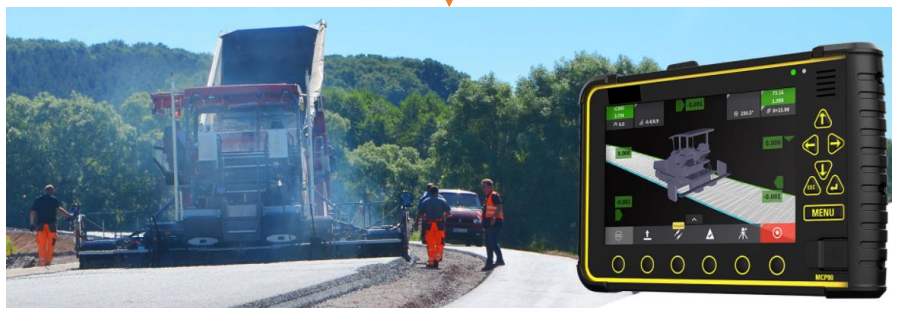




The current trend of market available solutions

Gathering, storing, documenting and analysing data in real-time

Telematics



Machine Control

The current trend of market available solutions

Europe

1. Have adopted high-tech solutions within their regulations.
2. Conventional technologies **or** adoption and research about other technologies

South America

1. Have not implemented regulations for high-tech solutions. However, there is research about them.
2. Have not implemented regulations for high-tech solutions. Furthermore, this concept is unfamiliar for them.

North America

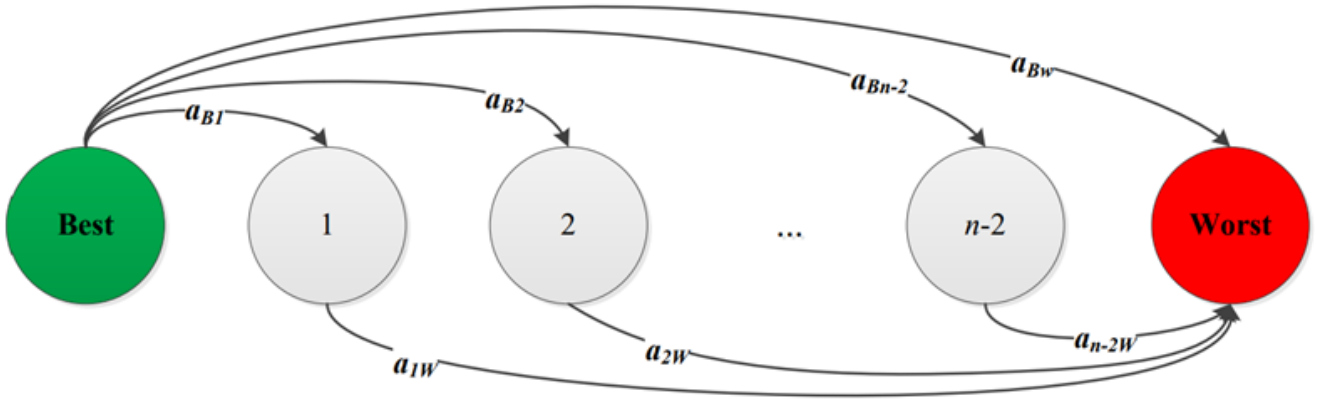
1. Only the US has implemented high-tech solutions within their specifications.
2. Canada and Mexico have not introduced specifications for high-tech solutions

Enablers and barriers

Enablers	rank	Barriers	rank
Increased productivity	4	Additional training	2
Reduction in maintenance costs	1	Increased systems costs	3
Assistance to the operators	2	Paving and compaction treated separately	4
User-friendly systems	3	Closed systems for integration	1
Long-term pavement performance		Operator's mindset	

Best-Worst Method

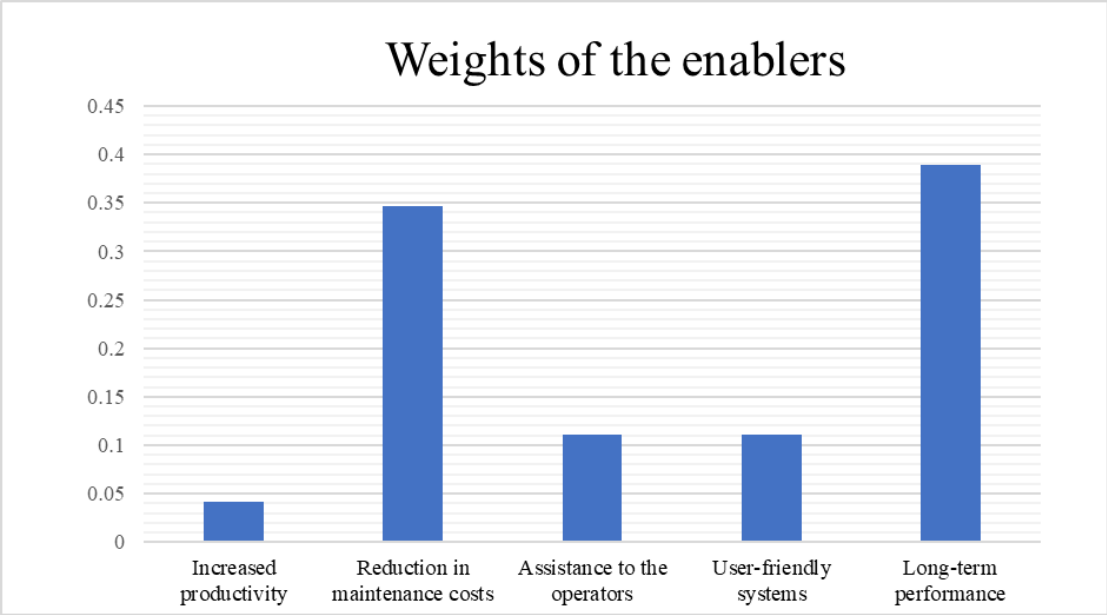
- Step 1:Determine a set of decision criteria
- Step 2:Determine the best (e.g. the most important), and the worst (e.g. the least important) criteria.
- Step 3 & 4: best criterion over all the other & all the criteria over the worst criterion

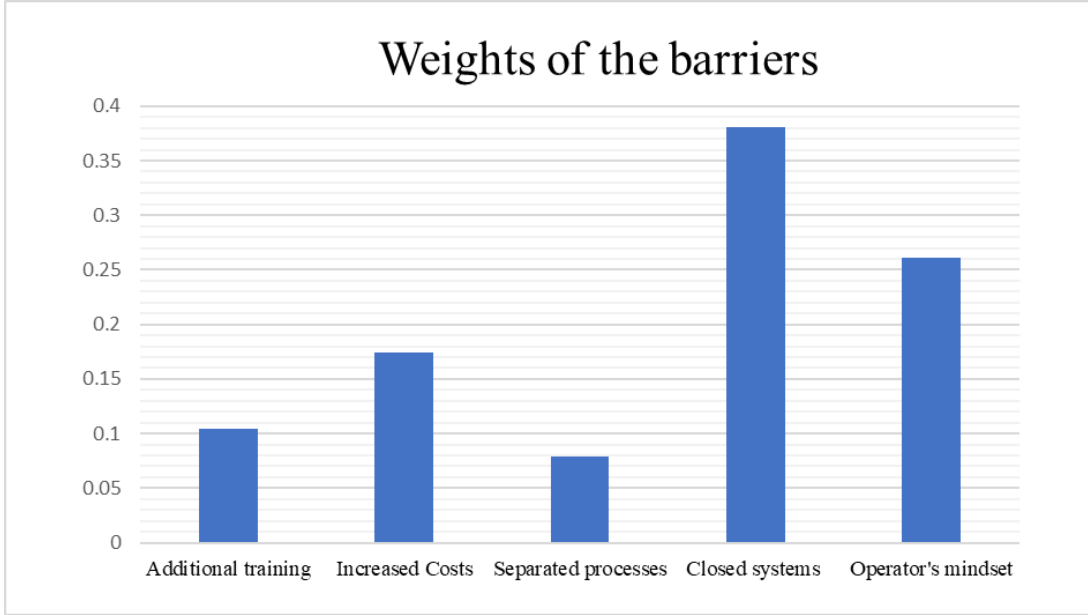


The meaning of the numbers 1-9:
1: Equal importance
2: Somewhat between Equal and Moderate
3: Moderately more important than
4: Somewhat between Moderate and Strong
5: Strongly more important than
6: Somewhat between Strong and Very strong
7: Very strongly important than
8: Somewhat between Very strong and Absolute
9: Absolutely more important than

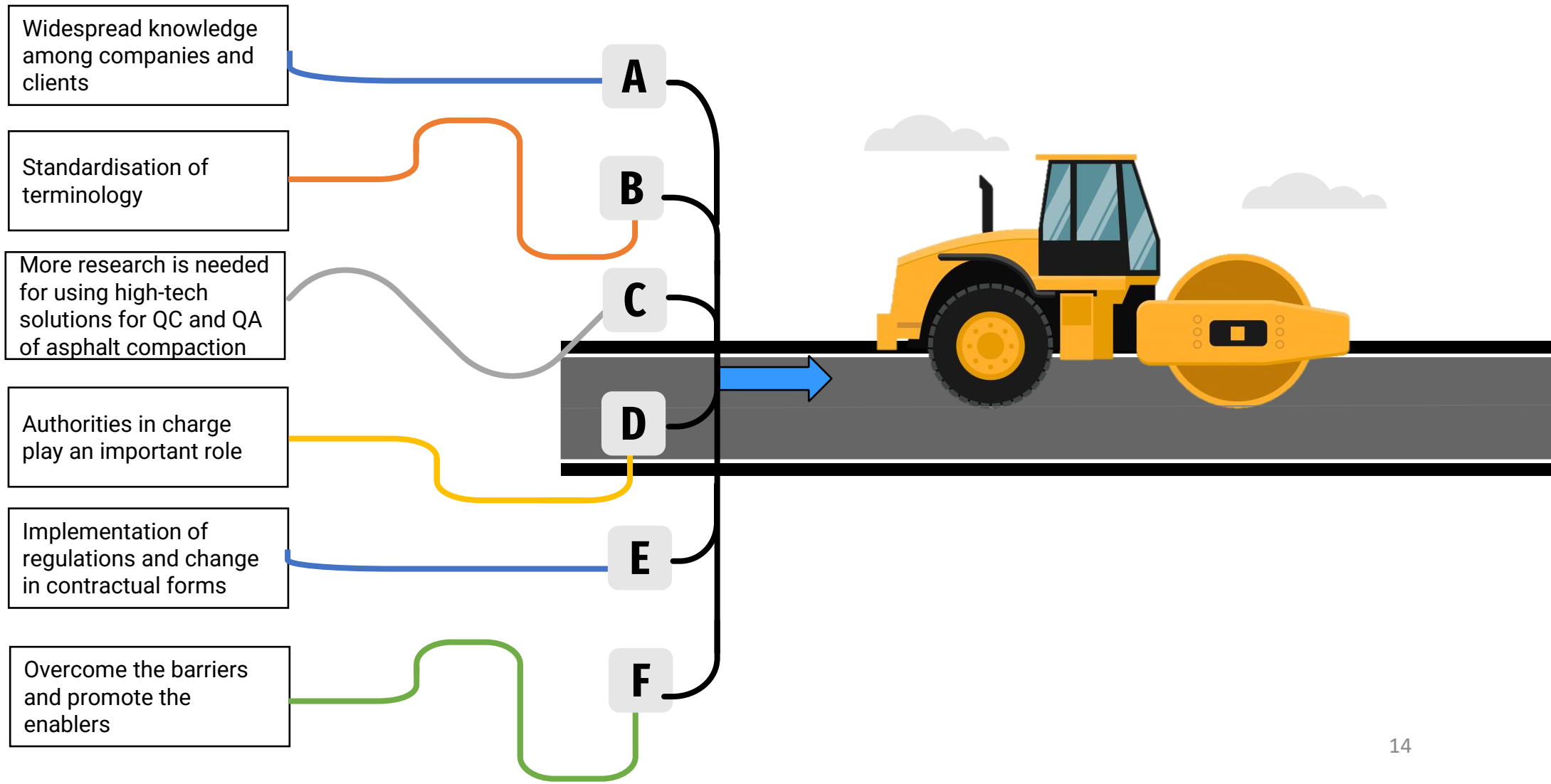
- Step 5: Find the optimal weights

Ranking of Enablers and Barriers





Conclusions and Recommendations



ASPARi

Paving the way forward

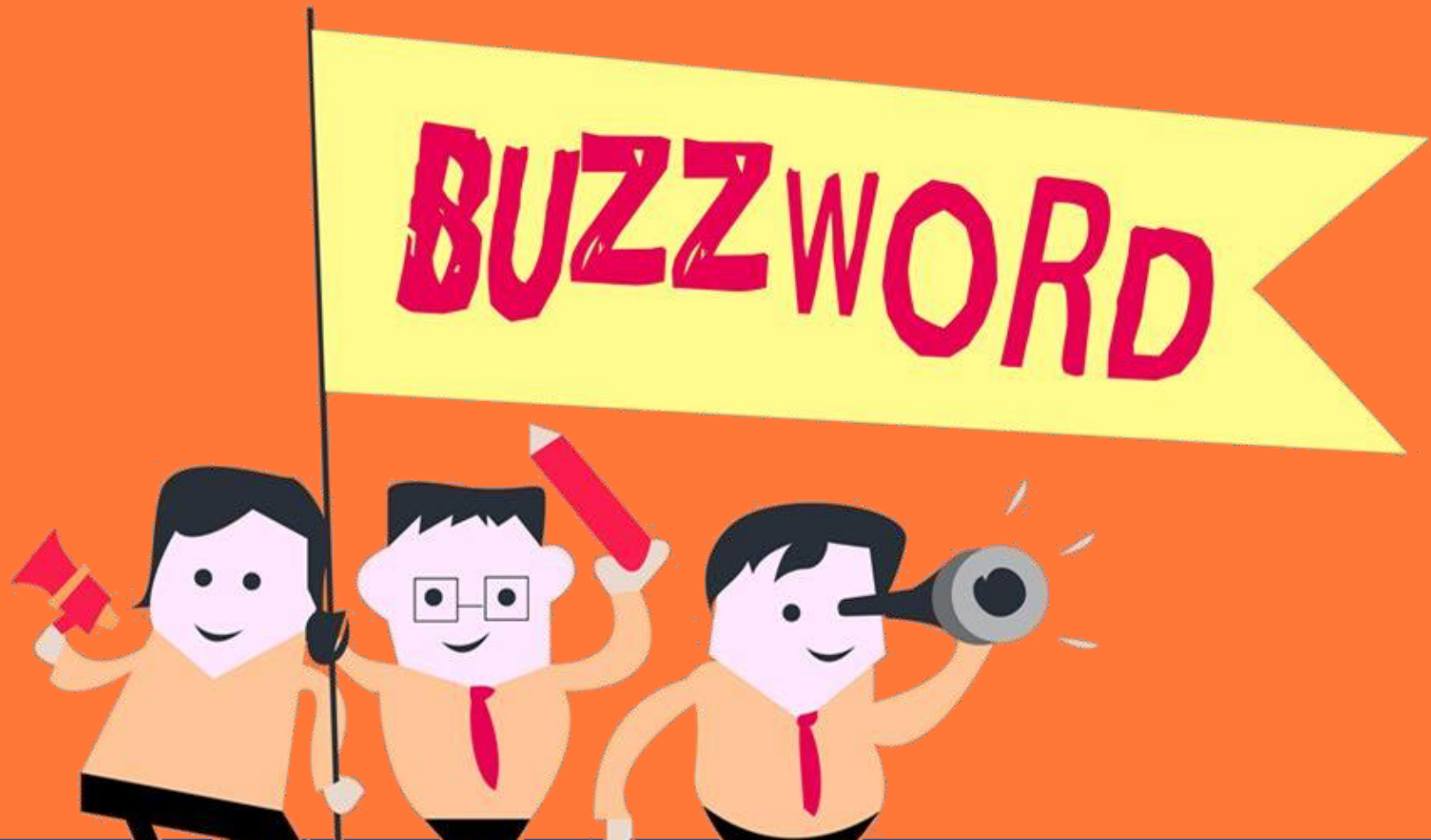
UNIVERSITY OF TWENTE.

What the Heck is Pavement Digital Twin?

building blocks, applications and road ahead

Dec. 8th, 2021
Farid Vahdati

IS DIGITAL TWIN JUST ANOTHER

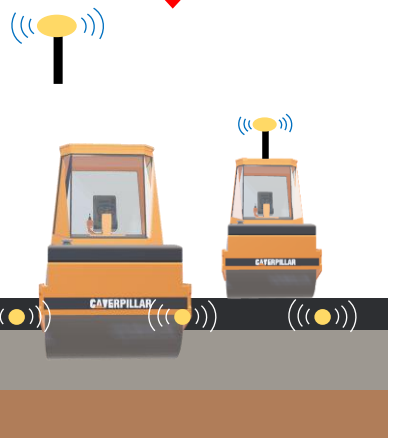


Pavement Life Cycle

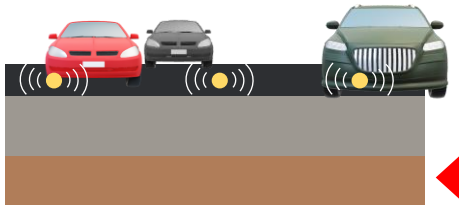
Slurry seal
Micro-surfacing
Disposal of material
Recycling activates

Mix Design
Logistic planning
Material extraction
Material processing

Design and Production



Construction



Operation

Maintenance

Condition assessment
Traffic monitoring
Data registry
Maintenance planning

Asphalt delivery
Site preparation
Paving and compaction
Project control
Quality control

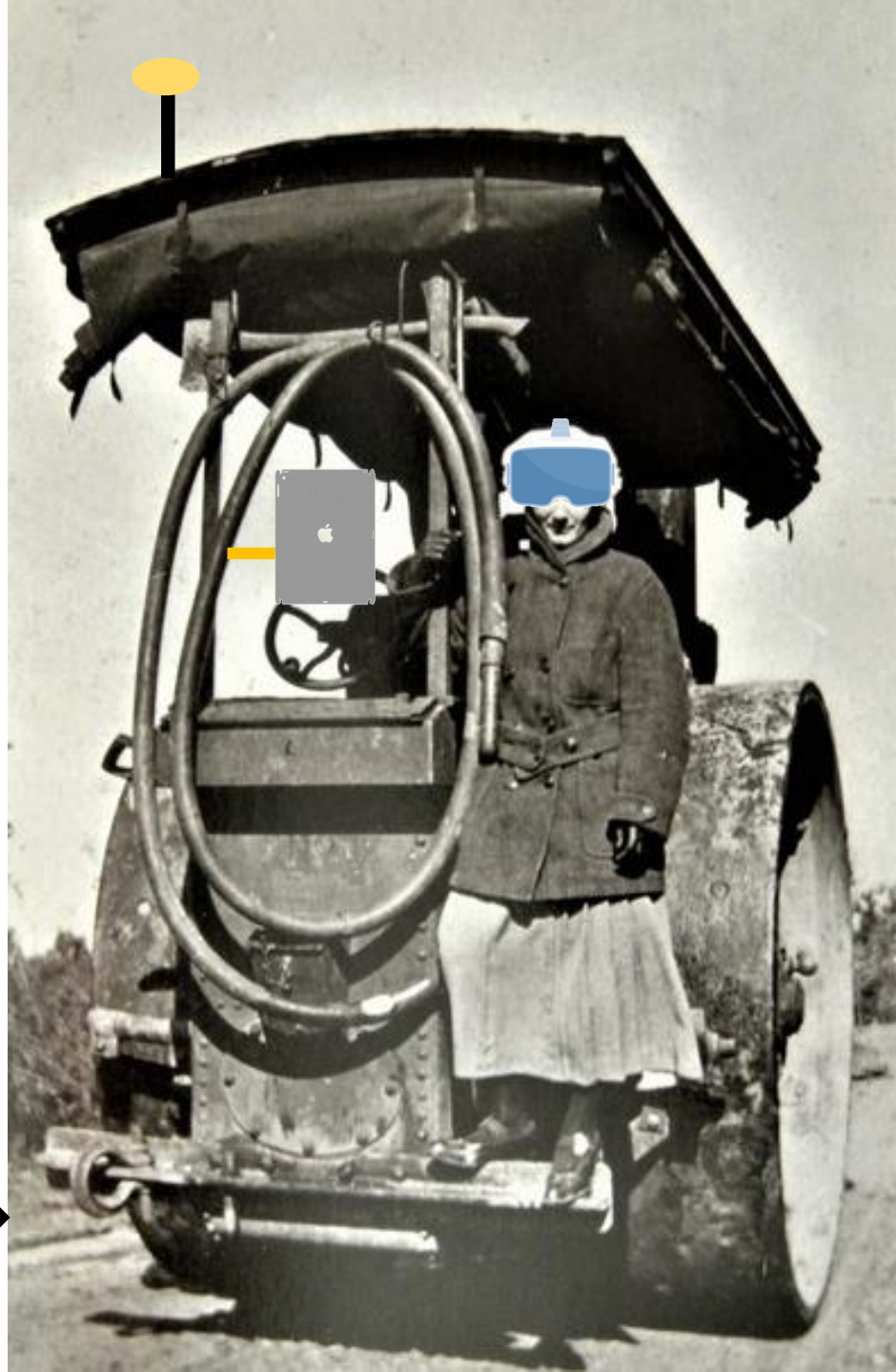
The use of new tools and technologies is becoming common practice nowadays

We have a lot of tools, but have they really disrupted the industry?

Before technology

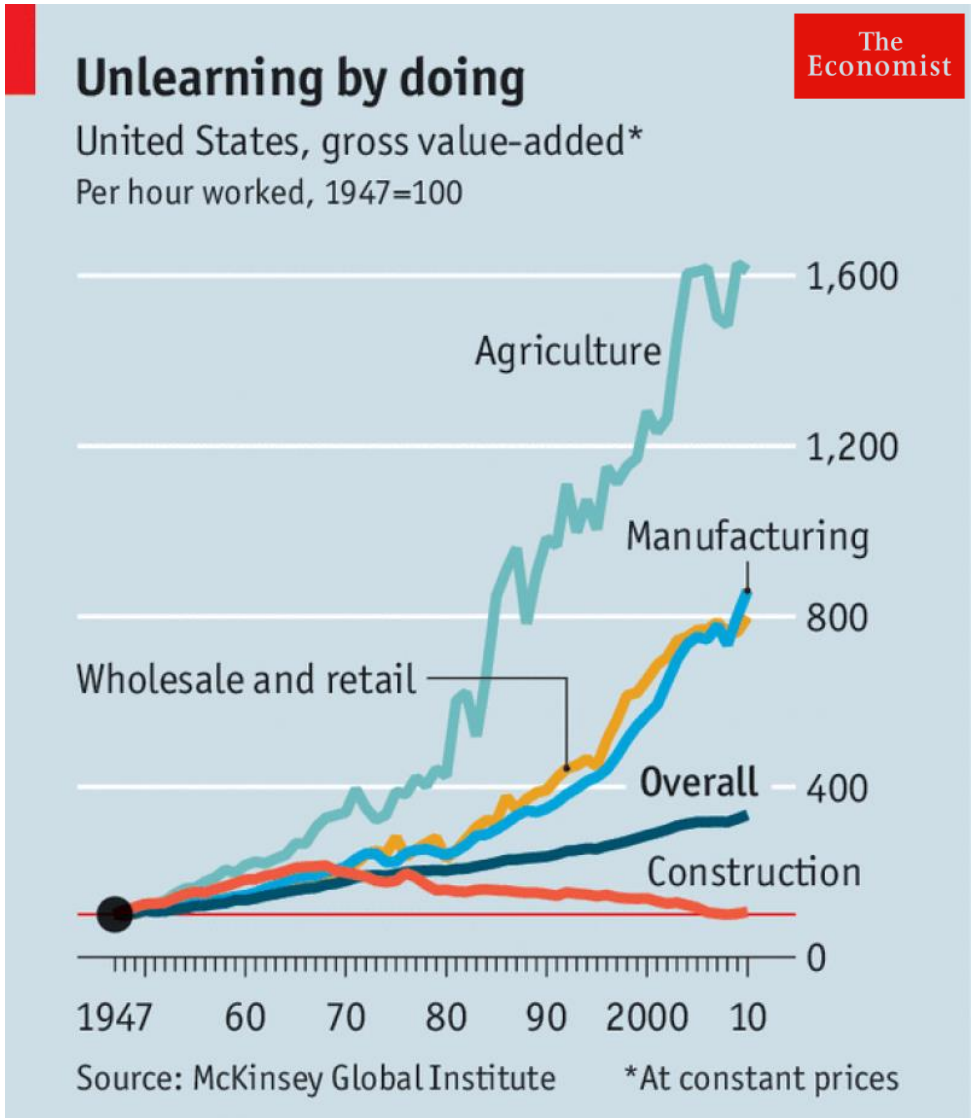
Find 3 differences in these photos!

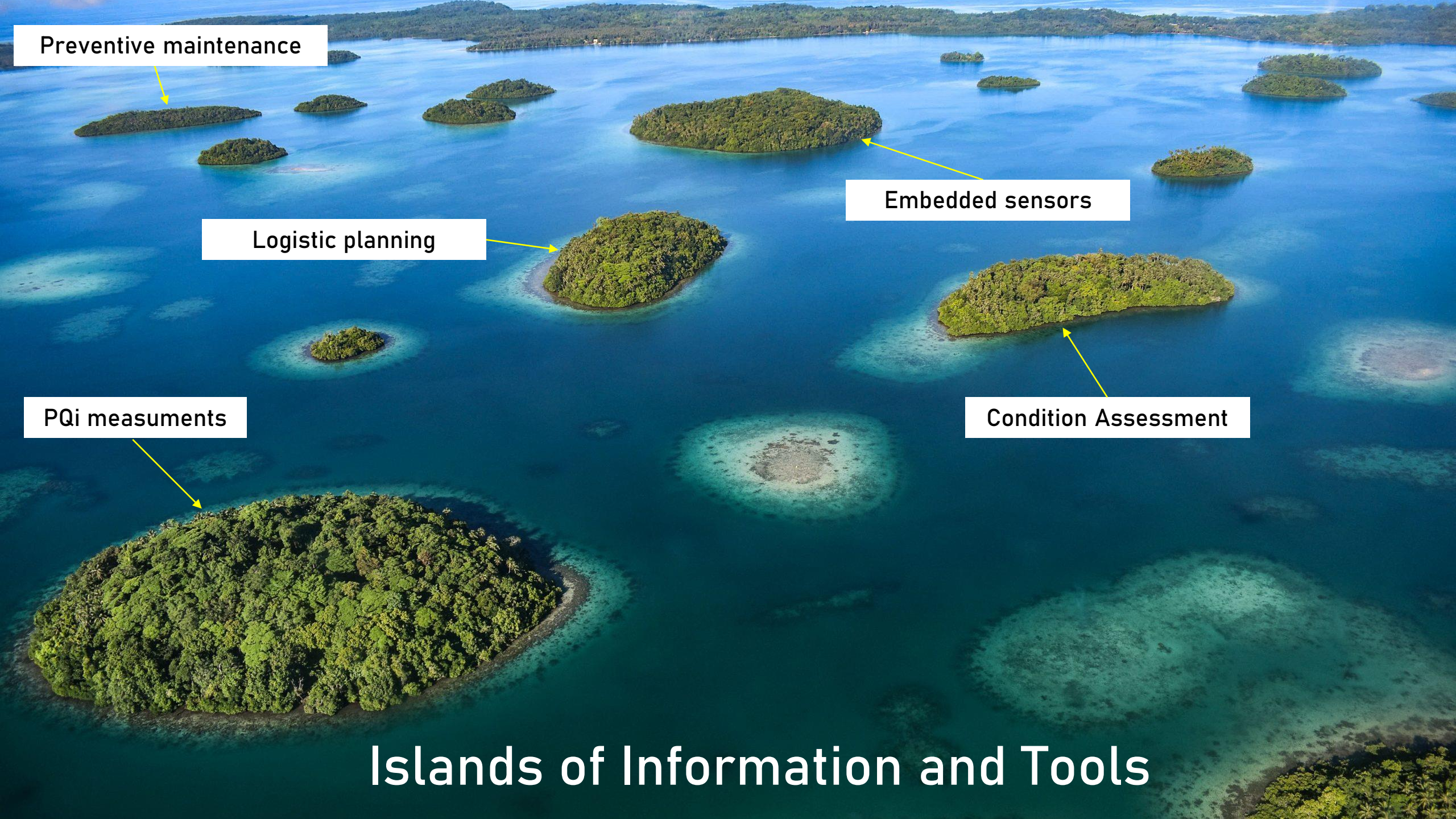
After technology



Where are we standing?

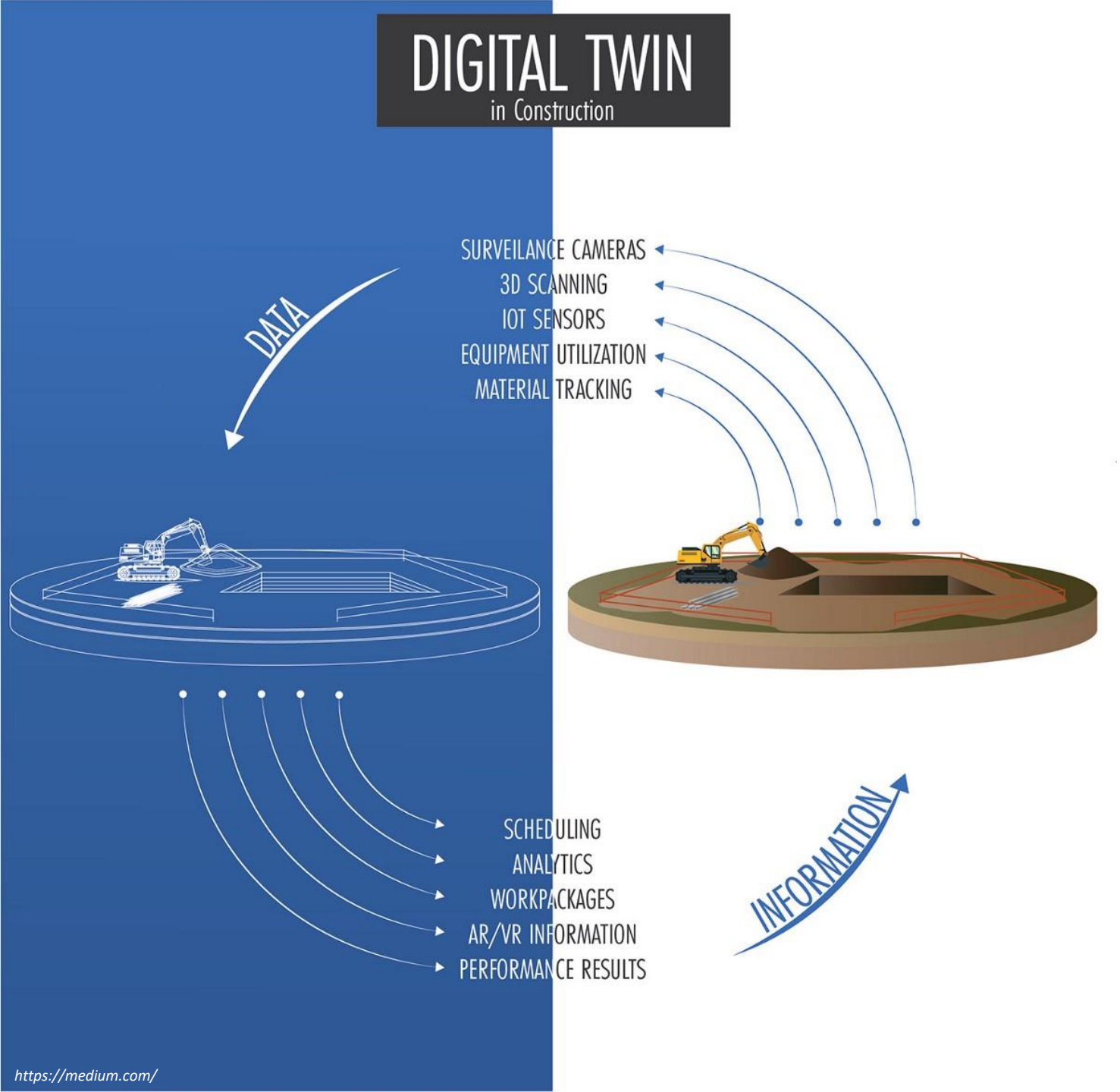
> Looking at construction projects today, I do not see much difference in the execution of the work in comparison to 50 years ago.
>
> John M. Beck, Executive Chairman, Aecon Group, Canada





Islands of Information and Tools

The role of Digital Twin



Digital Twin is a digital replica of an actual asset that stores the past, represents the current, and predicts the future of the asset.

Model Layer

3D Model

Object library

Feed

Generate

4D Model

Simulation Model

Update

Guide

Physical Layer

Processes

Human agent

Follow

Lead to

Design, Construct, use, maintain

Use

Asset

Construct, monitor, measure

Equipment

Define

Feed

Control

Feed

Domain Ontology

Structure

Databases

Historical Data

Sensor Data

Model Data

Operational Data

Condition Data

User Data

Generate data

User data

Data Layer

Feed

Propel

Clash detection

Operator support system

Operator training

Road condition prediction

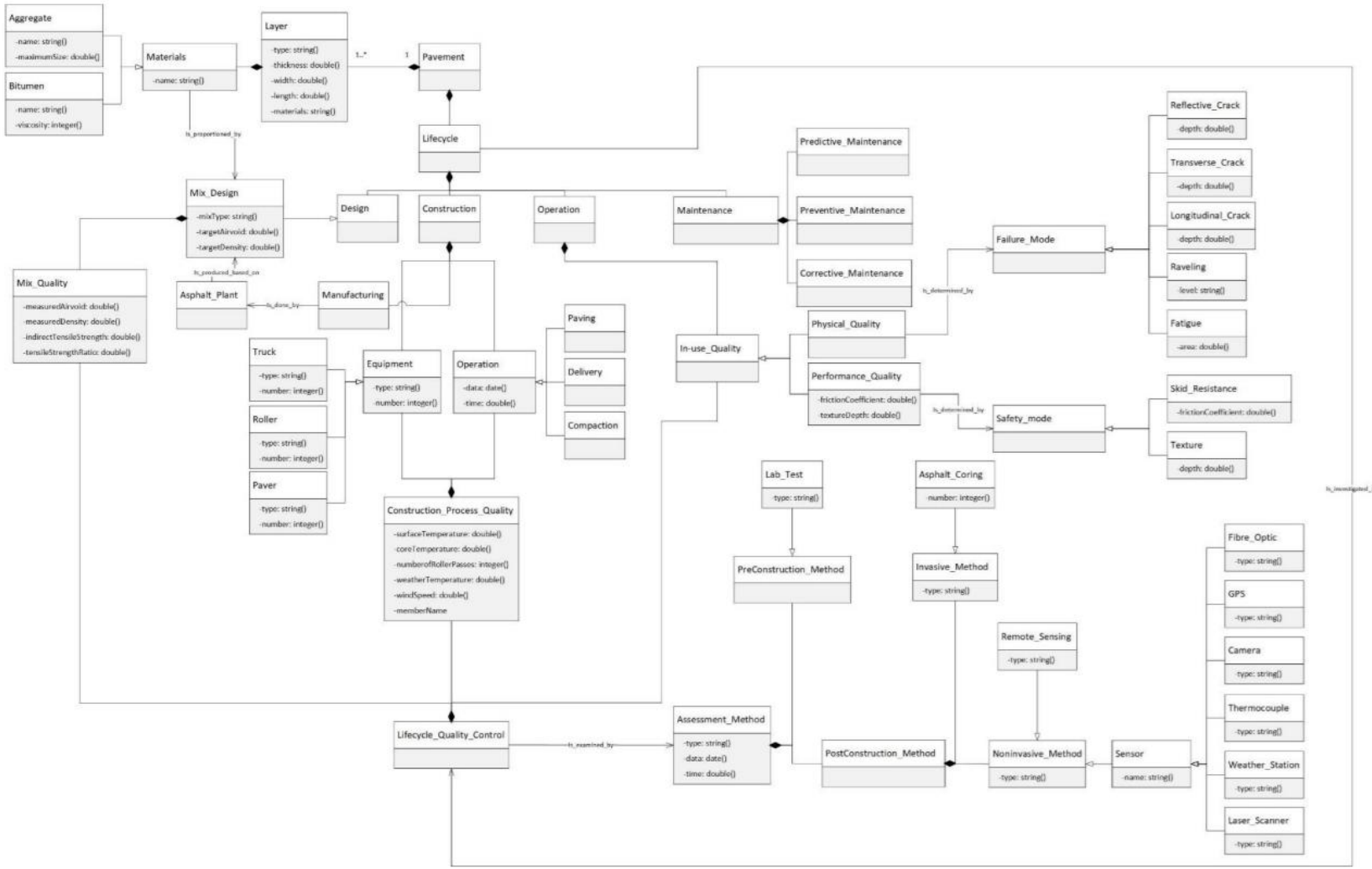
Network-level analysis

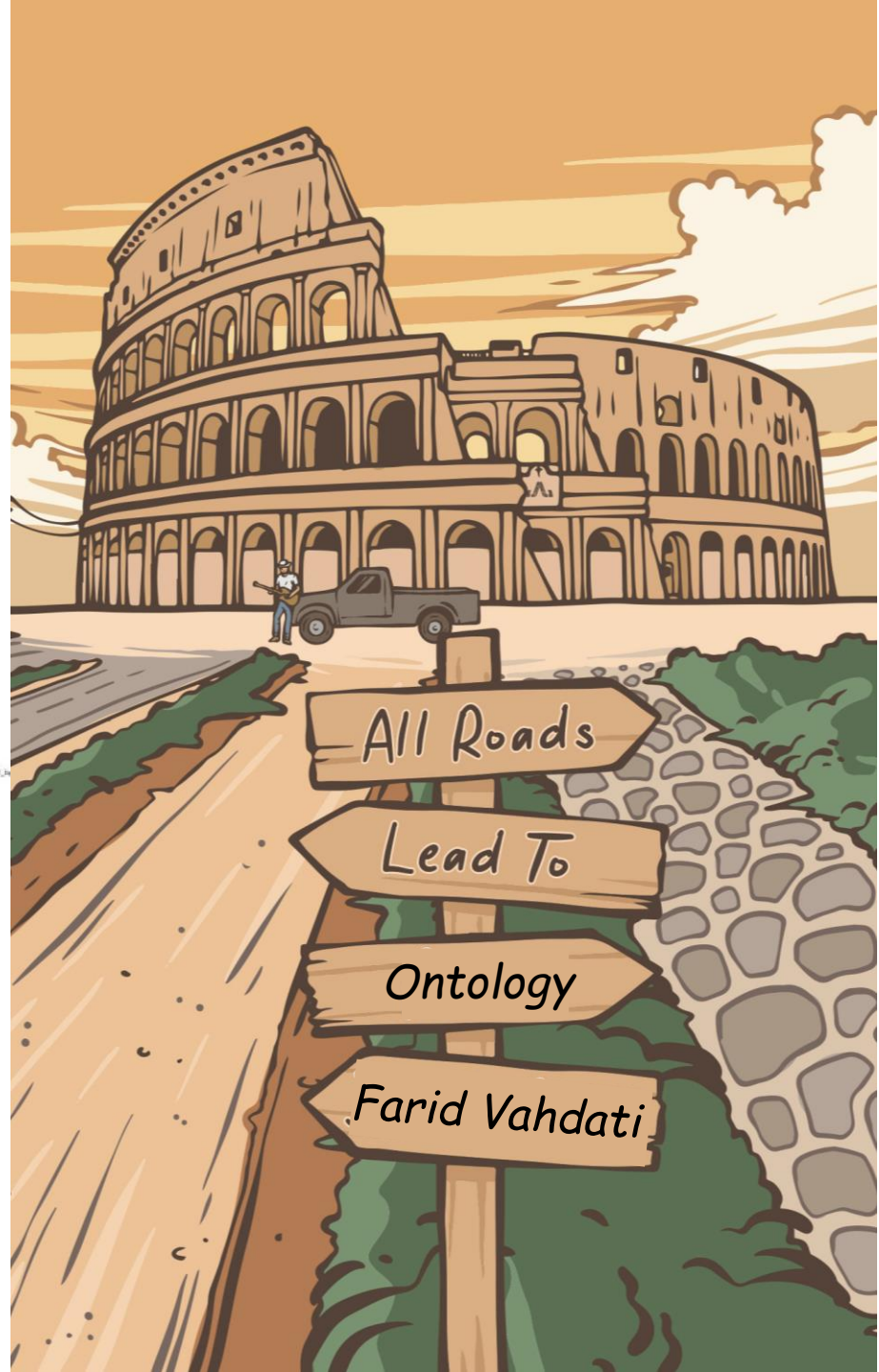
Correlational Studies

Service Layer

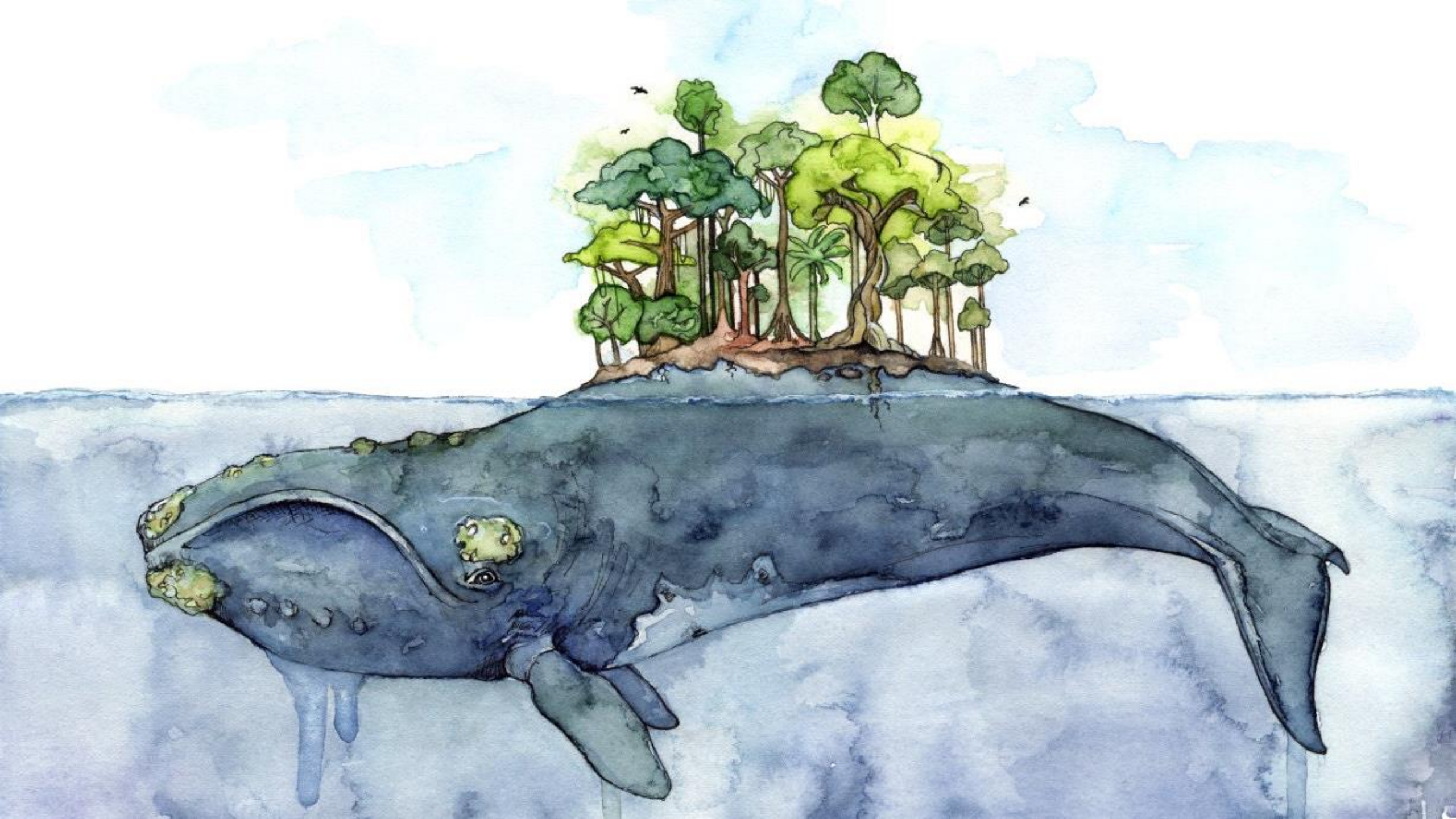
Lifecycle

So, Digital Twin is all about seamless integration of processes, actors, technologies and products across the entire lifecycle.


Aggregate
-name: string()
-maximumSize: double()
Bitumen
-name: string()
-viscosity: integer()
Materials
-name: string()
Layer
-type: string()
-thickness: double()
-width: double()
-length: double()
-materials: string()
1..*
1
Pavement
Lifecycle
Mix_Design
-mixType: string()
-targetAirvoid: double()
-targetDensity: double()
Design
Construction
Operation
Maintenance
Predictive_Maintenance
Preventive_Maintenance
Corrective_Maintenance
Failure_Mode
Reflective_Crack
-depth: double()
Transverse_Crack
-depth: double()
Longitudinal_Crack
-depth: double()
Raveling
-level: string()
Fatigue
-area: double()
Mix_Quality
-measuredAirvoid: double()
-measuredDensity: double()
-indirectTensileStrength: double()
-tensileStrengthRatio: double()
Asphalt_Plant
Manufacturing
Paving
Delivery
Compaction
Truck
-type: string()
-number: integer()
Roller
-type: string()
-number: integer()
Paver
-type: string()
-number: integer()
Equipment
-type: string()
-number: integer()
Operation
-data: date()
-time: double()
In-use_Quality
Physical_Quality
Performance_Quality
-frictionCoefficient: double()
-textureDepth: double()
Safety_mode
Skid_Resistance
-frictionCoefficient: double()
Texture
-depth: double()
Construction_Process_Quality
-surfaceTemperature: double()
-coreTemperature: double()
-numberofRollerPasses: integer()
-weatherTemperature: double()
-windSpeed: double()
-memberName
Lab_Test
-type: string()
Asphalt_Coring
-number: integer()
PreConstruction_Method
Invasive_Method
-type: string()
Remote_Sensing
-type: string()
Fibre_Optic
-type: string()
GPS
-type: string()
Camera
-type: string()
Thermocouple
-type: string()
Weather_Station
-type: string()
Laser_Scanner
-type: string()
Lifecycle_Quality_Control
Assessment_Method
-type: string()
-data: date()
-time: double()
PostConstruction_Method
Noninvasive_Method
-type: string()
Sensor
-name: string()

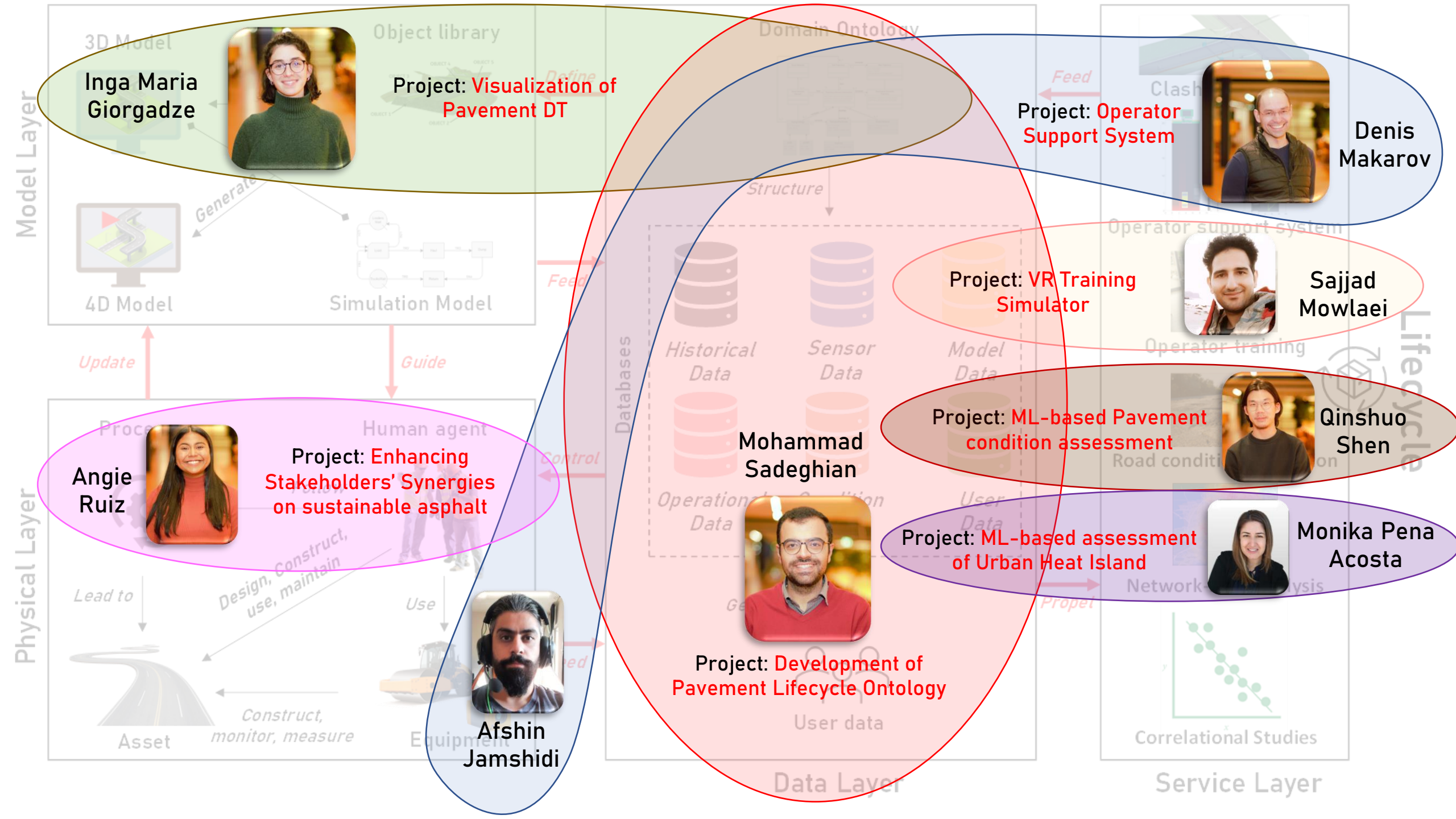

All Roads
Lead To
Ontology
Farid Vahdati


But what level of integration is enough? Would it be sufficient to confine the integration efforts to organization level?



A successful Digital Twin initiative requires industry-level commitment.

That is Why ASPARi is a perfect platform to bring forces together.


Model Layer
Physical Layer
Data Layer
Service Layer
Lifecycle
3D Model
Object library
4D Model
Simulation Model
Generate
Update
Guide
Feed
Define
Structure
Databases
Historical Data
Sensor Data
Model Data
Operational Data
User Data
Human agent
Control
Design, Construct, use, maintain
Lead to
Use
Asset
Equipment
Construct, monitor, measure
User data
Clash
Operator support system
Operator training
Road condition
Network analysis
Correlational Studies
Inga Maria Giorgadze
Project: Visualization of Pavement DT
Denis Makarov
Project: Operator Support System
Project: VR Training Simulator
Sajjad Mowlaei
Angie Ruiz
Project: Enhancing Stakeholders' Synergies on sustainable asphalt
Mohammad Sadeghian
Project: ML-based Pavement condition assessment
Qinshuo Shen
Project: ML-based assessment of Urban Heat Island
Monika Pena Acosta
Project: Development of Pavement Lifecycle Ontology
Afshin Jamshidi

Under the Umbrella of Pavement Lifecycle Digital Twin shall we unite

Question?

Good roads = Good data

Ontological modeling of pavement lifecycle data

ASPARi

Paving the way forward

Mohammad Sadeghian

UNIVERSITY OF TWENTE.

About the Presenter

Personal Background

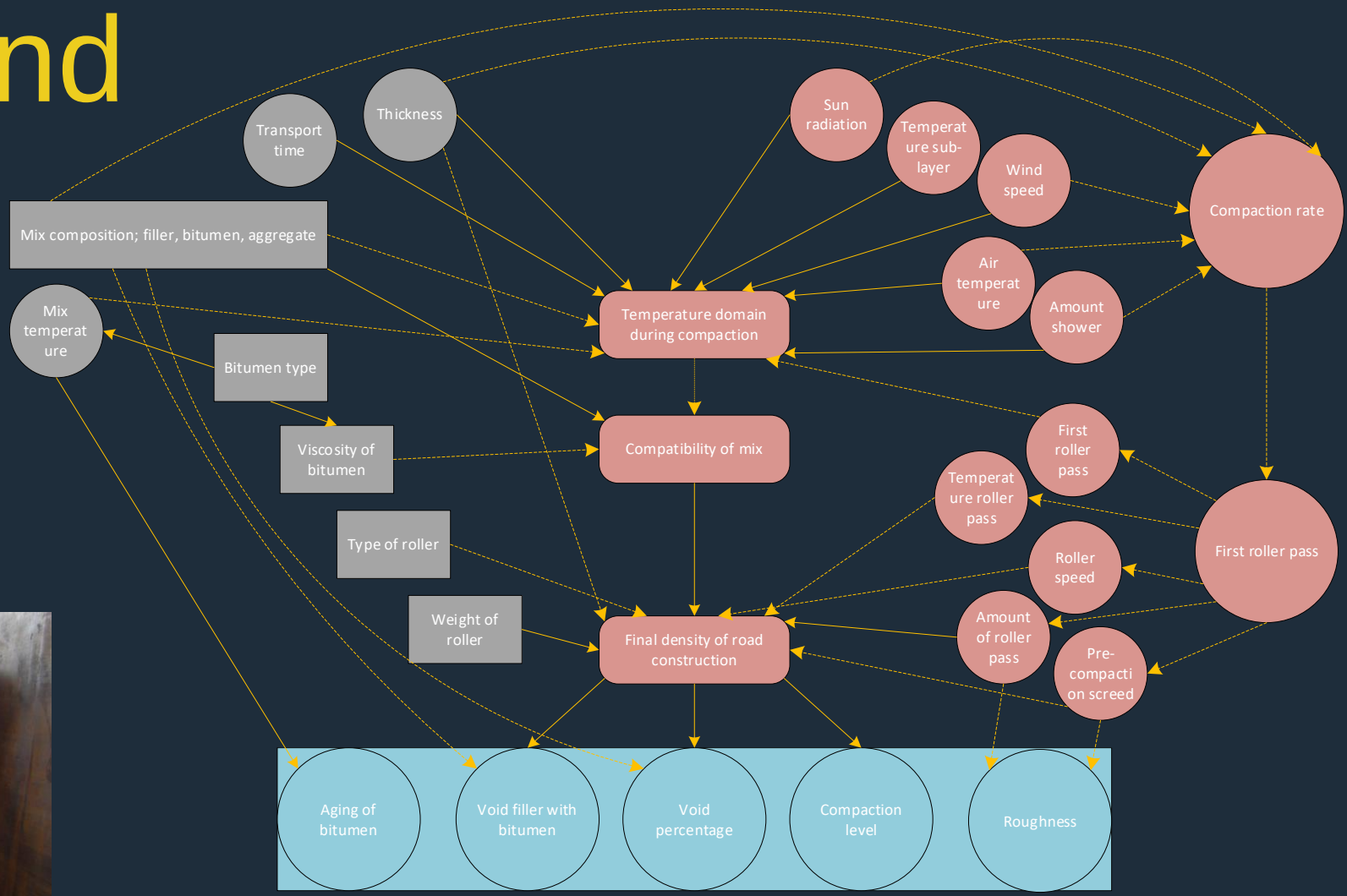
- Iran
- Live in NL since Jan 2021
- Love travelling
- Watch football

Academic Background

- BSc. Civil Eng (2016)
- MSc. Pavement Eng (2019)
- Master Thesis: 2 years at Asphalt Lab

Background

- Technological development



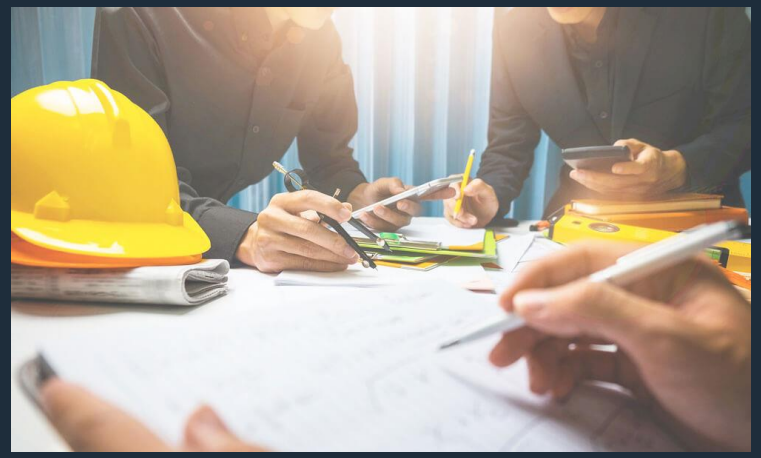
Why data needs to be structured?

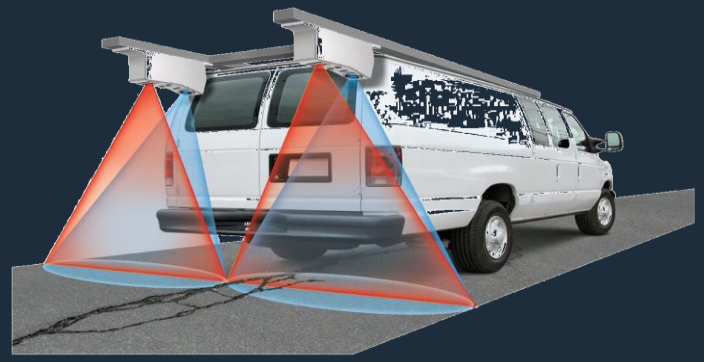
Pavement

Design

Construction

Operation/Maintenance



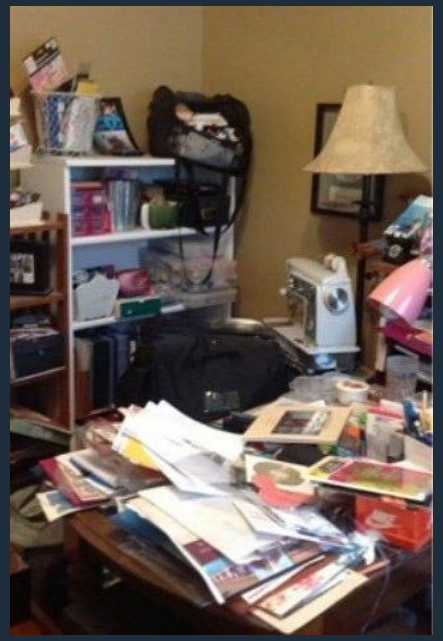


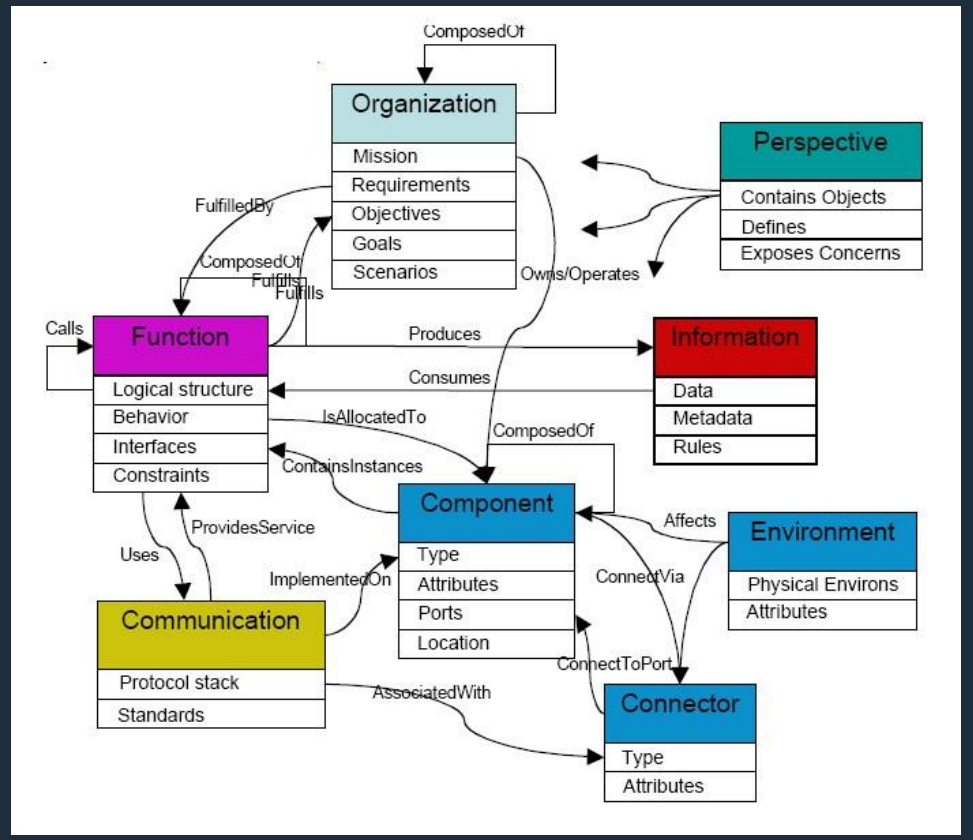
- Fragmentation
- Company priority

- Data loss and damage
- Misinterpretation of the information

Ontology Definition

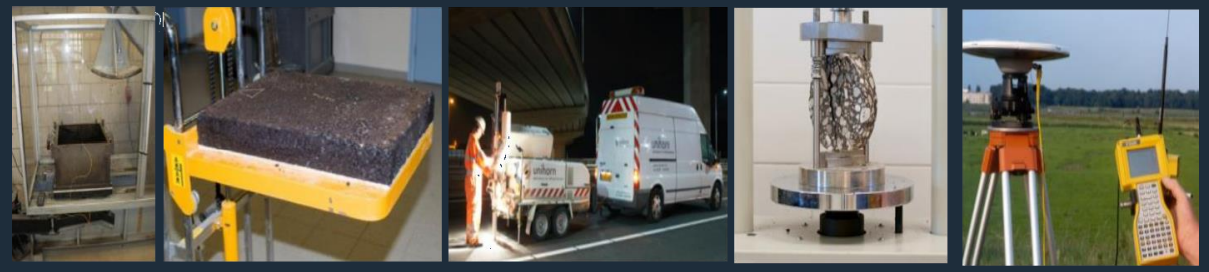
- “An explicit specification of a conceptualization”
- Formalize the information in a domain
- Classes and relationships



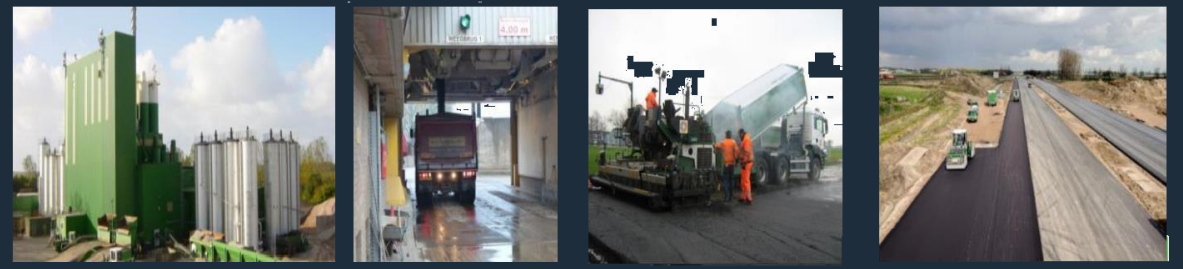


PIM

- 2016 to 2018, 8 Dutch road contractors
- Centralize the information



- Isolated view
- Only based on the requirement of the 8 contractors
- Bottom-up approach



Objective

Develop an ontology for pavement lifecycle to establish a more consistent structure for the data collection, storage, and management

Comprehensive view (design, construction, operation and maintenance)

Research Methodology

Identify the Requirements

Identify the terms and relations

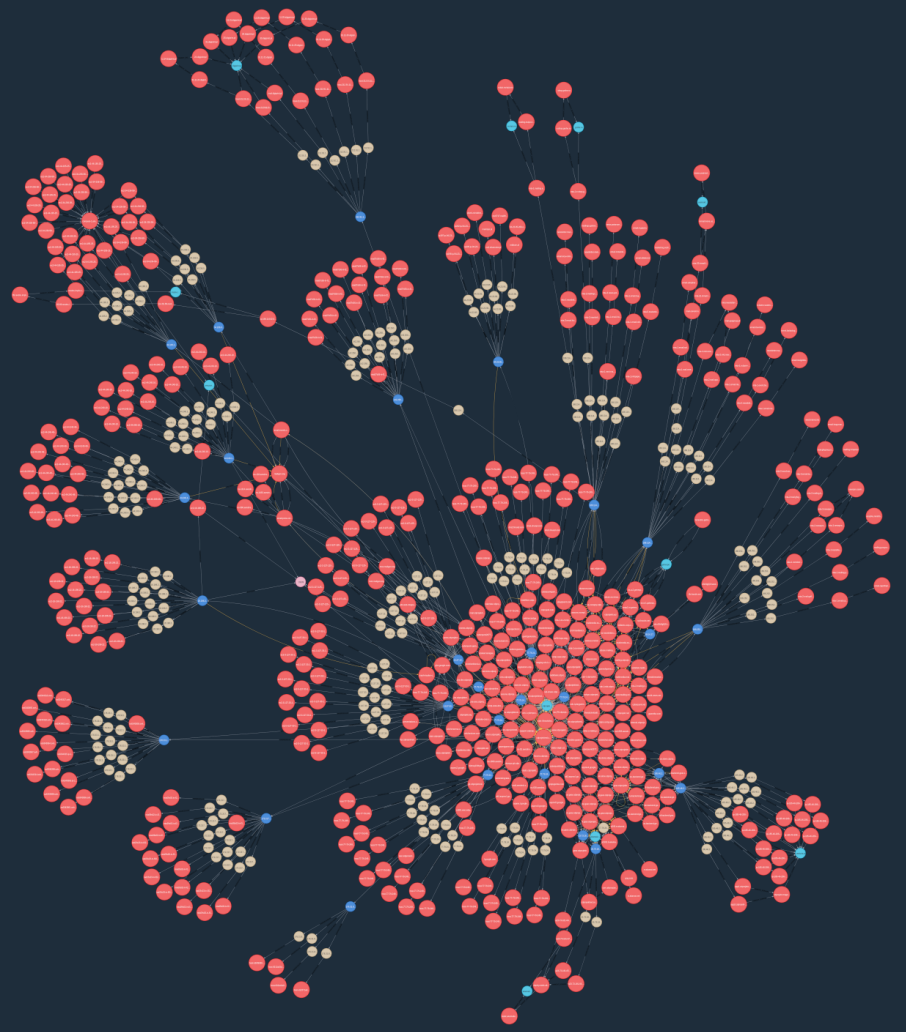
Represent the ontology

Test the ontology

Ontology Requirement

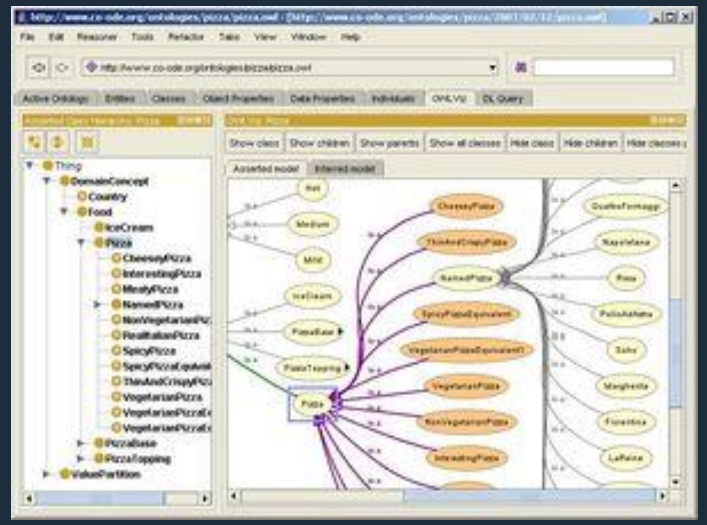
- 13 interviews (8 contractors, provinces and Rijkswaterstaat)
- Content (design, construction, operation and maintenance)
- Needs
- Future proof

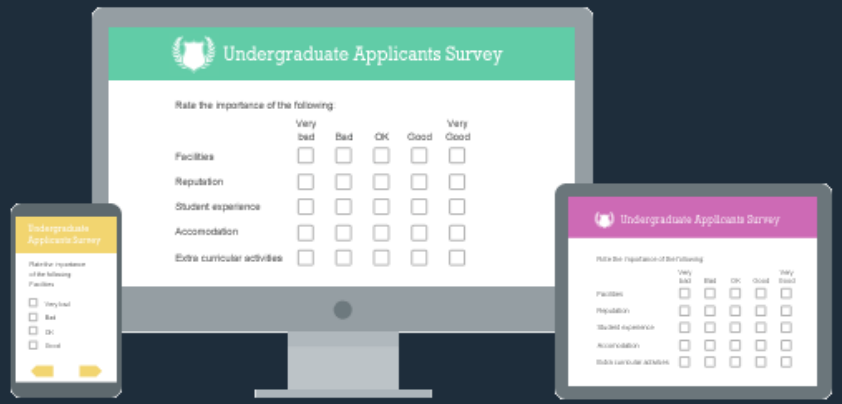
Define the terms and relations



present the ontology

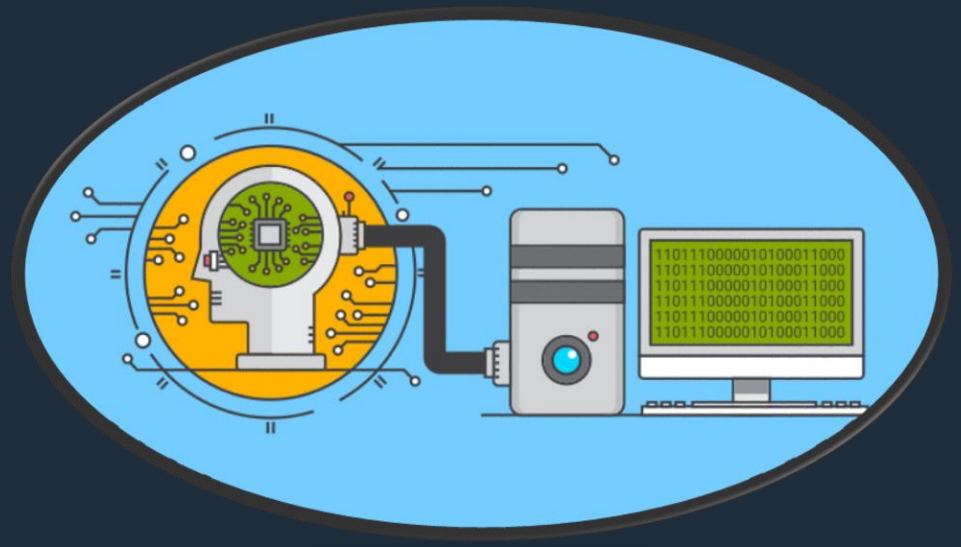
Test the ontology





Conclusion

- Importance of the ontology
- Future applications

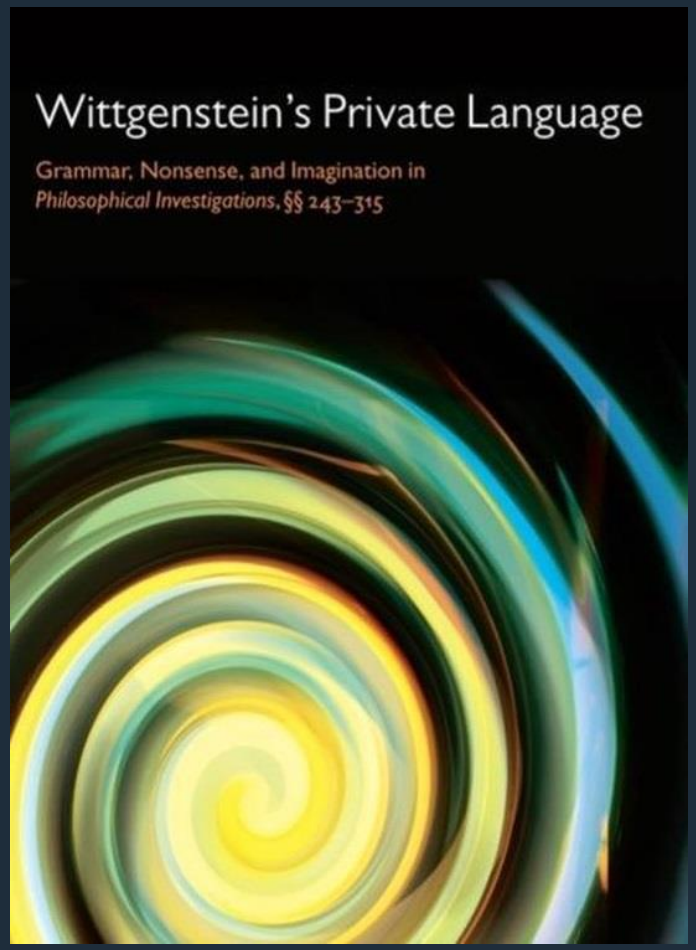


How to contribute

- Private language = Only by a single individual

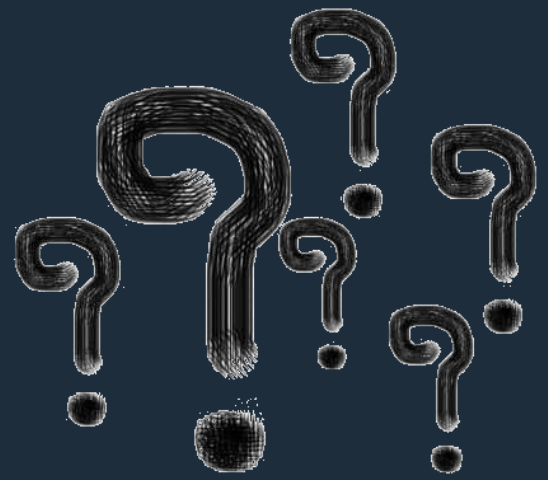
- Pavement ontology

- Interview
- Requirements



Thank you!

Contact:
M.sadeghian@utwente.nl
+31618559343



Can we find the hidden messages in asphalt construction quality?

Qinshuo Shen

ASPARi

Paving the way forward

UNIVERSITY OF TWENTE.

About the presenter

Born & raised in China
Living in The Netherlands since 2018

BSc in Structural Engineering
MSc in Construction Management & Engineering

Master Thesis about developing a generative design framework for wind turbine foundations using machine learning

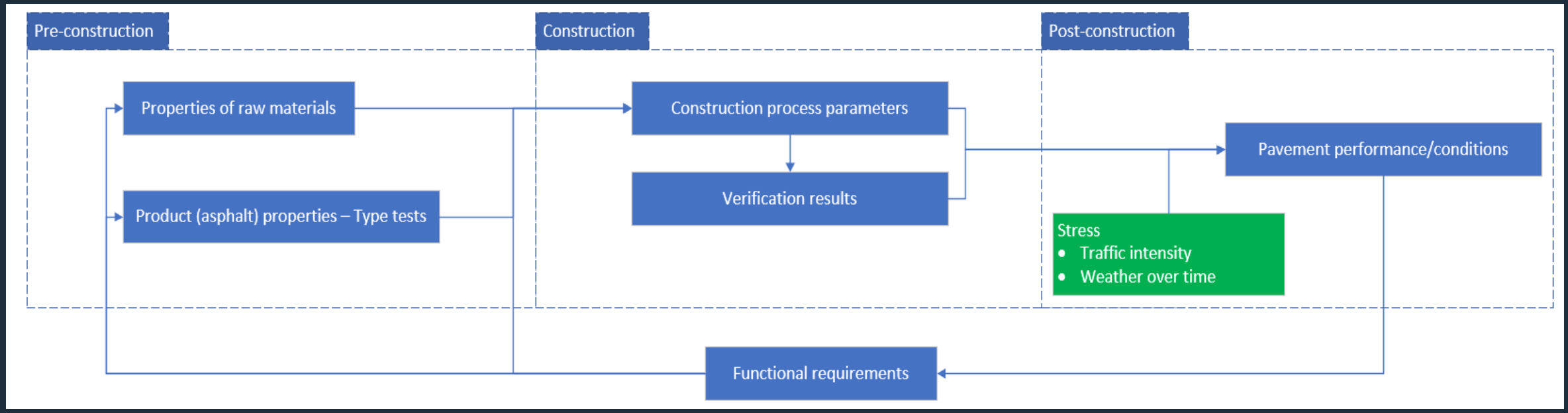
What does “quality” mean in asphalt construction?

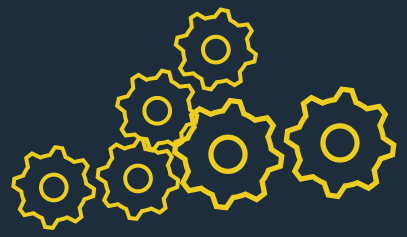
ASPARi
Paving the way forward
UNIVERSITY OF TWENTE.

Quality in asphalt construction

ASPARi
Paving the way forward
UNIVERSITY OF TWENTE.

Quality in asphalt construction lifecycle





Objective

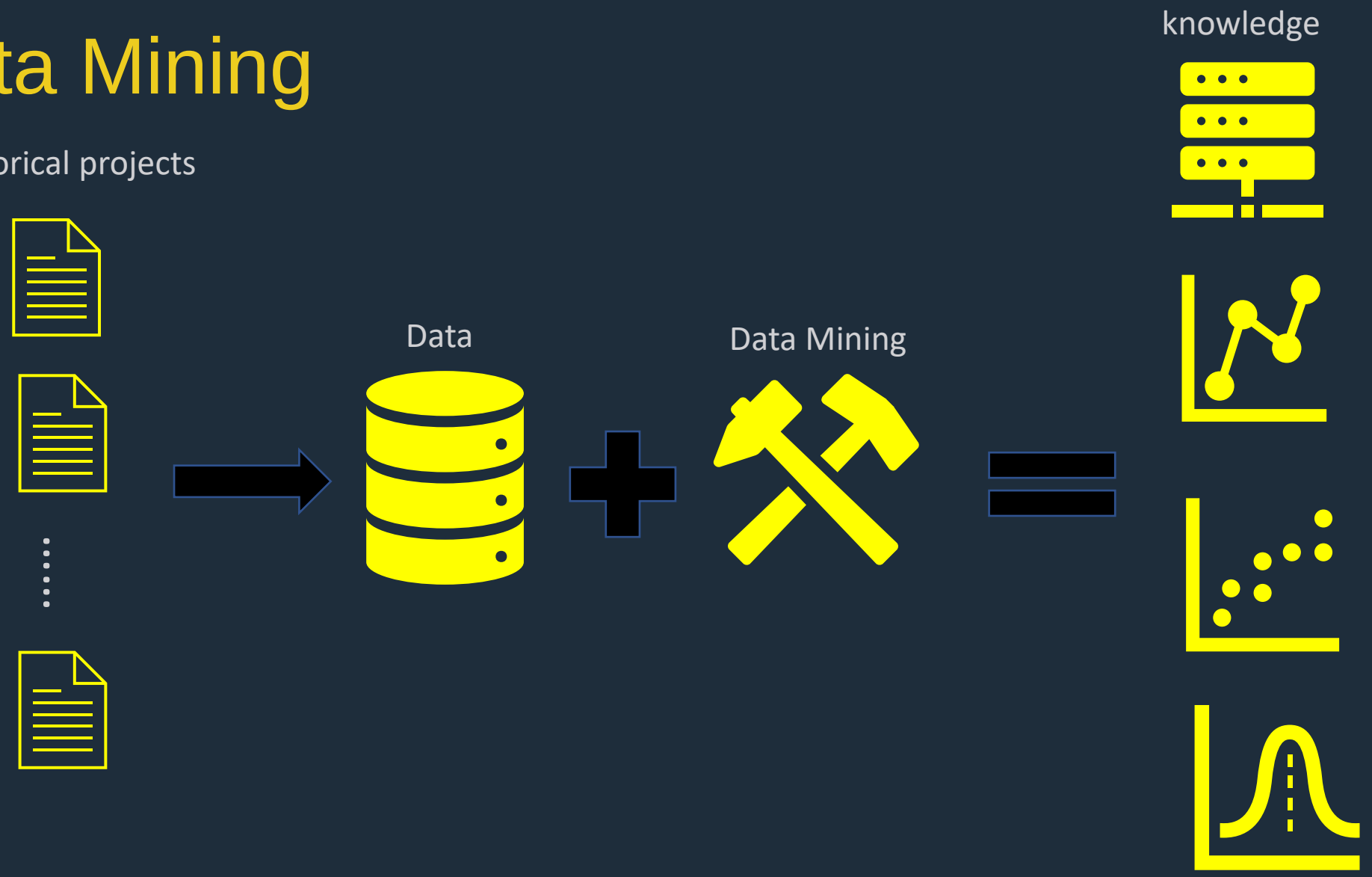
To explicitly map and correlate the **Process Quality Indicators** into the **Product Quality Indicators**

Using the power of data

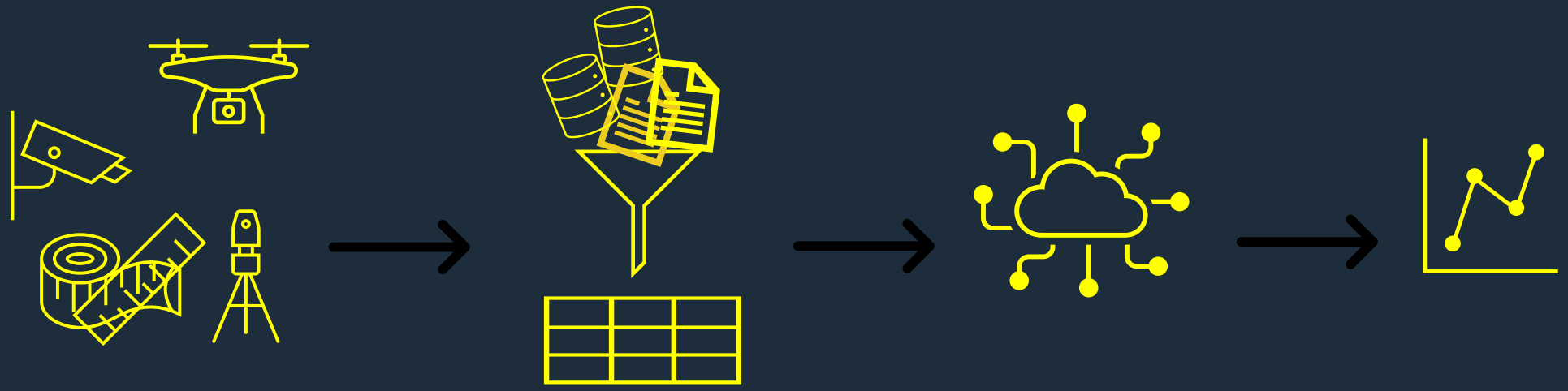
"In industry, we have no shortage of data."
— Berwich Sluer

"If you mine the data hard enough,
you can also find messages from God. "
— Scott Adams

Data Mining



Data Mining



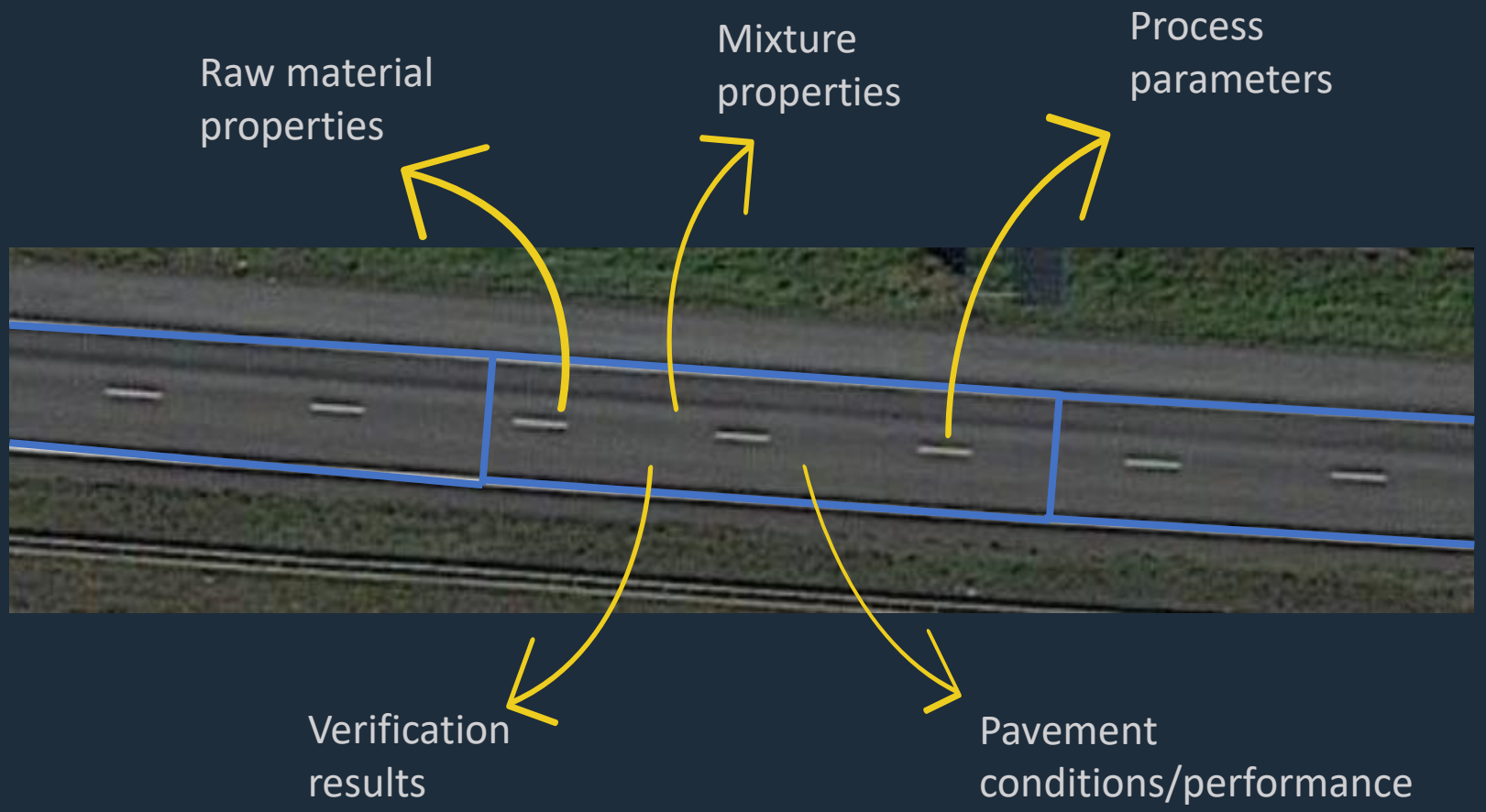
Data collection

Data preparation

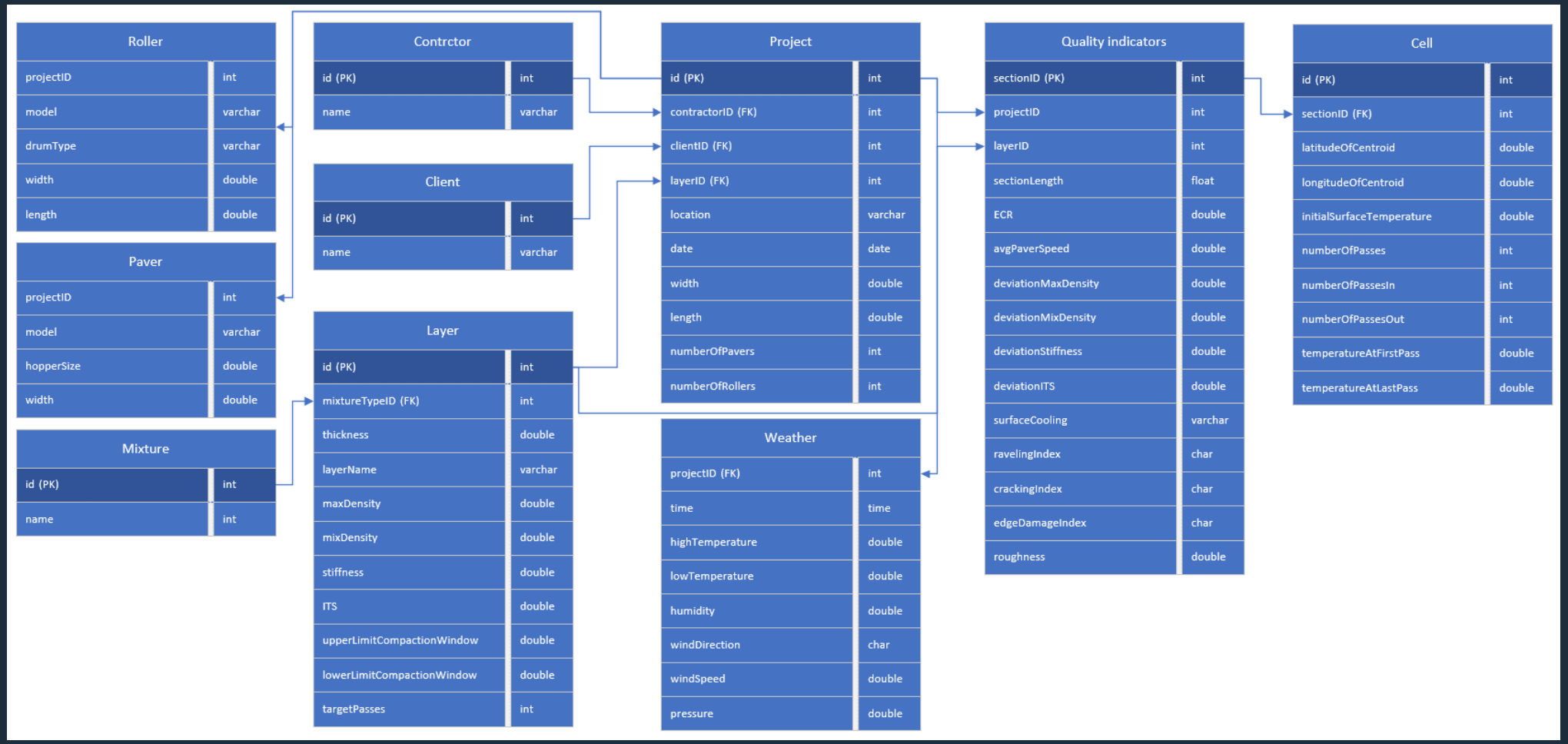
Machine learning model development

Analysis

Data collection



Data preparation



Data preparation

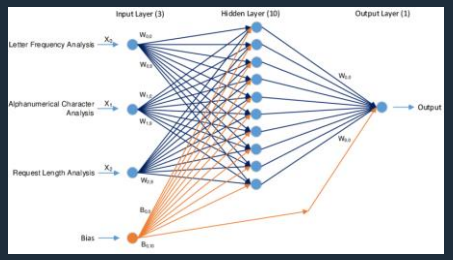
Input variables

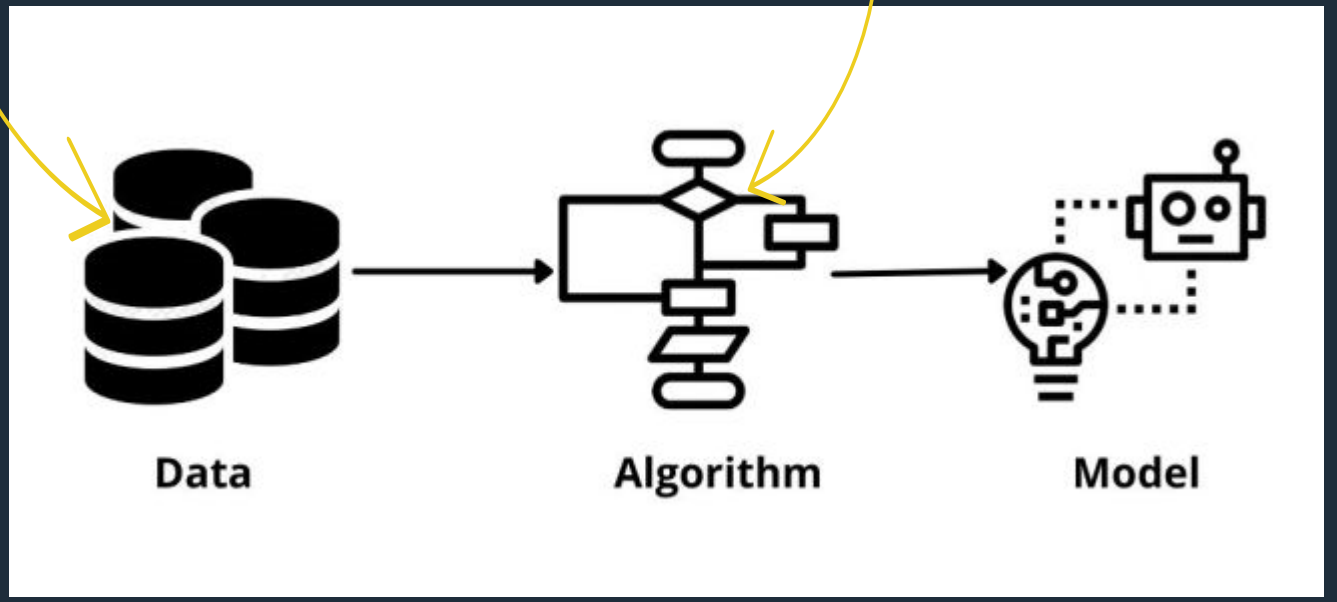
Output variables

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Project ID	Section ID	Effective Compaction Rate	avg. Paver Speed	Mixture Type	Weather conditions	Relative Max Density	Relative Mix Density	Relative Stiffness	Relative ITS	Raveling	Cracking	IRI
2	1	1	92.5	4.5	AC22	.....	98.8	96.7	94.5	92.5	M1	G	0.86
3	1	2	93.4	3.6	AC22	.....	95.7	97.2	96.3	94.5	E1	L1	1.02
4	1	3	91.6	3.5	AC22	.....	92.6	95.3	94.5	94.6	M2	L1	0.96
5	1	4	88.2	3.8	AC22	.....	94.6	94.6	94.5	94.4	E1	L1	0.92
6	1	5	94.1	3.4	AC22	.....	94.6	94.5	94.2	96.5	M2	G	0.83
7	1	6	91	3.9	AC22	.....	96.6	97.5	94.3	98.5	M1	G	1.02
8	1	7	89.9	4	AC22	.....	95.3	94.6	92.2	93.2	M2	G	1.13
9	1	8	89.8	4.1	AC22	.....	92.5	93.5	94.5	95.3	M2	G	0.92
10	1	9	87.2	3.2	AC22	.....	94.5	94	93.7	96.3	M1	G	0.89

Machine learning model development

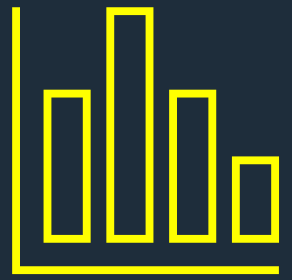
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Project ID	Section ID	Effective Compaction Rate	avg. Paver Speed	Mixture Type	Weather conditions	Relative Max Density	Relative Mix Density	Relative Stiffness	Relative ITS	Raveling	Cracking	IRI
2	1	1	92.5	4.5	AC22	.....	98.8	96.7	94.5	92.5	M1	G	0.86
3	1	2	93.4	3.6	AC22	.....	95.7	97.2	96.3	94.5	E1	L1	1.02
4	1	3	91.6	3.5	AC22	.....	92.6	95.3	94.5	94.6	M2	L1	0.96
5	1	4	88.2	3.8	AC22	.....	94.6	94.6	94.5	94.4	E1	L1	0.92
6	1	5	94.1	3.4	AC22	.....	94.6	94.5	94.2	96.5	M2	G	0.83
7	1	6	91	3.9	AC22	.....	96.6	97.5	94.3	98.5	M1	G	1.02
8	1	7	89.9	4	AC22	.....	95.3	94.6	92.2	93.2	M2	G	1.13
9	1	8	89.8	4.1	AC22	.....	92.5	93.5	94.5	95.3	M2	G	0.92
10	1	9	87.2	3.2	AC22	.....	94.5	94	93.7	96.3	M1	G	0.89





Analysis

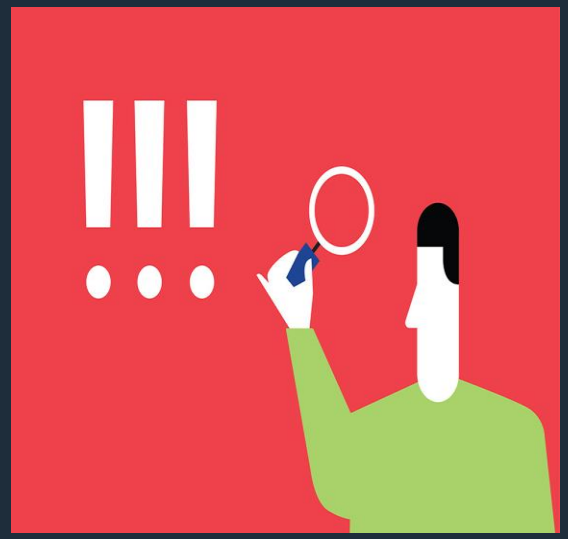
Performance evaluation



Sensitivity analysis

Applications

For contractors



For asset managers

Risks

Data with low quality

Data with different resolutions/formats

What do we need

Thank You!

q.shen@utwente.nl

+31534893825 (work)

+31633484789 (private)

Is it really a Digital Twin without the visualization?

Inga Maria Giorgadze

ASPARi

Paving the way forward

UNIVERSITY OF TWENTE.

About the presenter

Born in Georgia
Raised in Greece
Living in The Netherlands since 2018

Background in Civil Engineering
Specialization in Transportation Engineering
MSc in Construction Management & Engineering

Master Thesis about creating an ontology for Lifecycle Digital Twin for Bridges
Graduation Intern in BAM InfraConsult

Why focus on visualization?

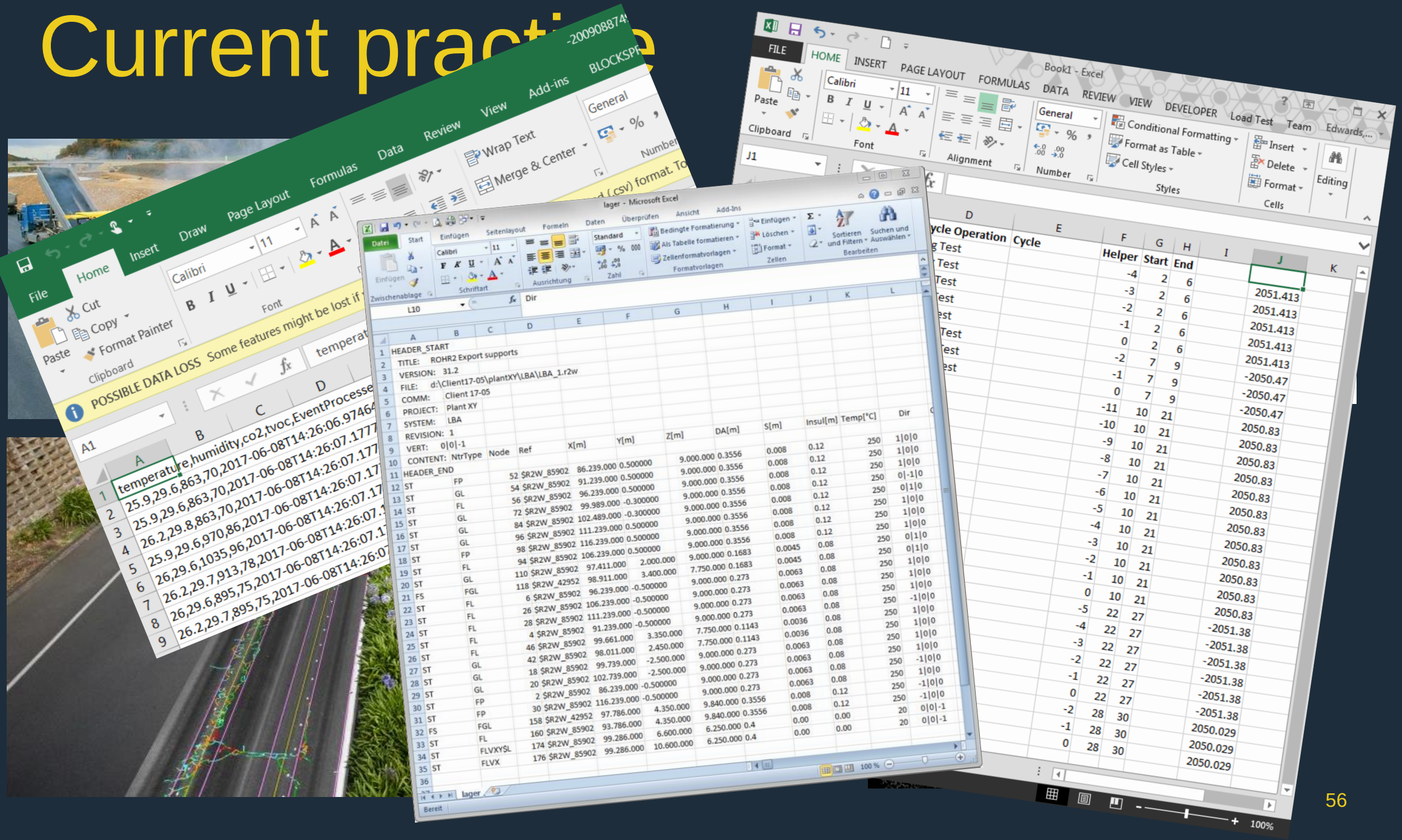
Efficient way of communication linking…

different disciplines

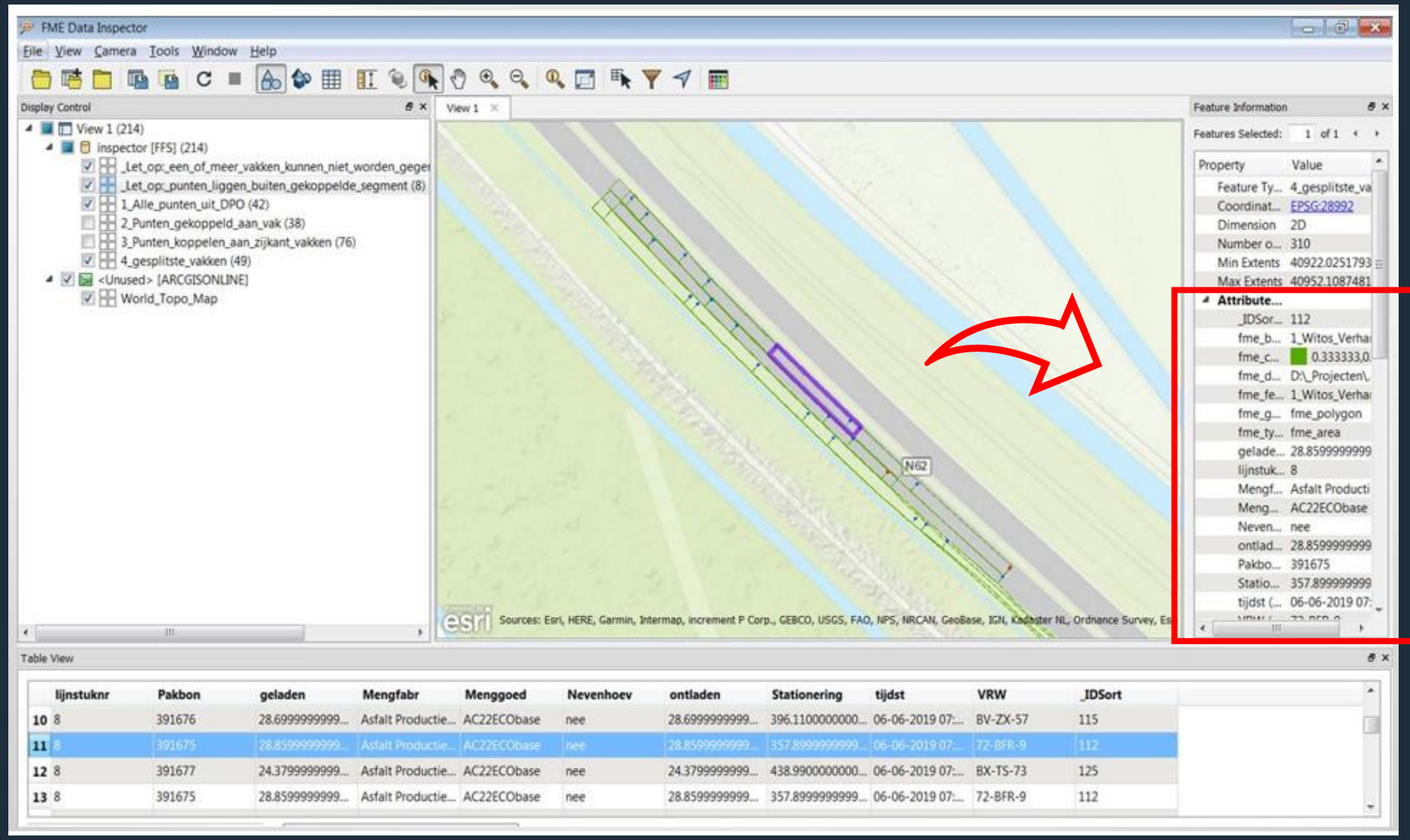
different lifecycle phases

past, present and future

Current practice



Georeferenced sensory data



Problem description

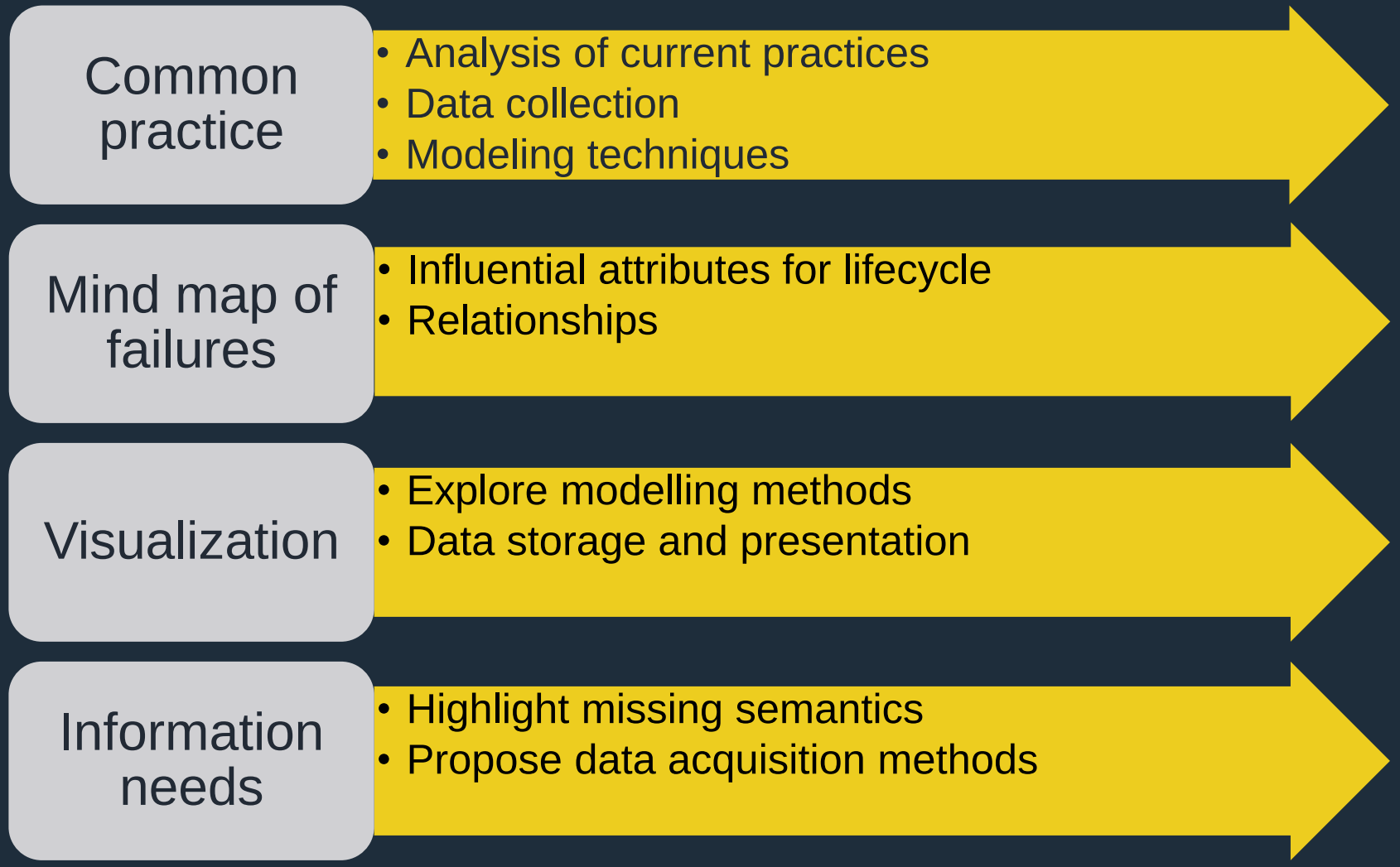
- Little consistency of how data is structured throughout lifecycle phases
- Immature asphalt failure data representation

- Semantics play a big role for data structure
- Important parameters that define the failure within the context of the entire lifecycle

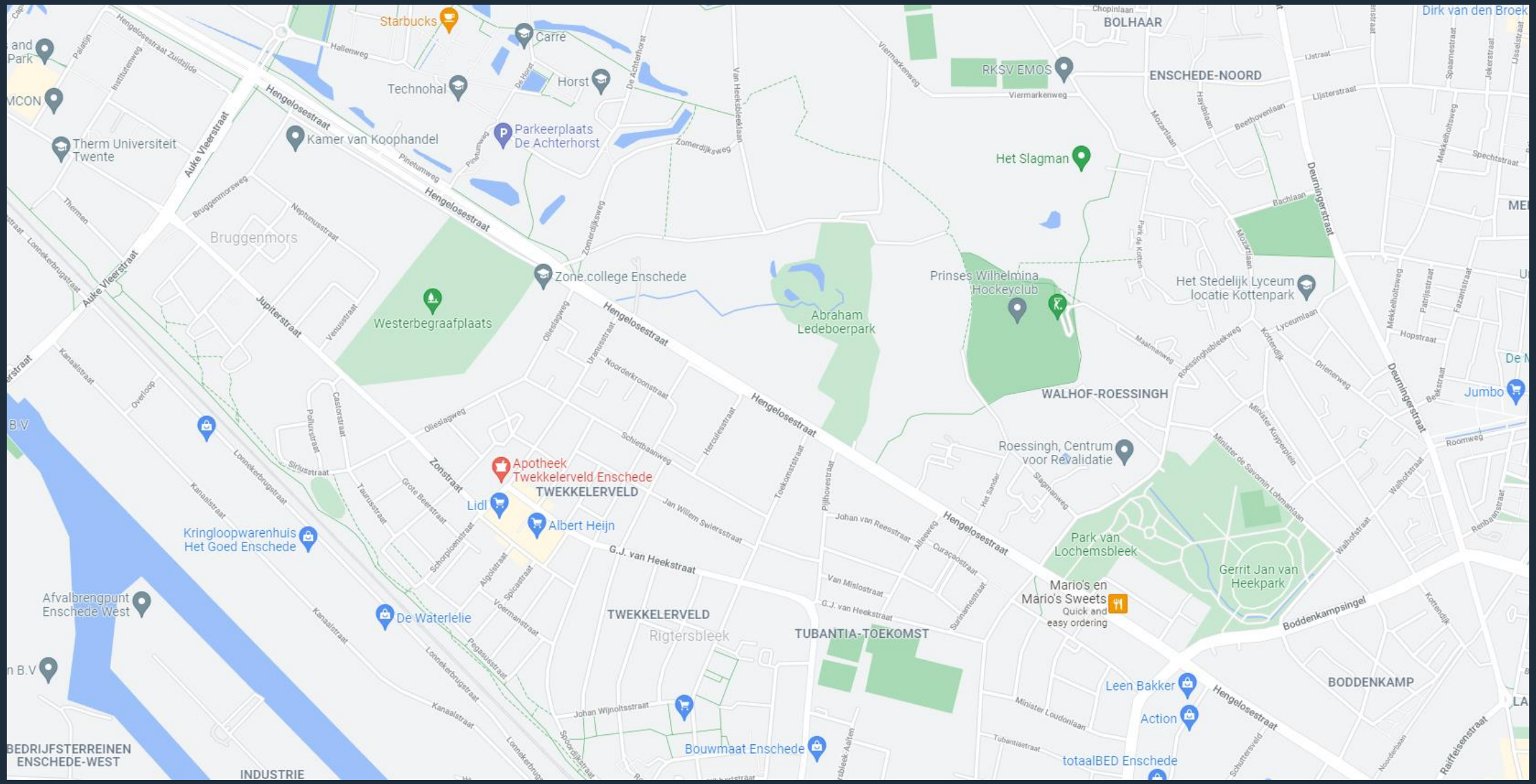
Research Objective

To systematically link the asphalt failure modes with their influential properties and the forms of visualization

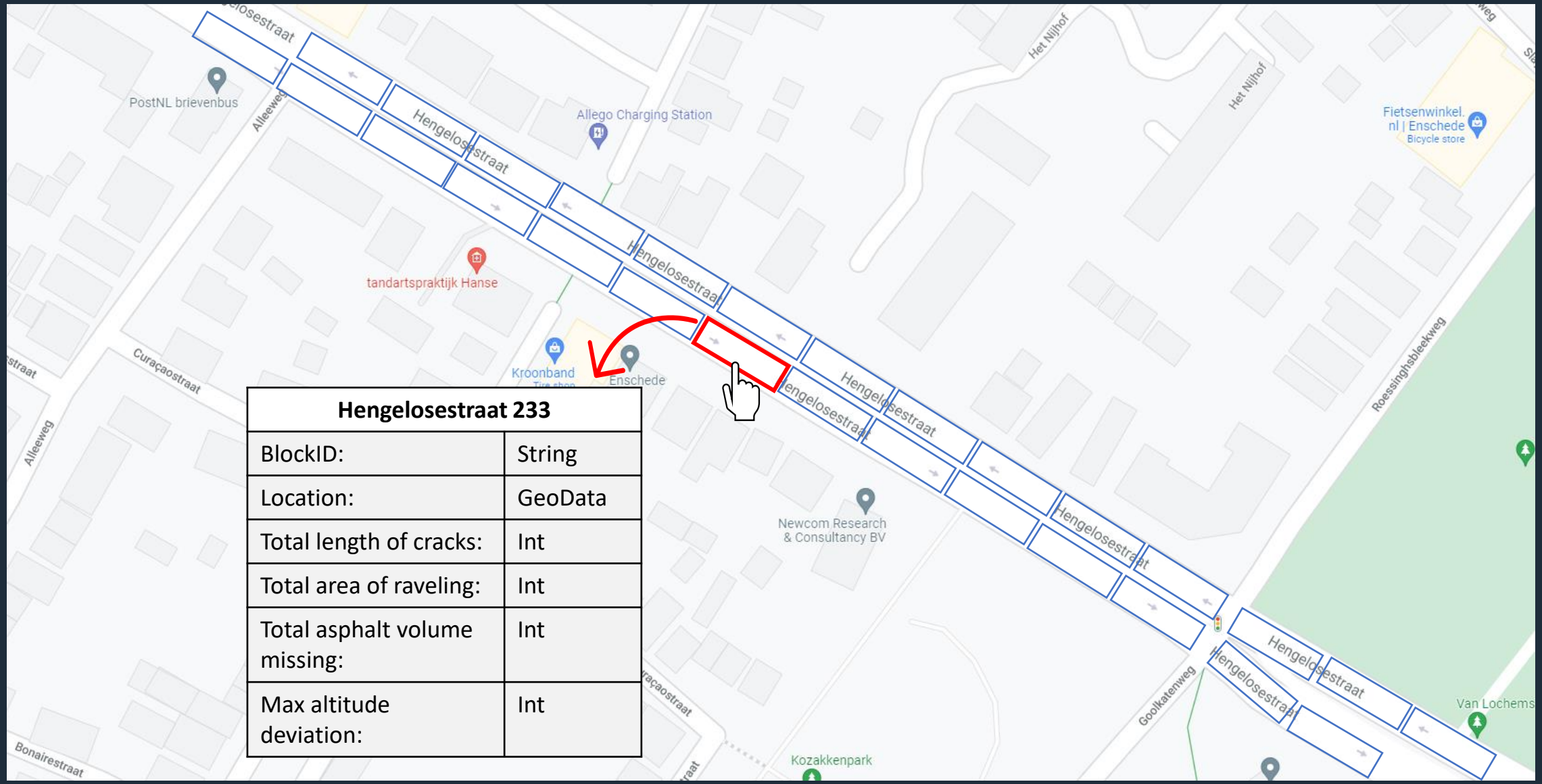
Methodology



Visualization of failure modes

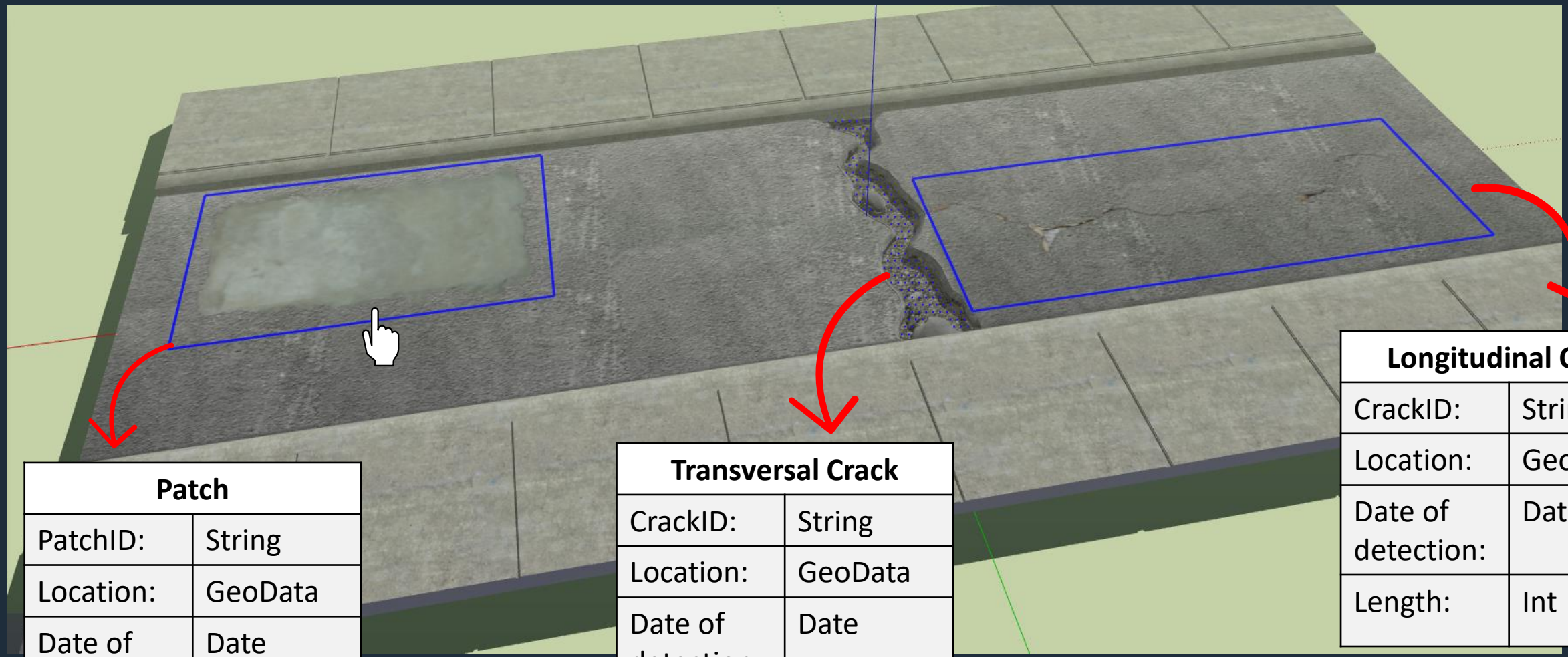


Visualization of failure modes



Hengelosestraat 233	
BlockID:	String
Location:	GeoData
Total length of cracks:	Int
Total area of raveling:	Int
Total asphalt volume missing:	Int
Max altitude deviation:	Int

Visualization of failure modes

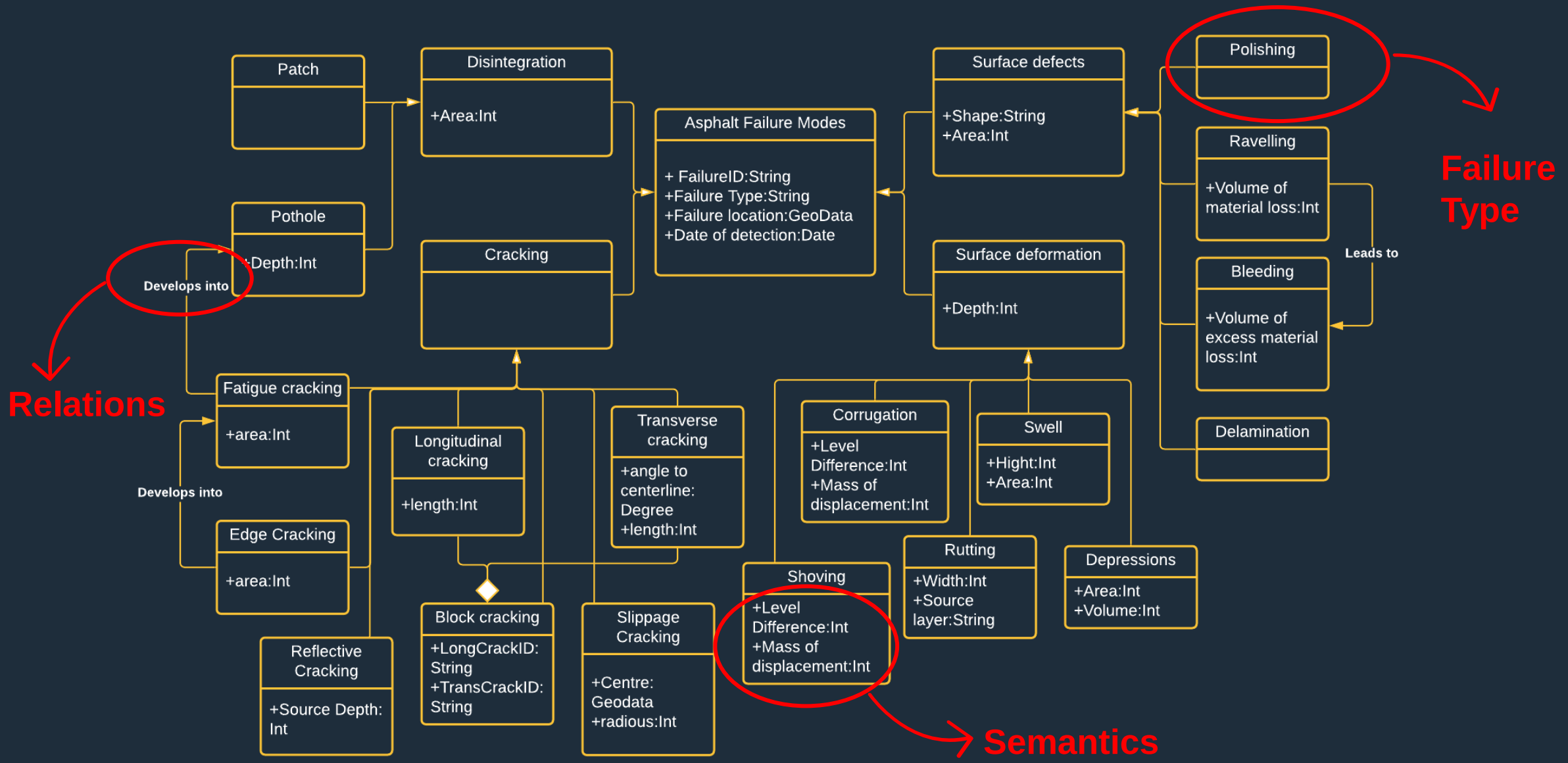


Patch	
PatchID:	String
Location:	GeoData
Date of detection:	Date
Area:	Int

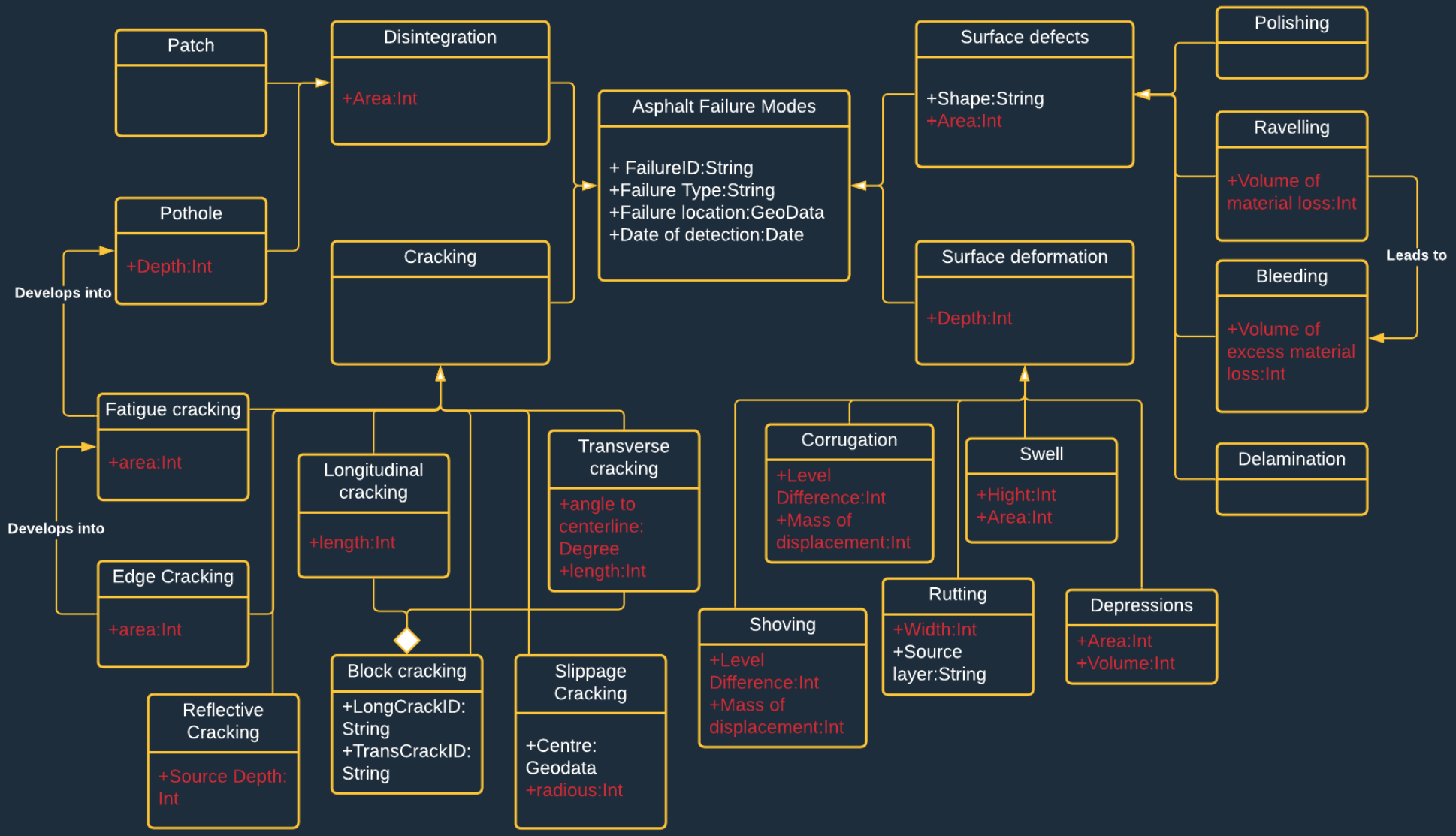
Transversal Crack	
CrackID:	String
Location:	GeoData
Date of detection:	Date
Angle to centerline:	Degree

Longitudinal Crack	
CrackID:	String
Location:	GeoData
Date of detection:	Date
Length:	Int

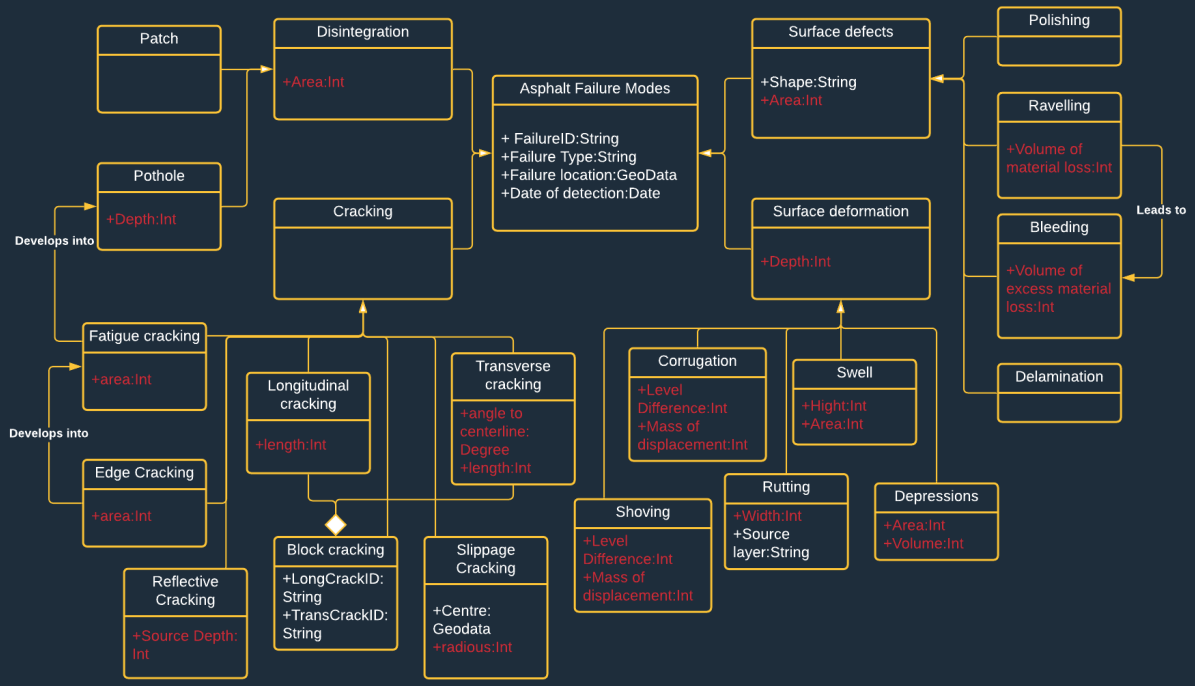
What is missing?



What is missing?



What is missing?



Focus of research

- Highlight information needs
- Indicate data acquisition techniques

What can you do with this research?

Precise localization and traceability

Filtering and logic application

Optimization of maintenance planning

Insight in failure behavior and prediction

How can you contribute?

Access to sensory data and databases

Insight in modelling techniques

Specific requirements for different users

Do you want to know more?

i.m.giorgadze@utwente.nl

Inga Maria Giorgadze

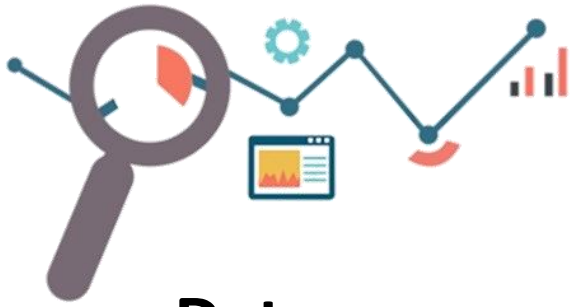
Thank you

ASPARi VR Simulator

Training and Beyond

How this simulator set up

Simulator



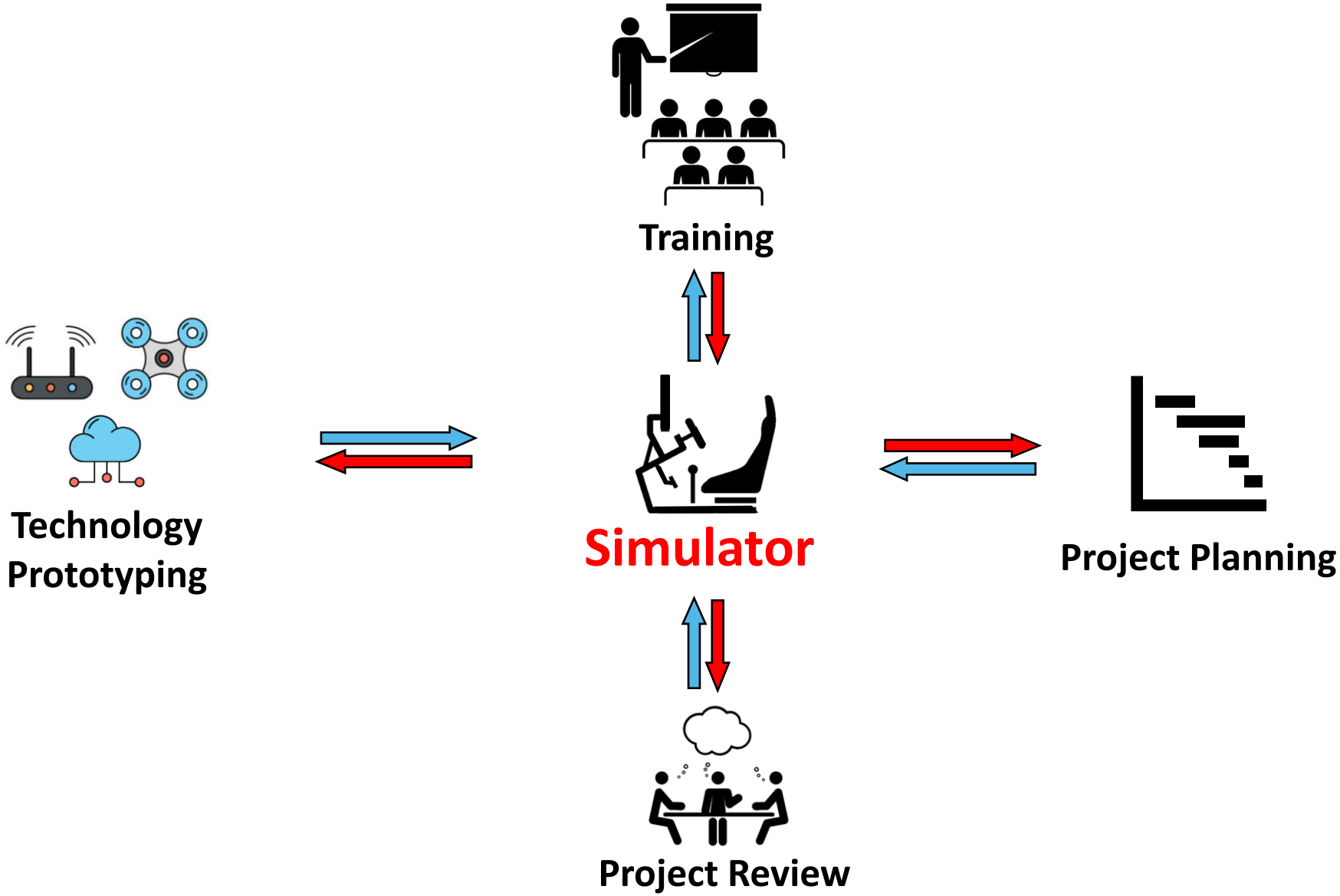
Data

Practice

UNIVERSITY OF TWENTE.

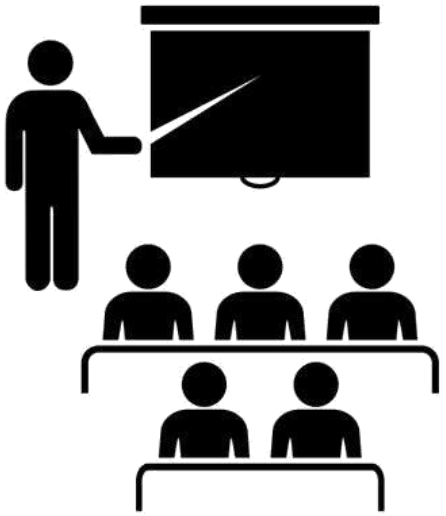
What the Simulator look like?

It is not all about training though!

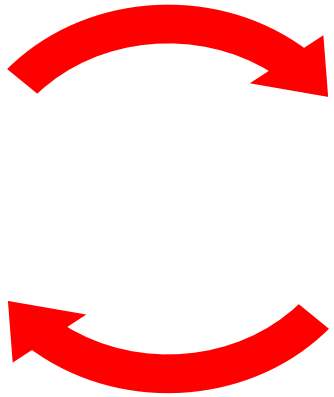


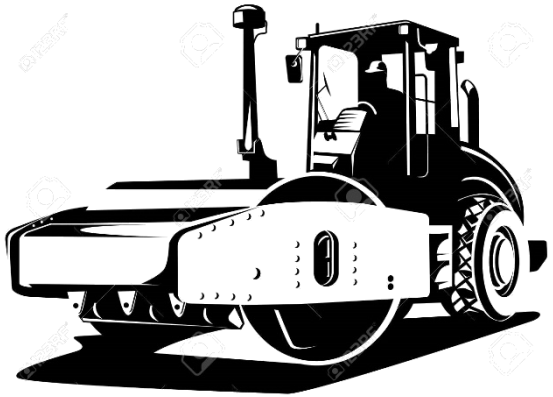
UNIVERSITY
OF TWENTE.

(1) Construction Training



Theorical Sessions



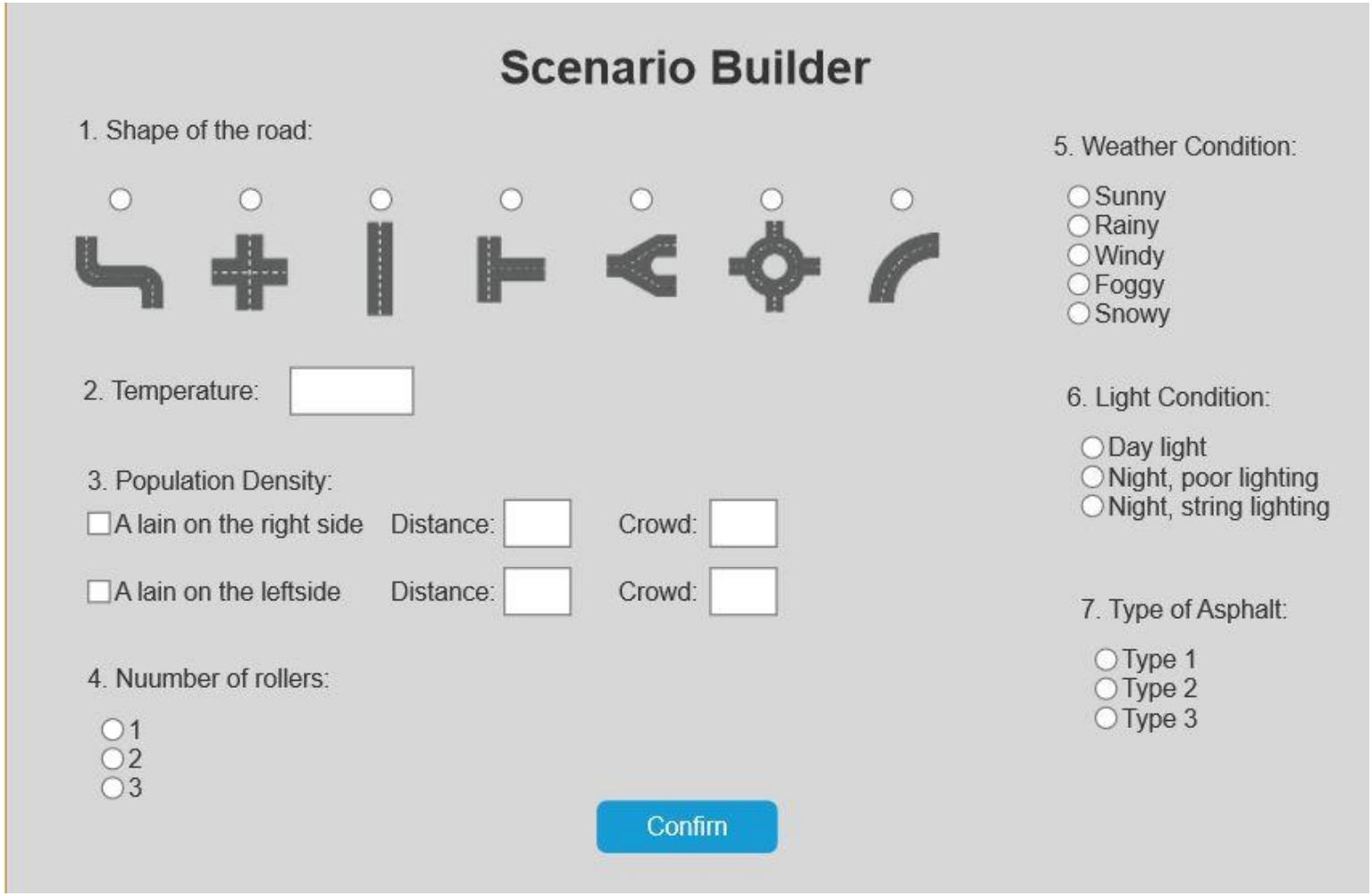


Practical Sessions

This process is **costly**, **unsafe**, and **fragmented** and **under-exposed** trainees to delicacies of working on sites. Besides, insight we gained through PQI is barely incorporated in education.

UNIVERSITY OF TWENTE.

(1) Construction Training



VR simulator should be **comprehensive** enough to capture various scenarios and conditions.

Customizable Simulator

UNIVERSITY OF TWENTE.

(1) Construction Training

UNIVERSITY OF TWENTE.

(1) Construction Training

Now expanding!

We have a room in SOMA

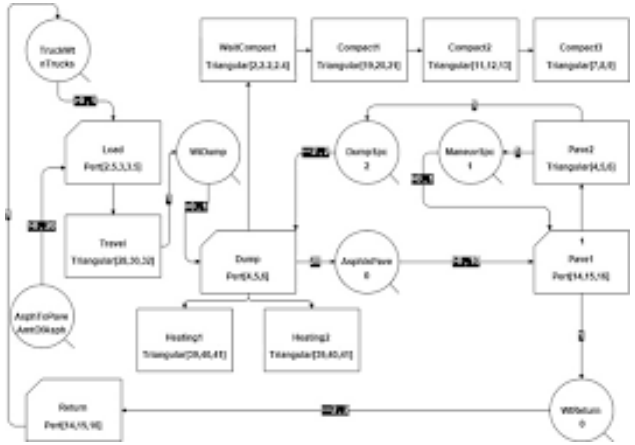
UNIVERSITY OF TWENTE.

(2) Construction Planning

Strategic Planning

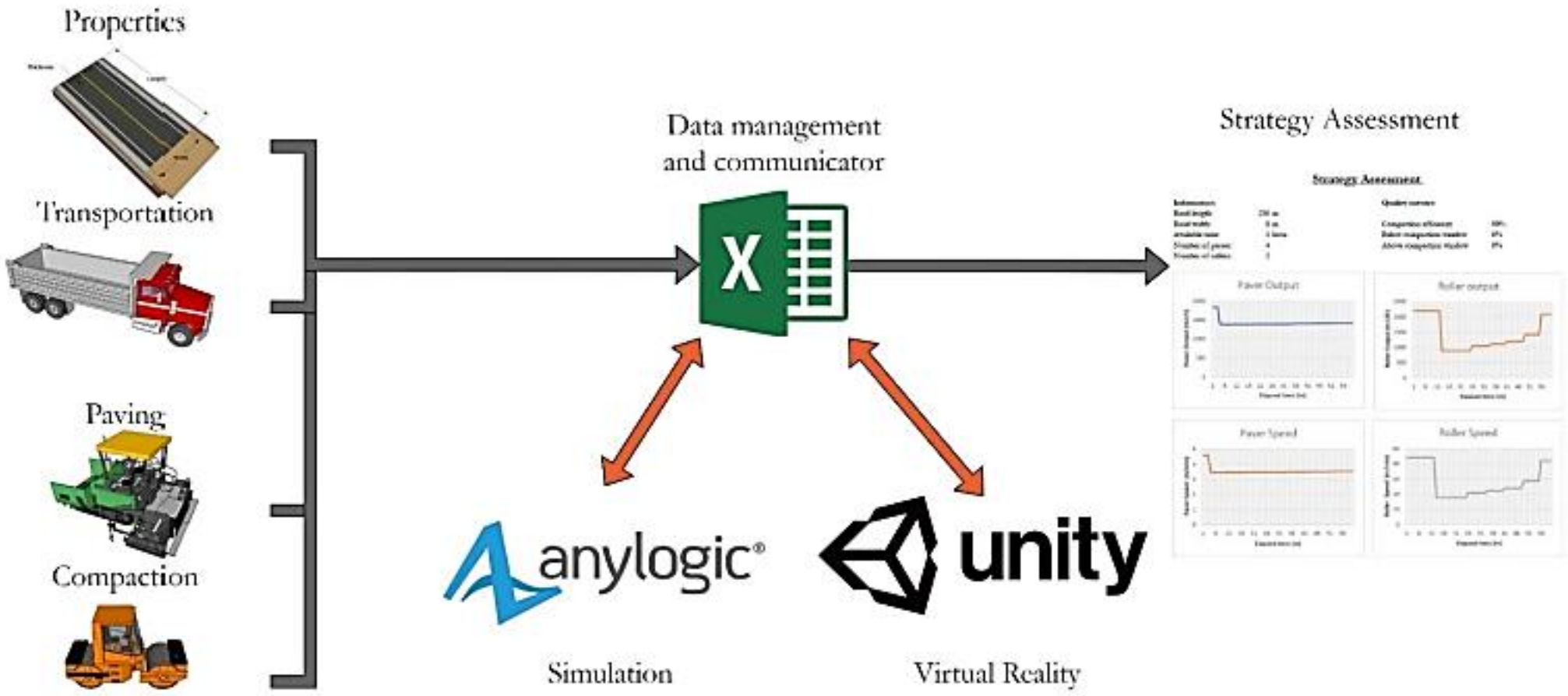
Tactical Planning

There is a **disconnect** between **Strategic/Logistic** Planning and **Tactical** Planning on site. However, the two are heavily interdependent



UNIVERSITY OF TWENTE.

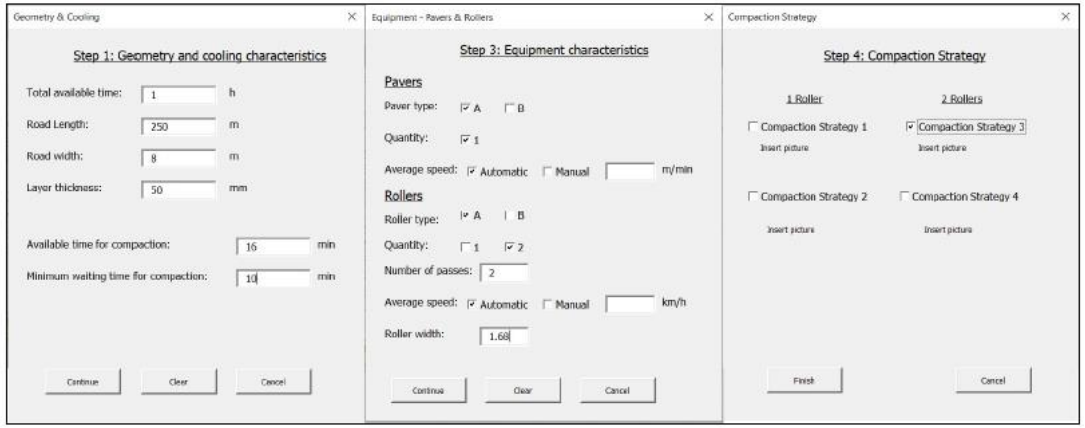
(2) Construction Planning

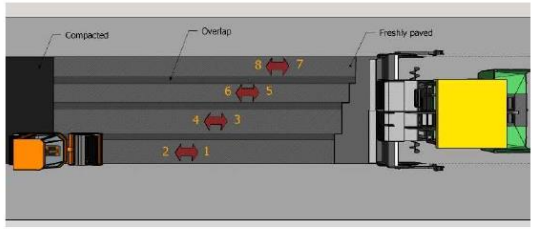


Simulation-Simulator Integration

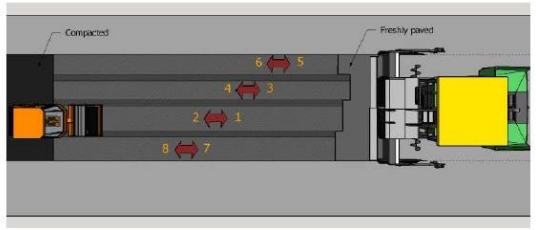
UNIVERSITY OF TWENTE.

(2) Construction Planning

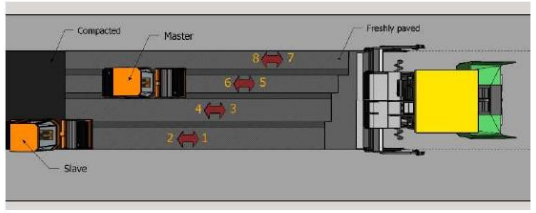




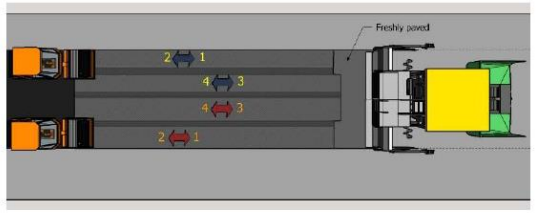
(a) 1 roller uniform (Kloubert, 2009)



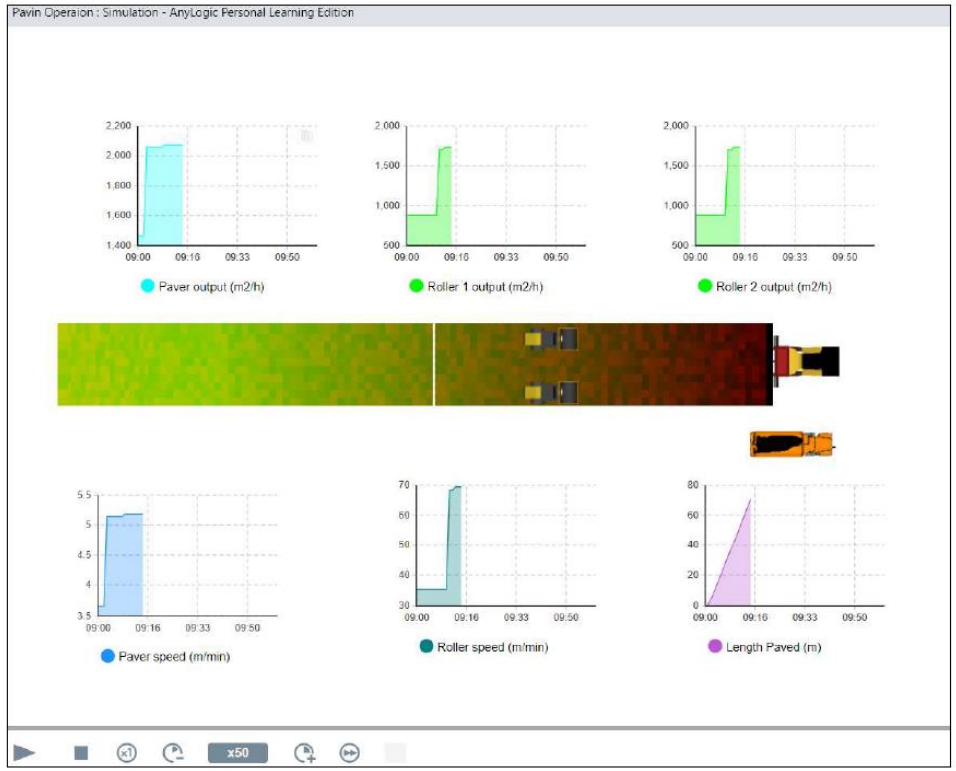
(b) 1 roller alternate (Kloubert, 2009)



(c) 2 rollers in series (Lender, 2019)



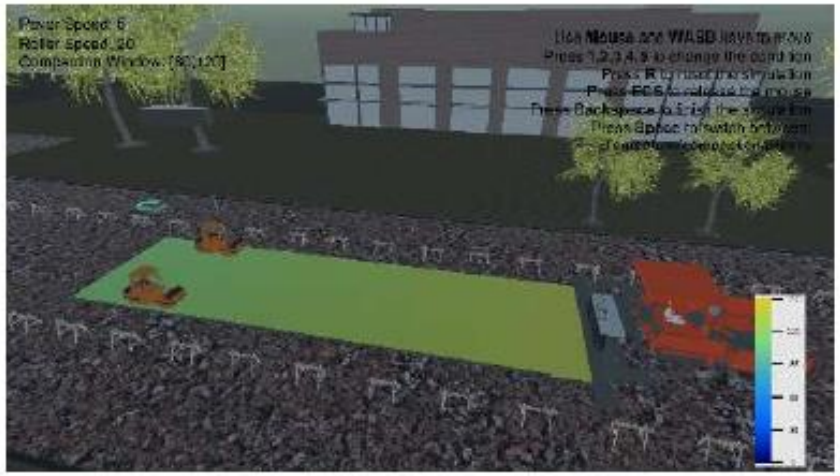
(d) 2 rollers in parallel (For Construction Pros, 2019)



Interface of the tool

UNIVERSITY OF TWENTE.

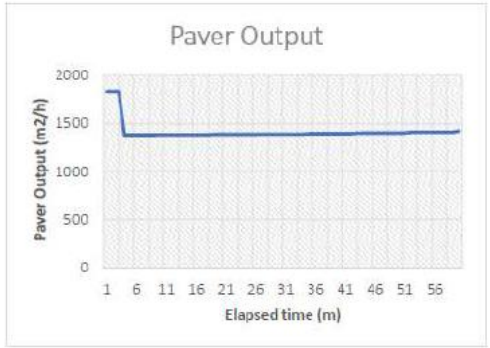
(2) Construction Planning

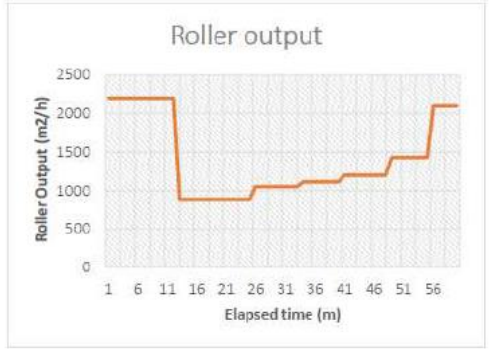


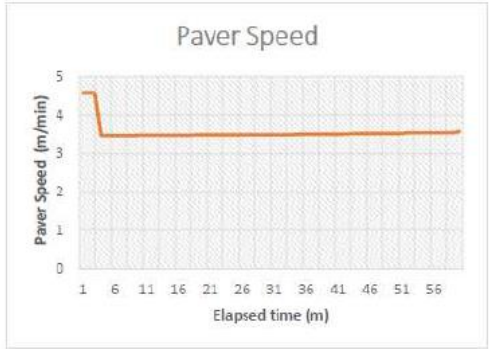
Strategy Assesment

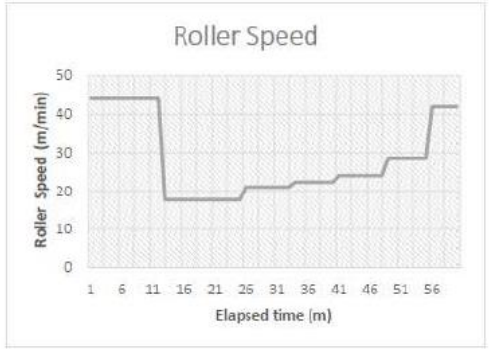
Information	
Road length:	250 m
Road width:	8 m
Available time:	1 hour
Number of passes:	4
Number of rollers:	2

Quality metrics	
Compaction efficiency	90%
Below compaction window	6%
Above compaction window	0%







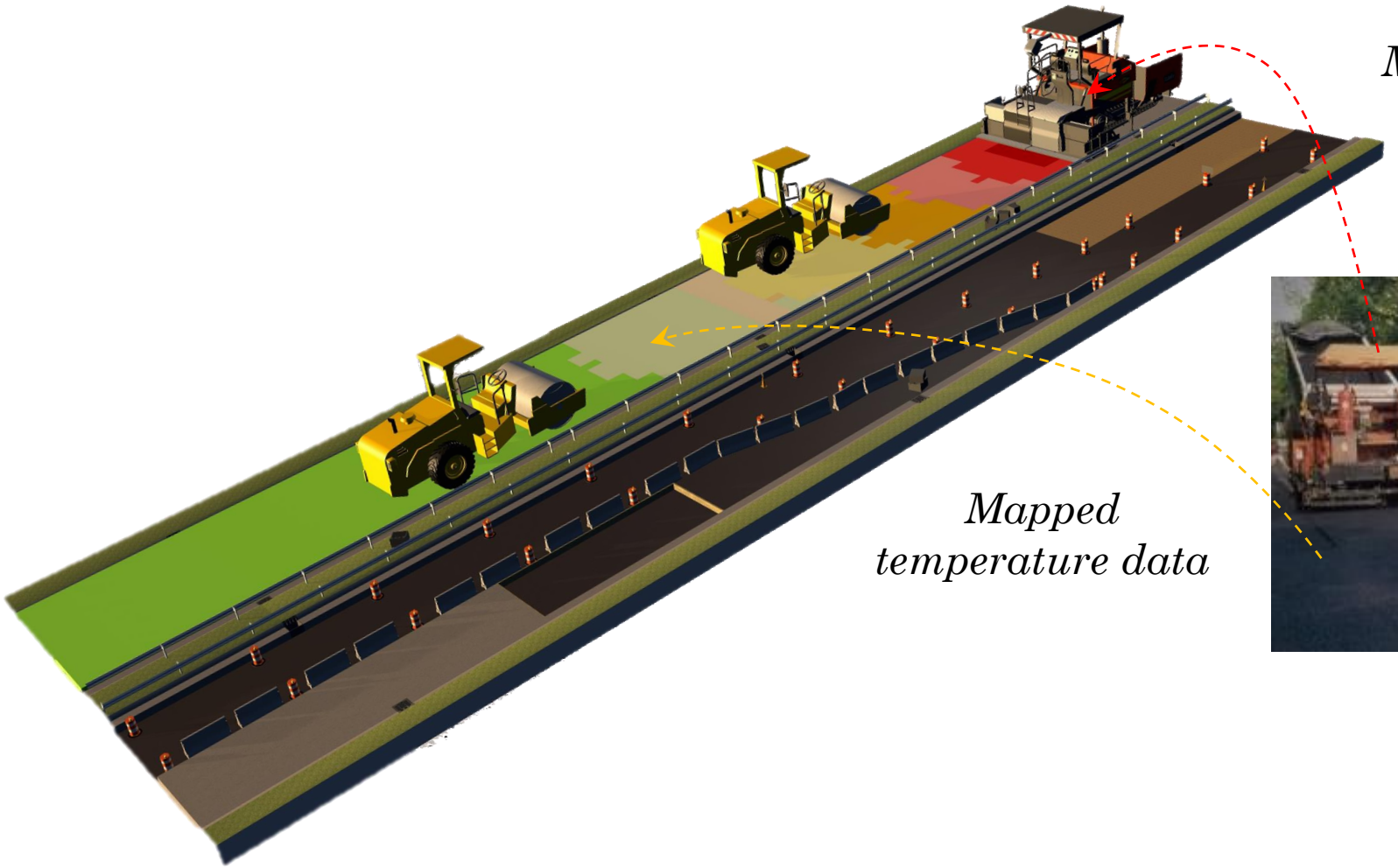


The output in terms of 3D visualization and graphs

(3) Project Review

Sensors

Simulator

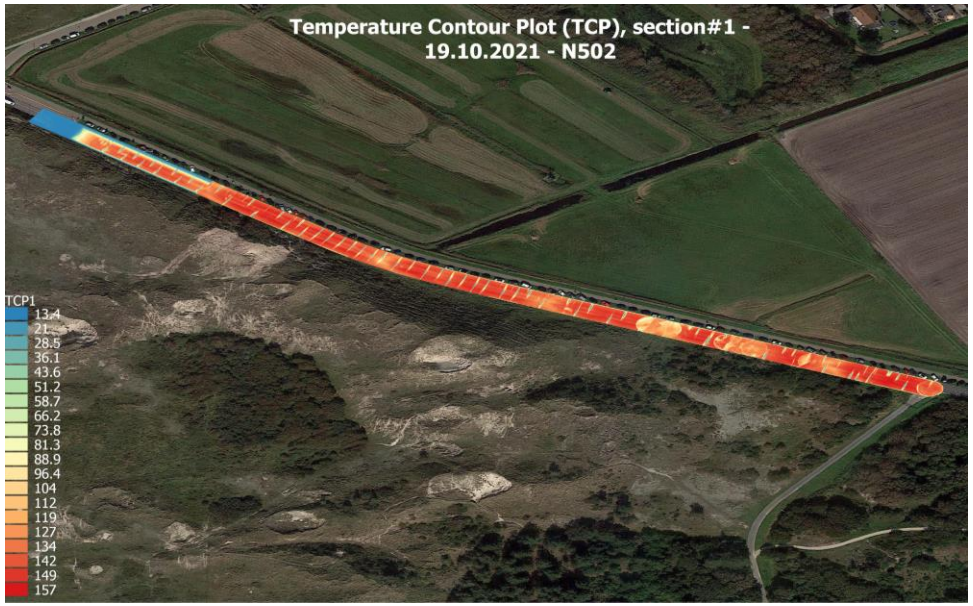


Mapped mobility data

Mapped temperature data

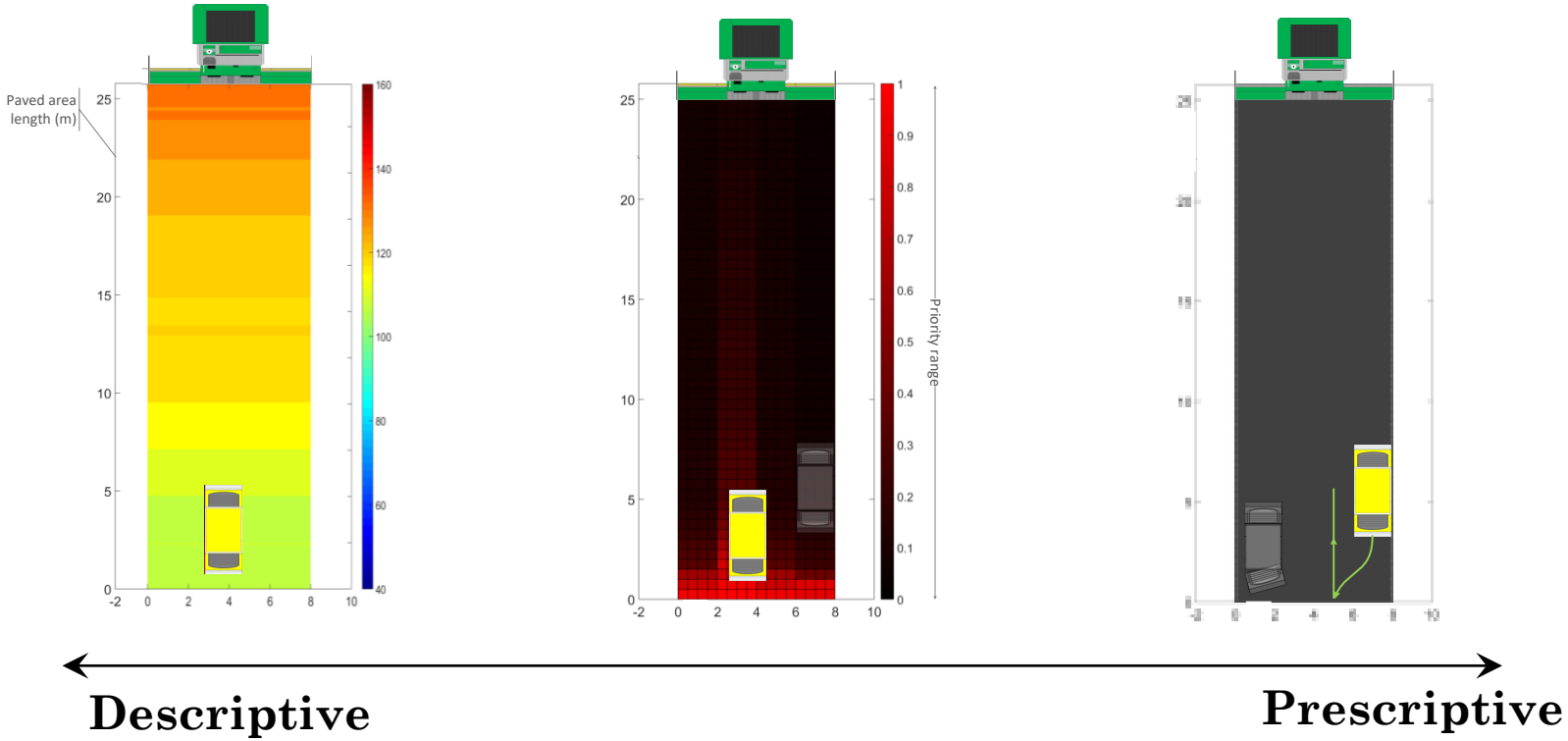
UNIVERSITY OF TWENTE.

(3) Project Review



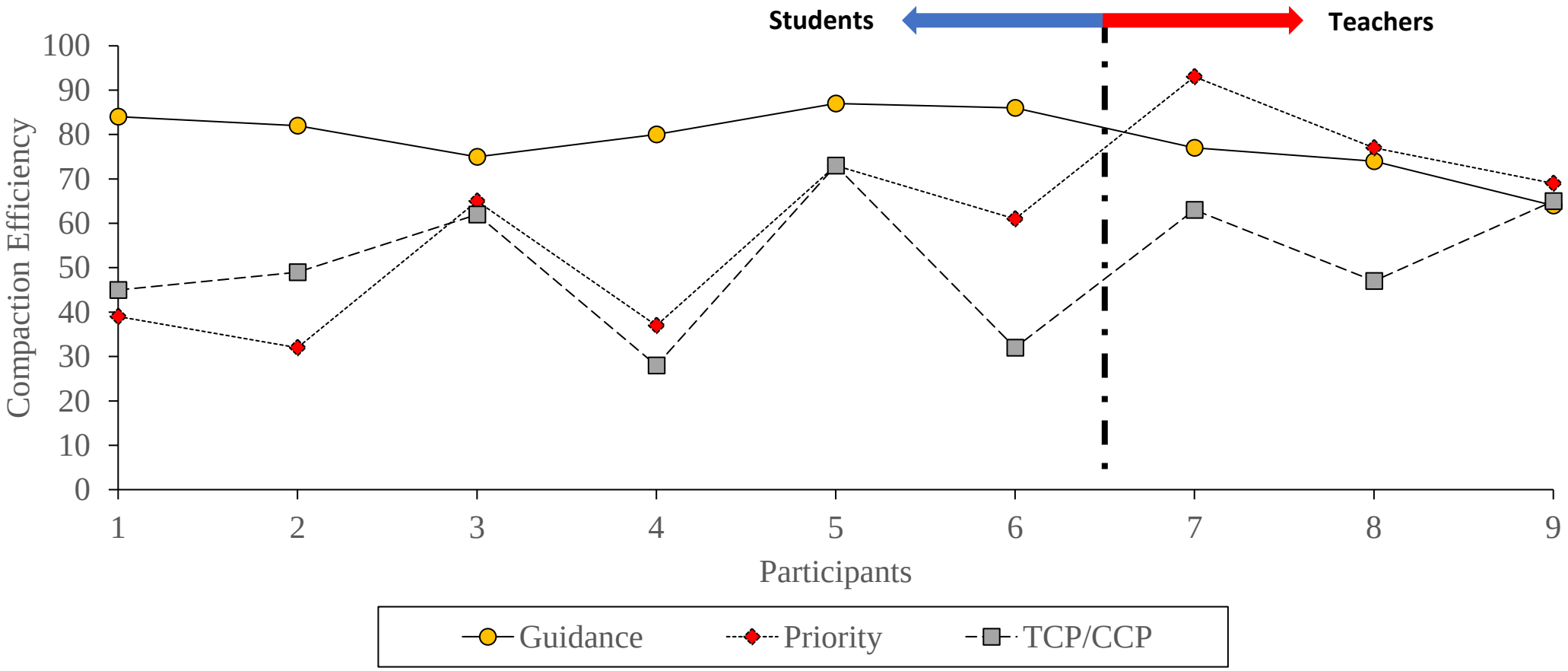
VS.

(4) Technology Prototyping



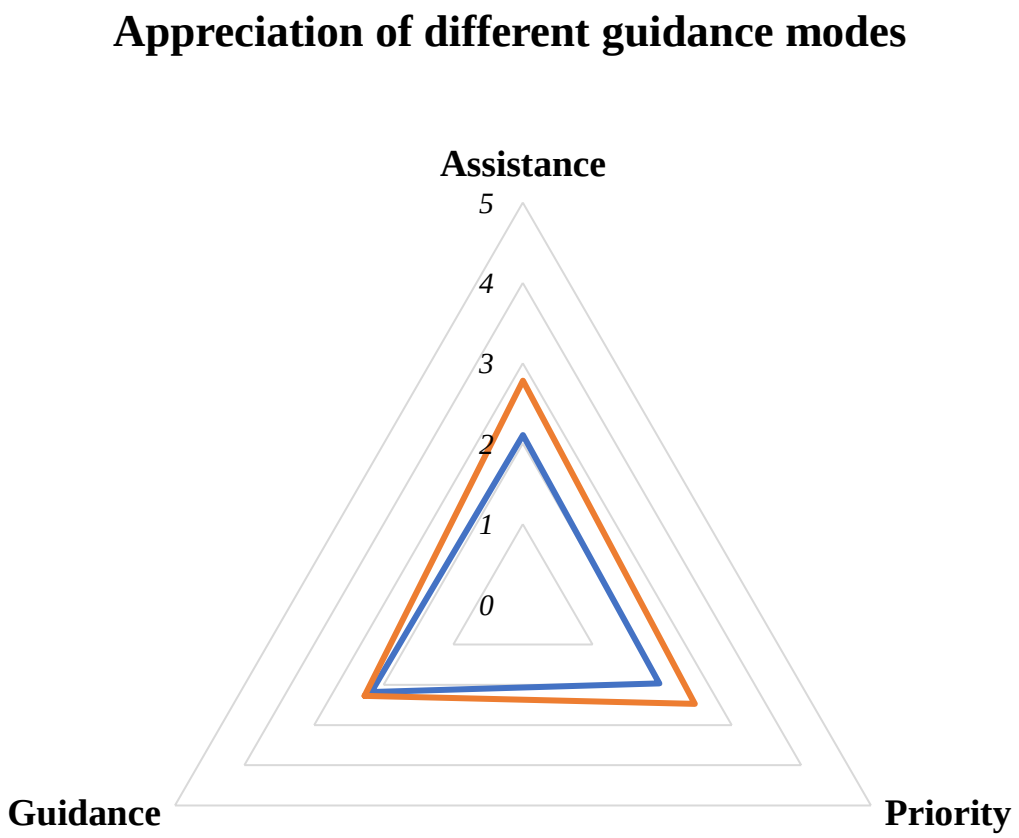
How should we develop new types of guidance and how useful are they?

(4) Technology Prototyping



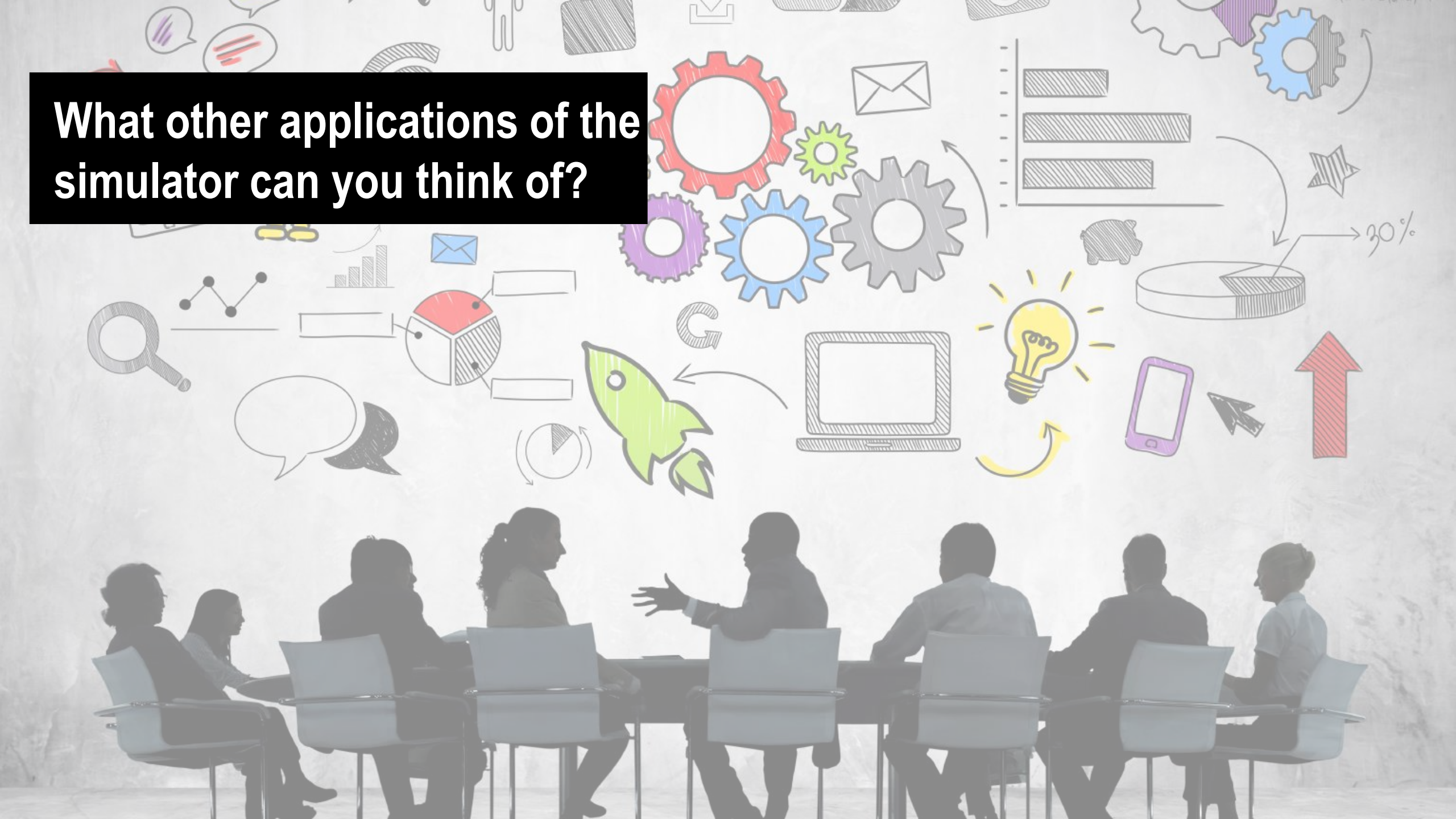
What we learnt

(4) Technology Prototyping



What we learnt

What other applications of the simulator can you think of?



How to move faster towards sustainable asphalt?

Angie Lorena Ruiz Robles

ASPARi

Paving the way forward

UNIVERSITY OF TWENTE.

ABOUT ME

Only asphalt producer in the country.

Born in Barrancabermeja, Colombia.

Universidad de Los Andes, Bogotá D.C., Colombia.

- Bachelor's degree in Civil Engineering
- Master of Science in Civil Engineering
  Emphasis on Road Infrastructure

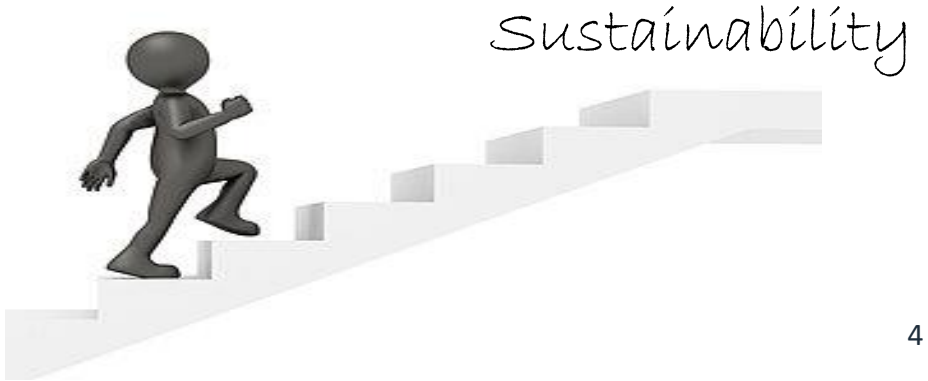
PROBLEM CONTEXT

- Road infrastructure development impact significantly our **environment**.

- Transport sector:
  - **23%** of CO_2 emissions worldwide
  - **10%** development of roads

- Main materials: **asphalt** and aggregates.

PROBLEM CONTEXT



ASPARi
Paving the way forward
UNIVERSITY OF TWENTE.

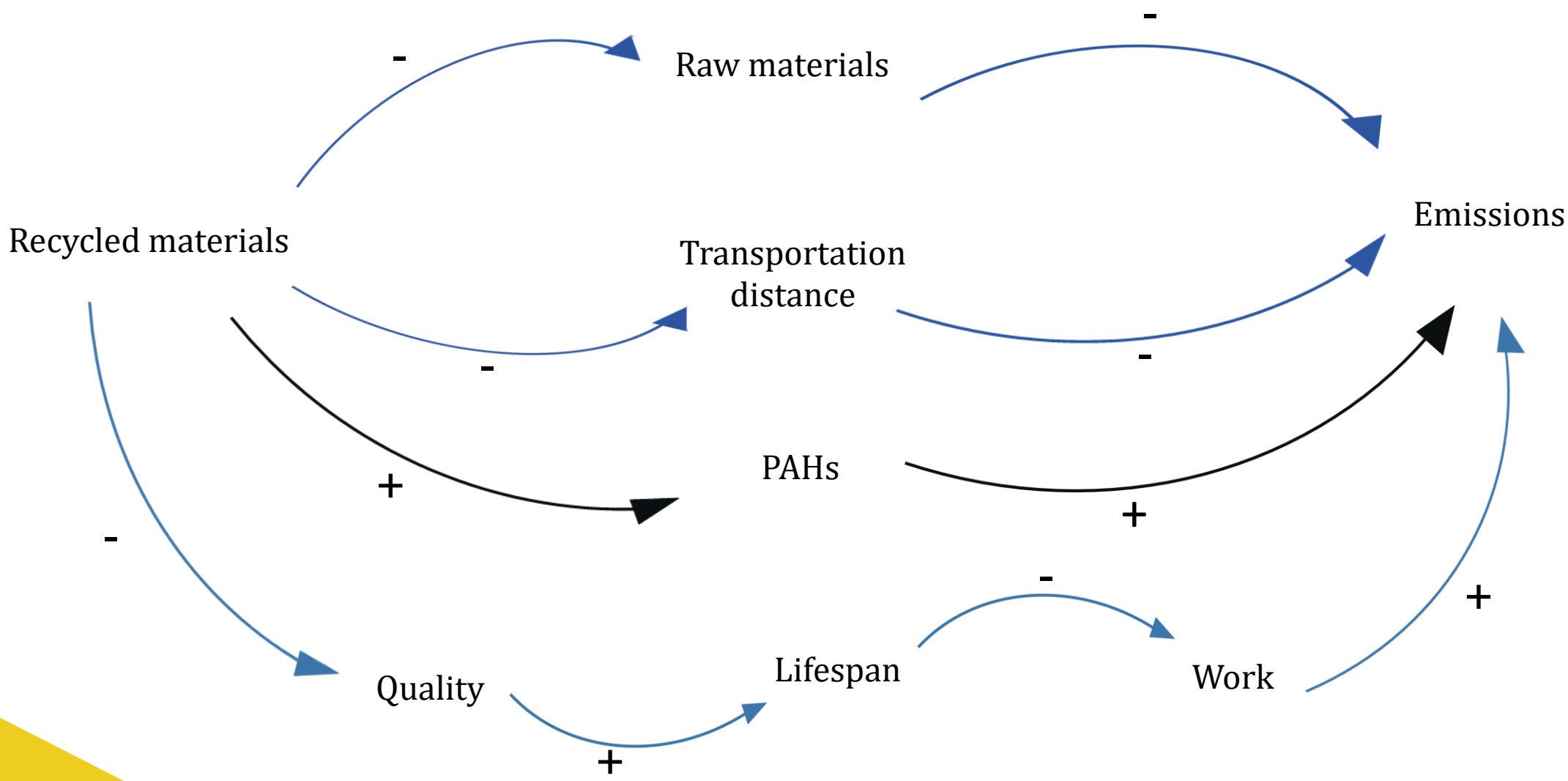
PROBLEM CONTEXT

- Efforts are not unified
- Lack of coordination among stakeholders

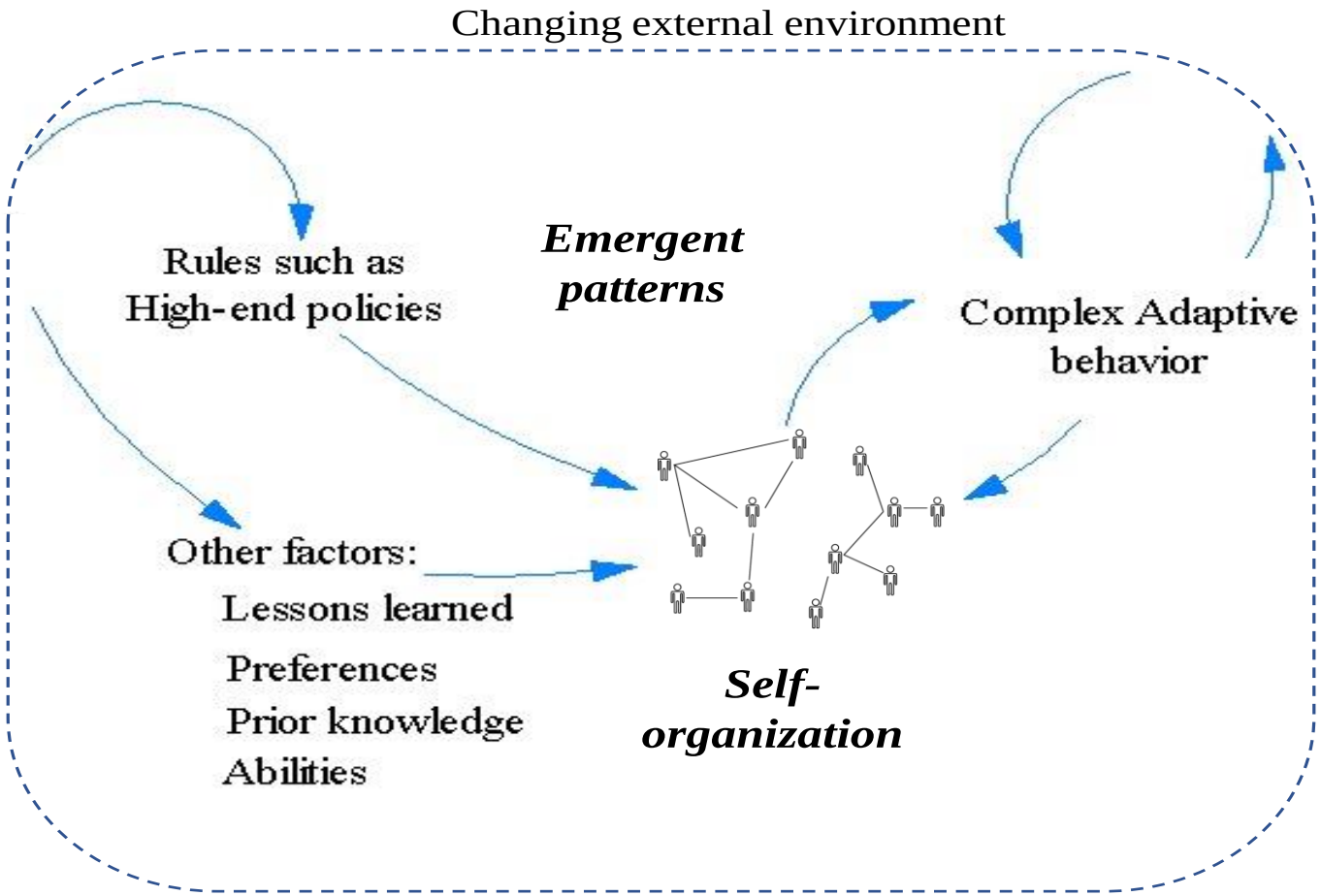
What is holding us back?

ASPARi
Paving the way forward
UNIVERSITY OF TWENTE.

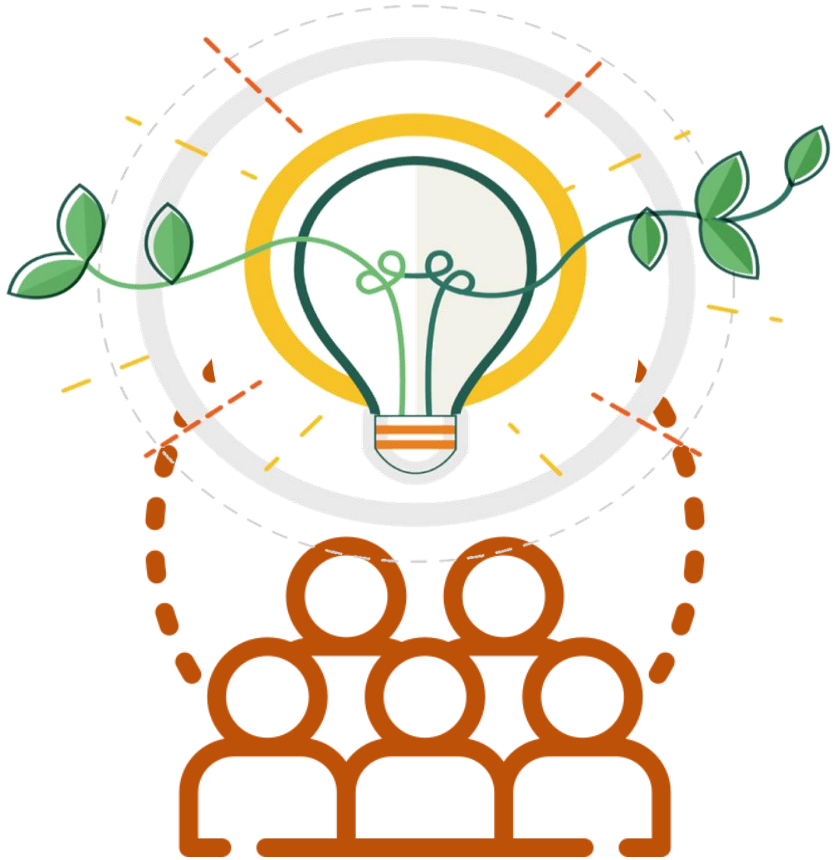
PROBLEM CONTEXT (EXAMPLE)



COMPLEX ADAPTIVE SYSTEMS (CAS)



OBJECTIVE



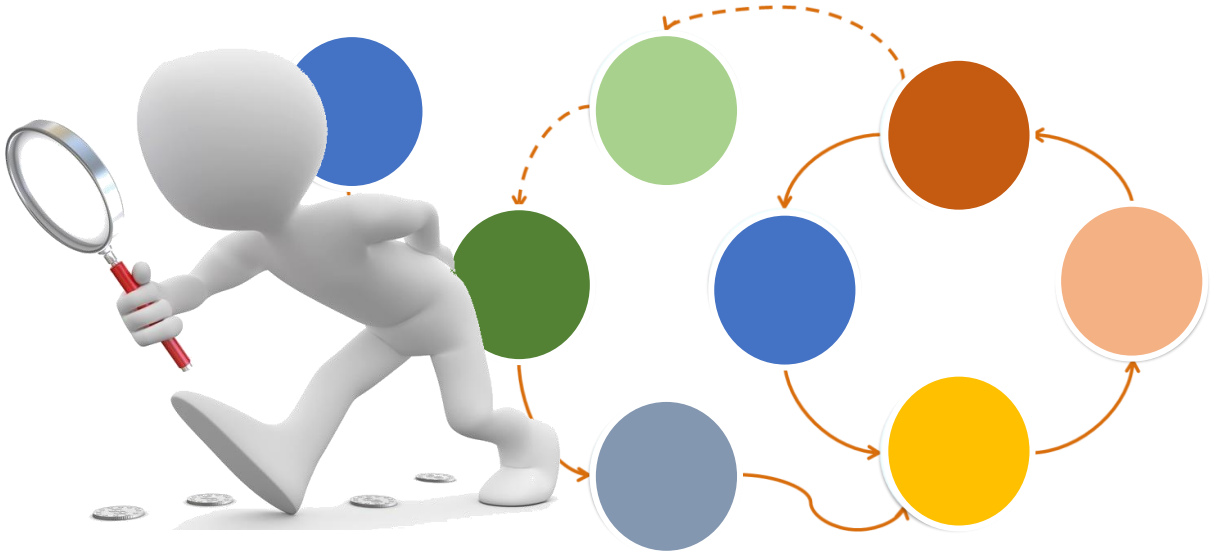
Works towards a guideline - for the stakeholders - to overcome confusion and promote agreement when implementing sustainable innovations in the asphalt sector

IDENTIFYING KEY FACTORS

Interviews and documents review

Expected outcome: main factors (categories and priorities)

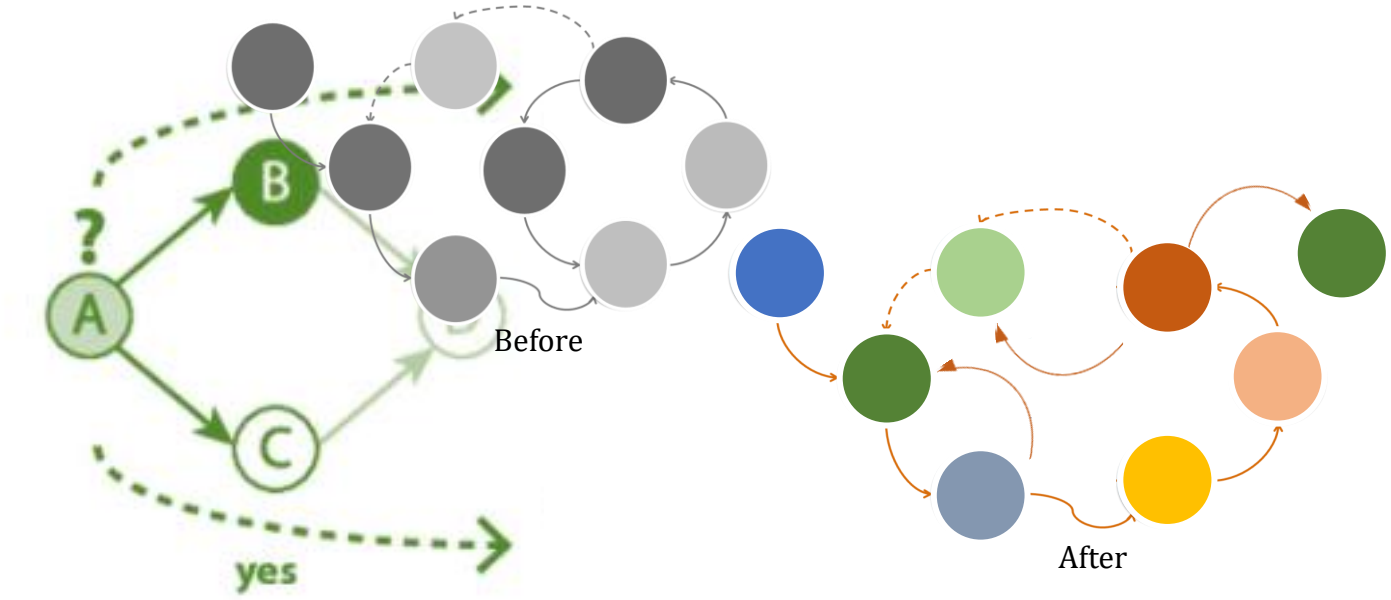
UNDERSTANDING THE CURRENT PATTERNS



Direct observation, past experiences, focus groups

Expected outcome: qualitative description of the implementation process as a CAS

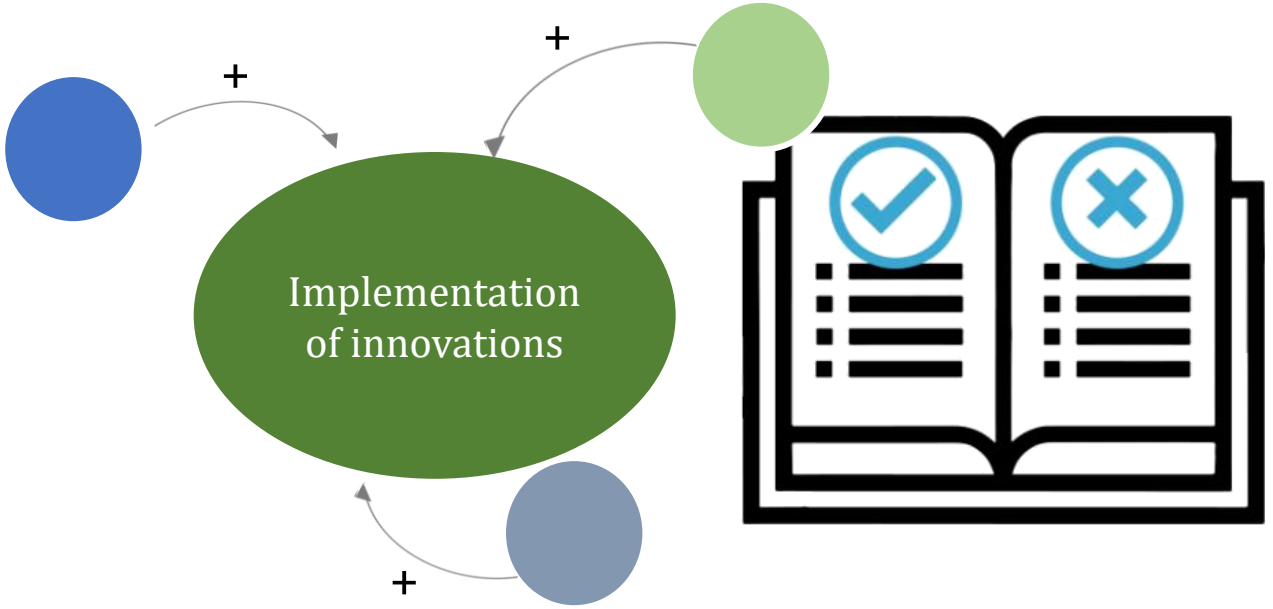
HOW TO REFORM THE CURRENT PATTERNS?



Lessons learned and counterfactual reasoning

Expected outcame: set of strategies to reform the current patterns

STRATEGIES TO PROMOTE SUSTAINABLE INNOVATIONS



Positive interactions

Expected outcome: set of strategies for stakeholders to speed up the process

EXPECTED OUTCOME

Recommendations for stakeholders in the public and private sector to boost the implementation of asphalt sustainable innovations under the requirements of contemporary sustainability policies.

Collaboration is the key!

Thank you

Collaboration is always welcome:
a.l.ruizrobles@utwente.nl

A GENERALIZABILITY ANALYSIS OF A DATA-DRIVEN METHOD FOR THE URBAN HEAT ISLAND PHENOMENON ASSESSMENT

M. Pena Acosta

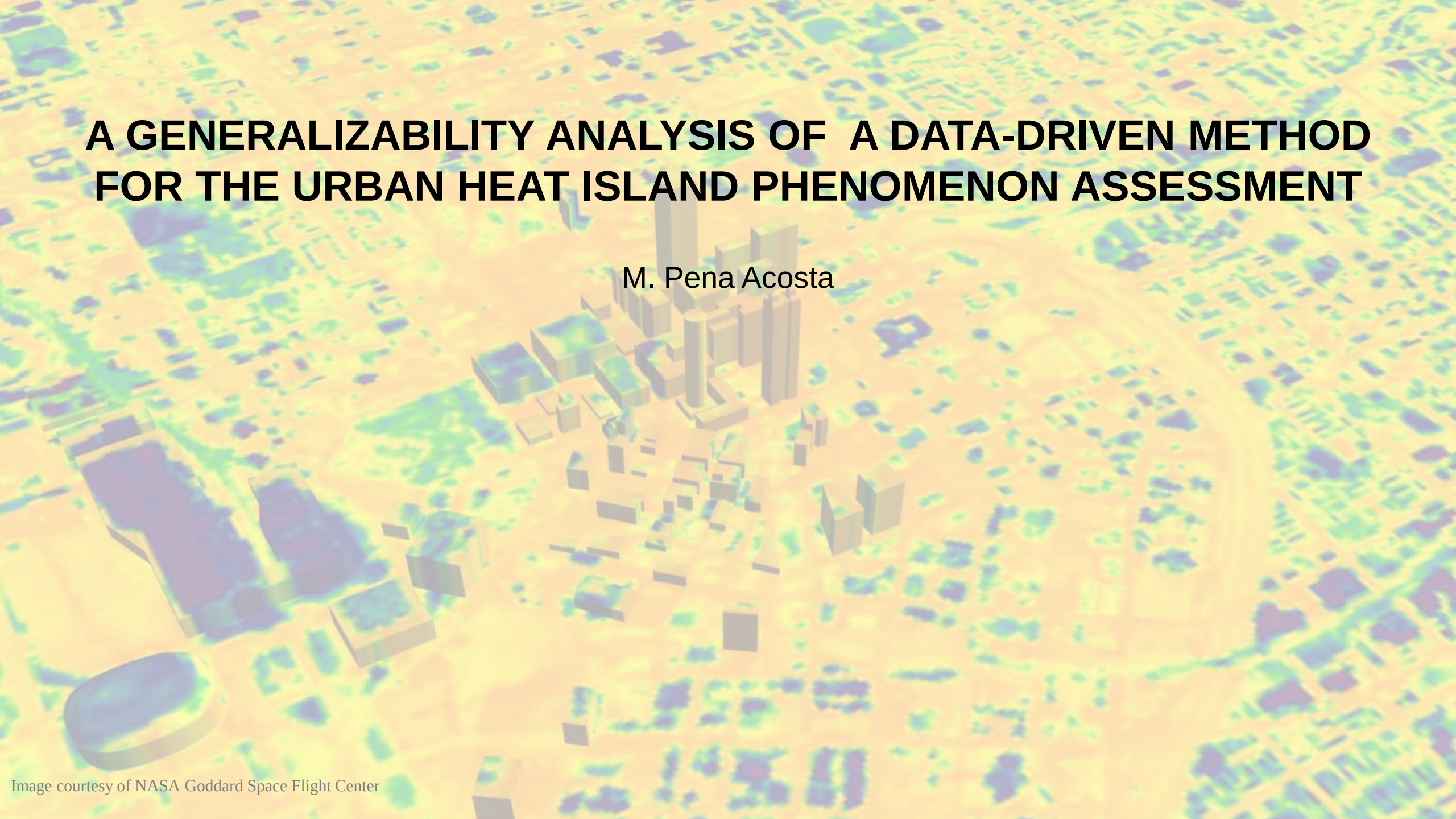
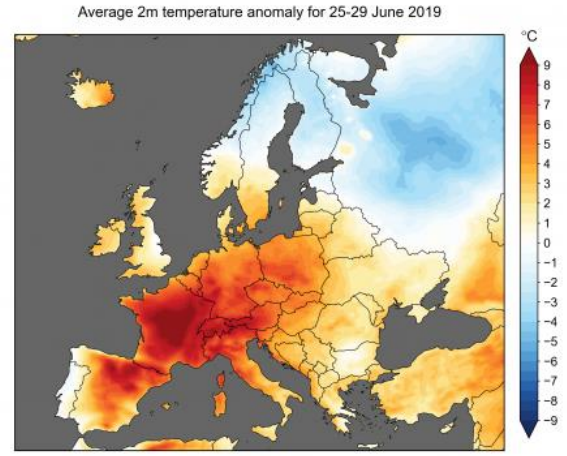


Image courtesy of NASA Goddard Space Flight Center

The Urban Heat Island Phenomenon (UHI)

- Climate change is causing more extreme weather
- “Climate change is already ravaging the world,” President Biden, COP26
- The number of days with extreme heat doubled in Europe between 1960 and 2017
- Exceptionally hot years (2003, 2010, 2015, and 2018) result in an annual loss of 0.3-0.5% of European gross domestic product (GDP)



opernicus

ECMWF

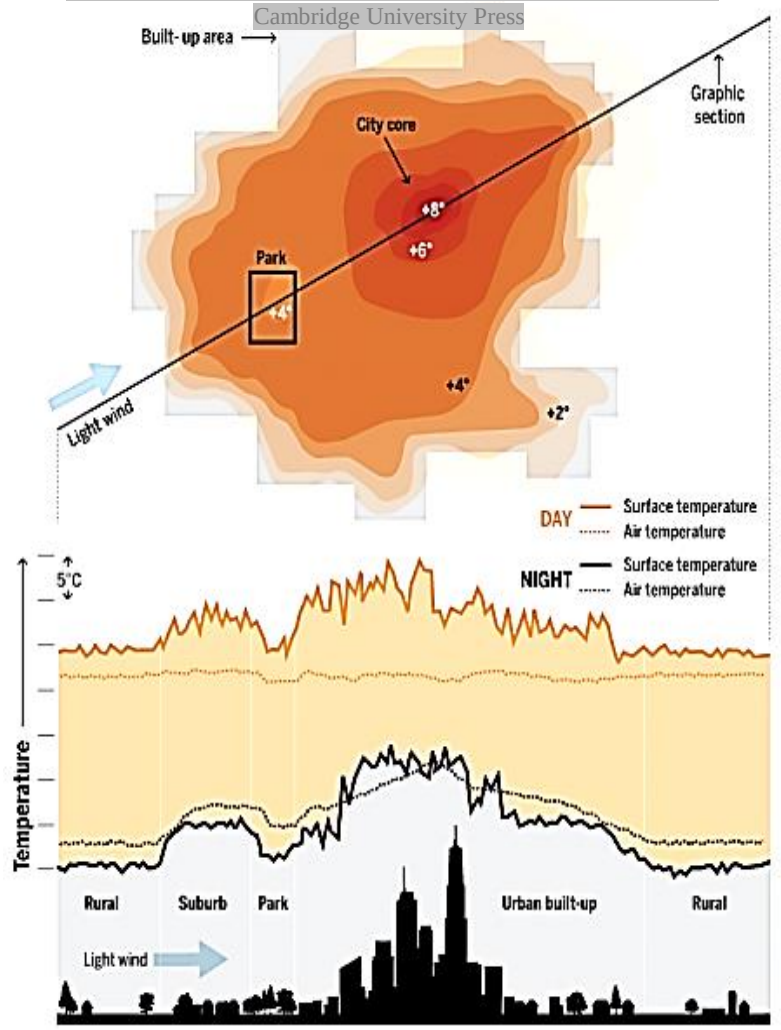
ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

The Urban Heat Island Phenomenon (UHI)

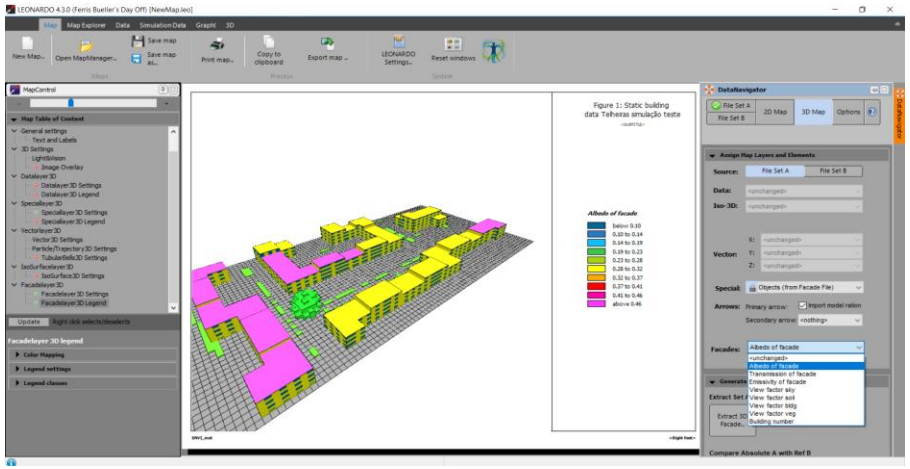
- Cities are only projected to continue expanding. Today, about 55% of the world's population – 4.2 billion inhabitant. By 2050, nearly 7 of 10 people in the world will live in cities.
- The UHI phenomenon refers to the temperature difference between the suburbs and the inner city
- Because of changes in the natural environment cities are more prone to store solar radiation
- To address UHI it is important to understand and model the phenomenon

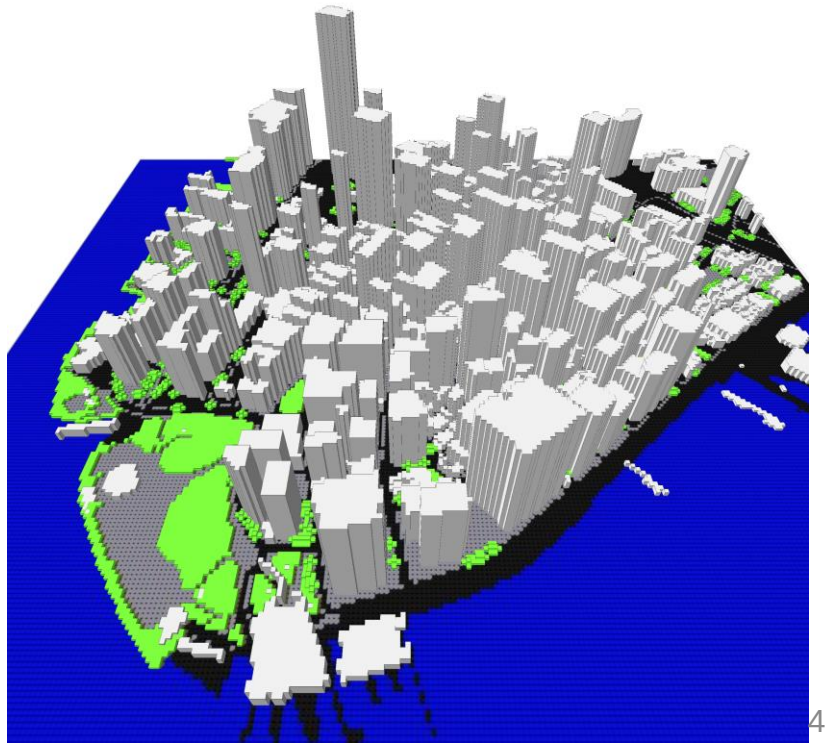
Image adapted from Oke, et al. Urban Climates, forthcoming from Cambridge University Press



Current approaches to assess UHIs

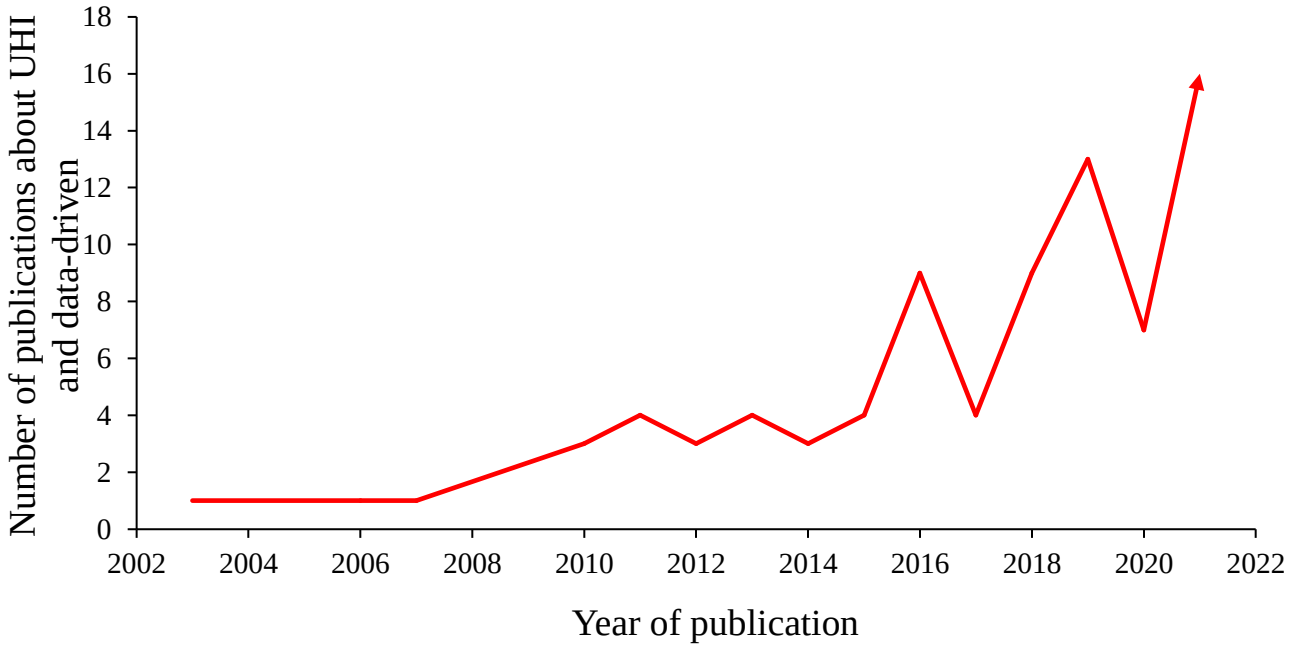
- Physics-based mimics the thermal exchanges between urban surfaces and air temperatures
- Details about the material properties of the built environment are required
- This makes physics-based simulations computationally expensive and time consuming
- Therefore, UHI considerations play very little role in urban planning





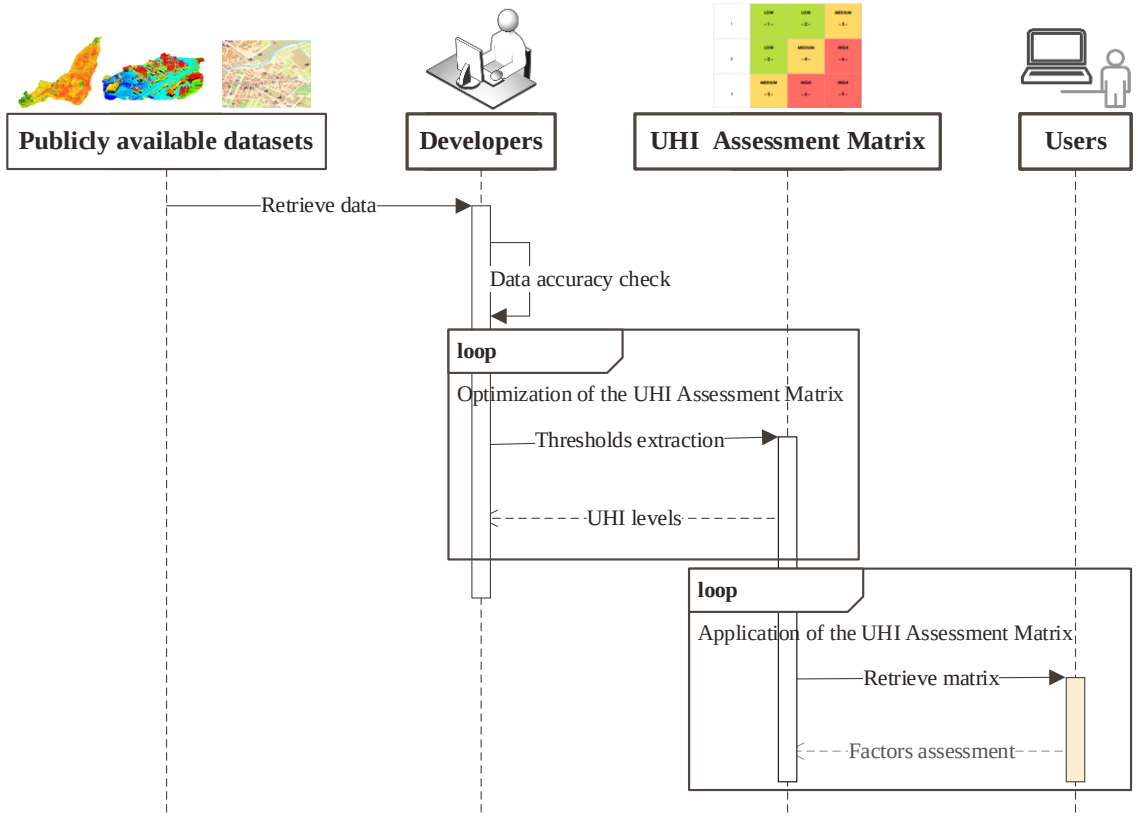
Current approaches to assess UHIs

- Urban data (e.g., building geometry, canopy coverage, population density, etc.) is becoming increasingly available
- This allows us to leverage data-driven methods for solving this complex multi-dimensional problems



The UHI Assessment Matrix

- The authors have previously developed a data-driven modeling pipeline to assist urban planners, accurately and easily assess the UHI impact of there urban planning decisions



The UHI Assessment Matrix

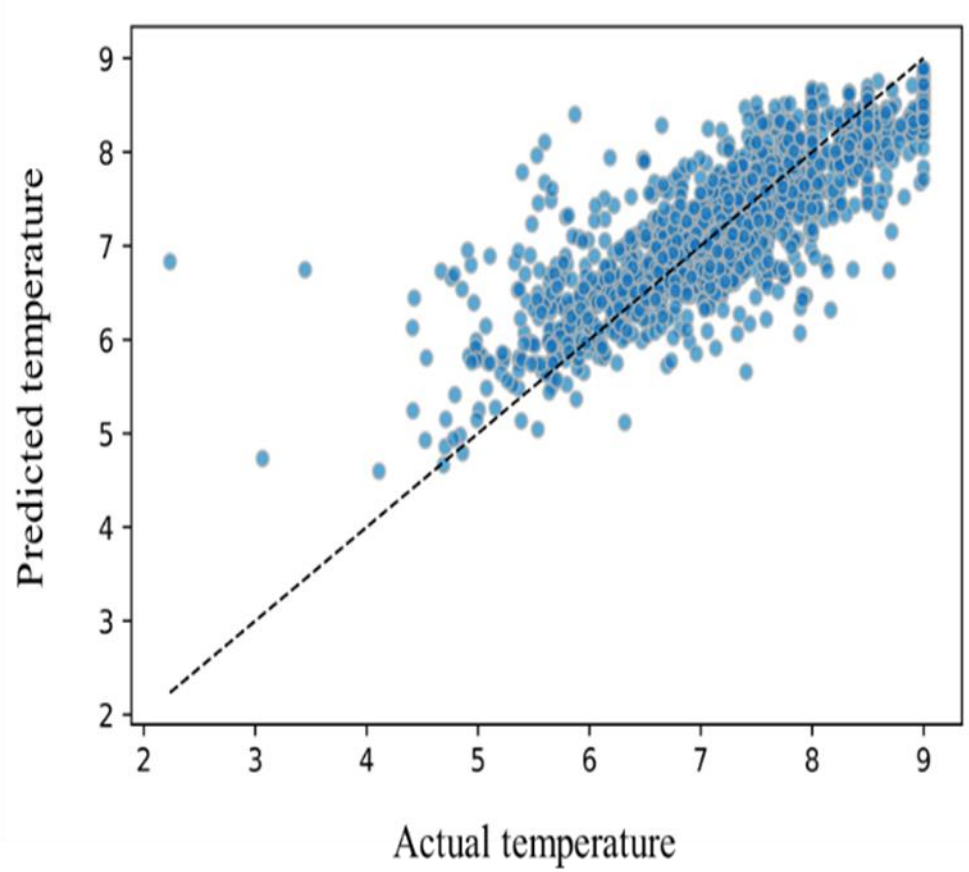
- Using tree-based data-driven models, the authors previous research developed a simple to use UHI assessment matrix

Categories of UHI potential	Built-up density (buildings/m2)	Vegetation density (greenery/m2)	Average building height (m)	Predominant façade materials	Predominant land-use	Population density (inhabitants/km2)	Average traffic count (# of vehicles)
L	[0.00~0.05]	[0.11~0.57]	[12.91~29.94]	Masonry [bricks/stones]	Parks and conversation	[13.82~22.01]	[60.41~68.99]
ML	[0.05~0.1]	[0.00~0.48]	[14.11~18.81]		Residential	[22.01~94.88]	[68.99~99.59]
M	[0.09~0.32]	[0.00~0.38]	[7.69~29.38]		Residential	[94.88~96.30]	[99.59~139.60]
MH	[0.09~0.32]	[0.00~0.23]	[11.30~17.99]		Residential, commercial, and industrial	[94.88~96.30]	[139.60~145.25]
H	[0.32~0.51]	[0.00~0.23]	[6.65~77.17]	Glass and concrete	Commercial, and industrial	[0.00~68.07]	[41.93~99.59]

Research Problem and objective

- Although the proposed method is demonstrated to perform well in the specific context for which it was developed, **it is not clear to what extent the data-driven models can be generalized**

- Therefore, **this research aims to assess the generalizability of data-driven models** considering to distinctly different urban contexts (Montreal, Apeldoorn)



Research Scope

Montreal, Canada

Metropolitan area: 499 km2

Population: 4,221,000

Climate: Humid continental climate

Density: 3,889 inhabitants/km2

Can explain?

Apeldoorn, the Netherlands

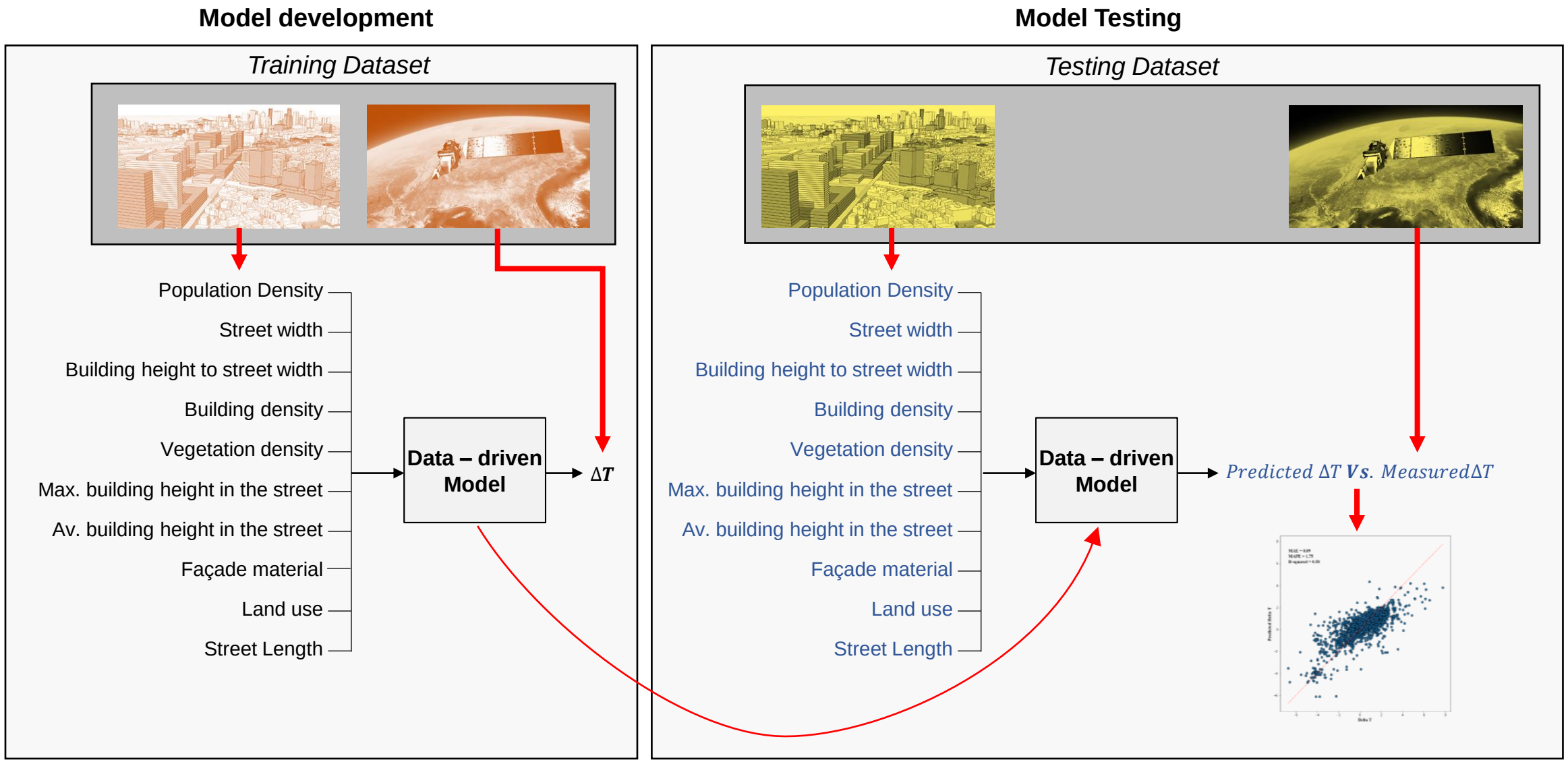
Metropolitan area: 341 km2

Population: 150,000

Climate: Oceanic climate

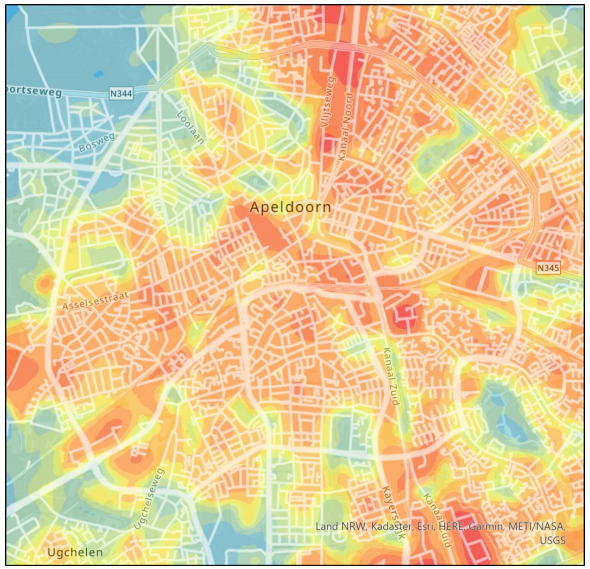
Density: 478 inhabitants/km2

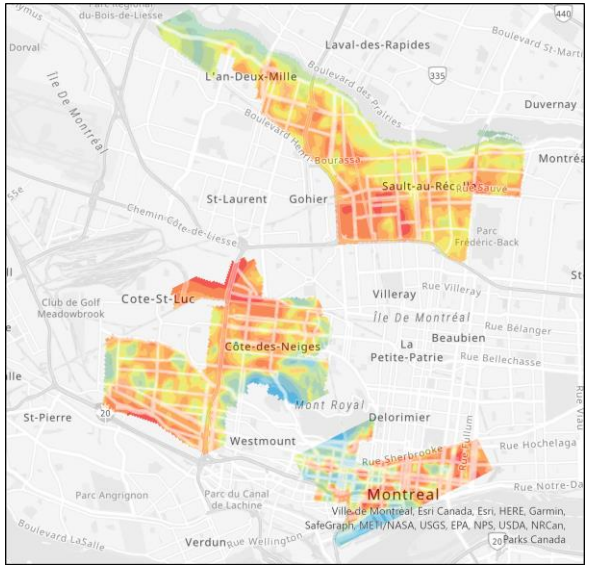
Research Methodology



Data collection

- **Temperature data**: Land surface temperatures (LST)
- **Temperature data source:** Images captured by Landsat 8, C2, Level1, OLI (Operational Land Imager), and TIR (Thermal Infrared Sensor)
- **Period:** Summer months, Jun – Aug, of 2019 – 2021
- **Urban data source:** Publicly available Cadastral GIS data





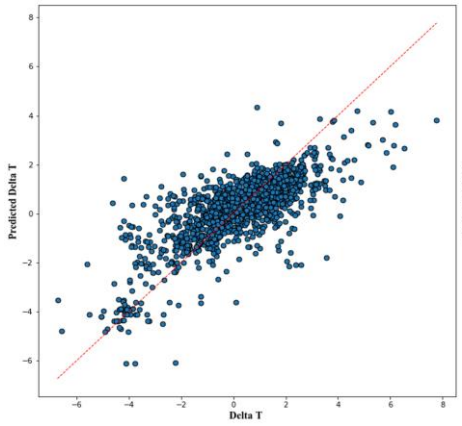
Analysis

- Data-driven UHI models of these two cities can be developed and assessed in five different scenarios

Dataset	Scenarios				
	1	2	3	4	5
Training	Apeldoorn	Apeldoorn	Montreal	Montreal	Combined
					
Testing	Apeldoorn	Montreal	Montreal	Apeldoorn	Combined
					

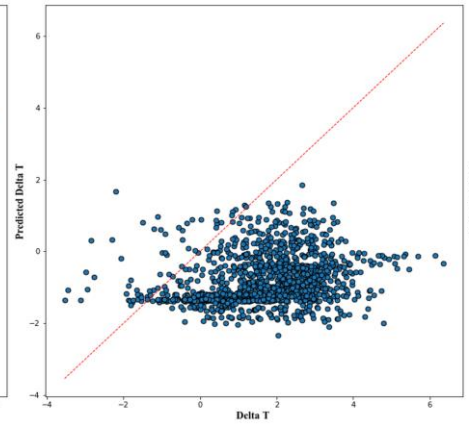
Results

Scenario 1



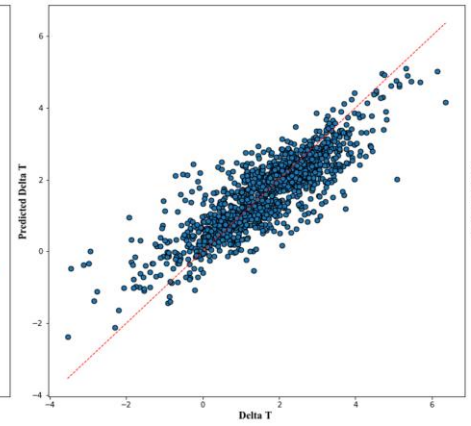
MAE (°C): 0,89

Scenario 2



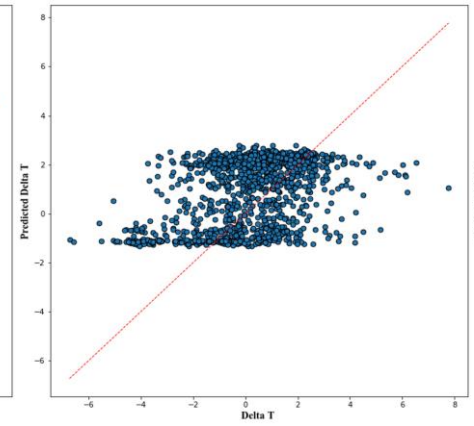
MAE (°C): 2,49

Scenario 3



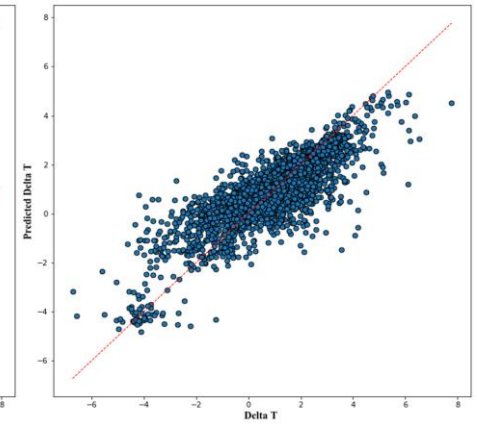
MAE (°C): 0,51

Scenario 4



MAE (°C): 1,54

Scenario 5

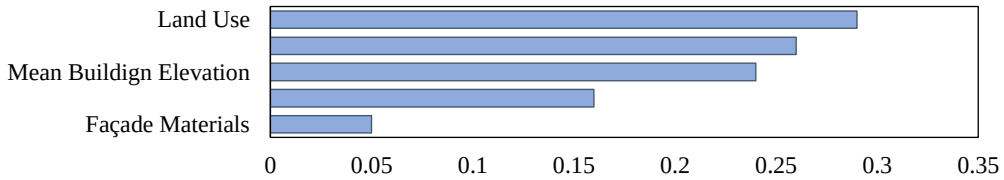


MAE (°C): 0,76

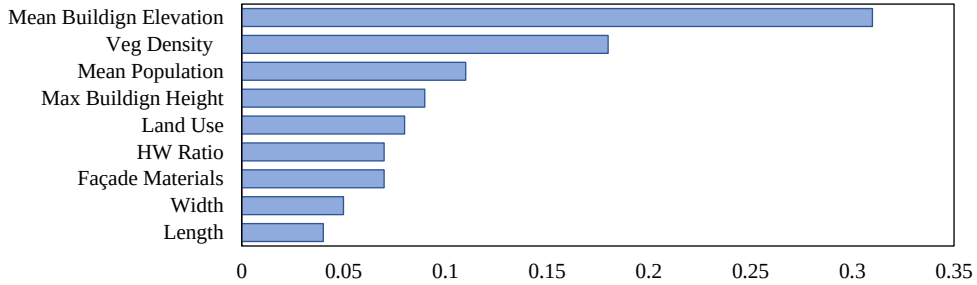
Feature importance

- For all models, the street width, average building elevation and land use are important
- Models three and five share the same number of features, but their importance varies

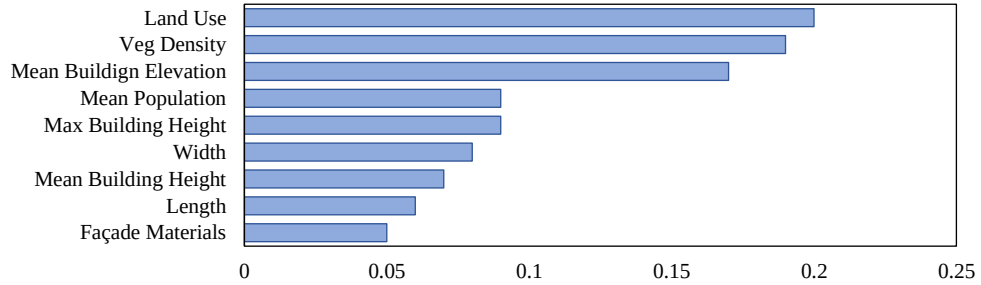
Scenario 1 and 2



Scenario 3 and 4



Scenario 5



Highlights from the study

- In the Netherlands, particularly in Apeldoorn, where the presence of greenery is homogeneous, features such as the height of buildings play a more important role

- In the case of Montreal, where the city is more dynamic and densely built, the presence of vegetation plays a more important role

- However, when data sets are combined, the features that important for Montreal are more predominant

Highlights from the study

- From the results, the models perform well in specific contexts but in general have low generalizability

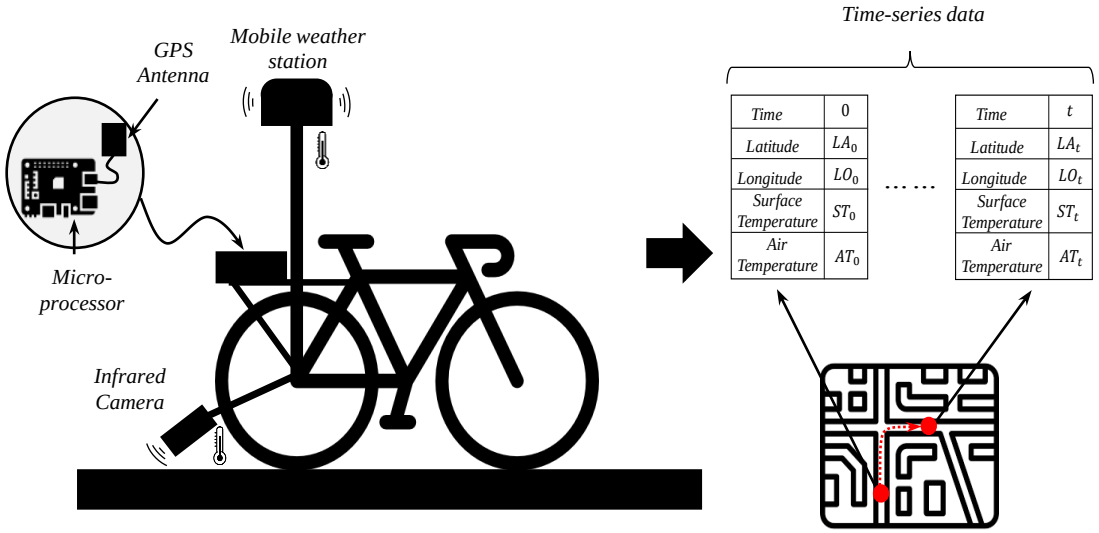
- A very recurrent problem during this research has been the inconsistency of what is understood by UHI in different urban contexts

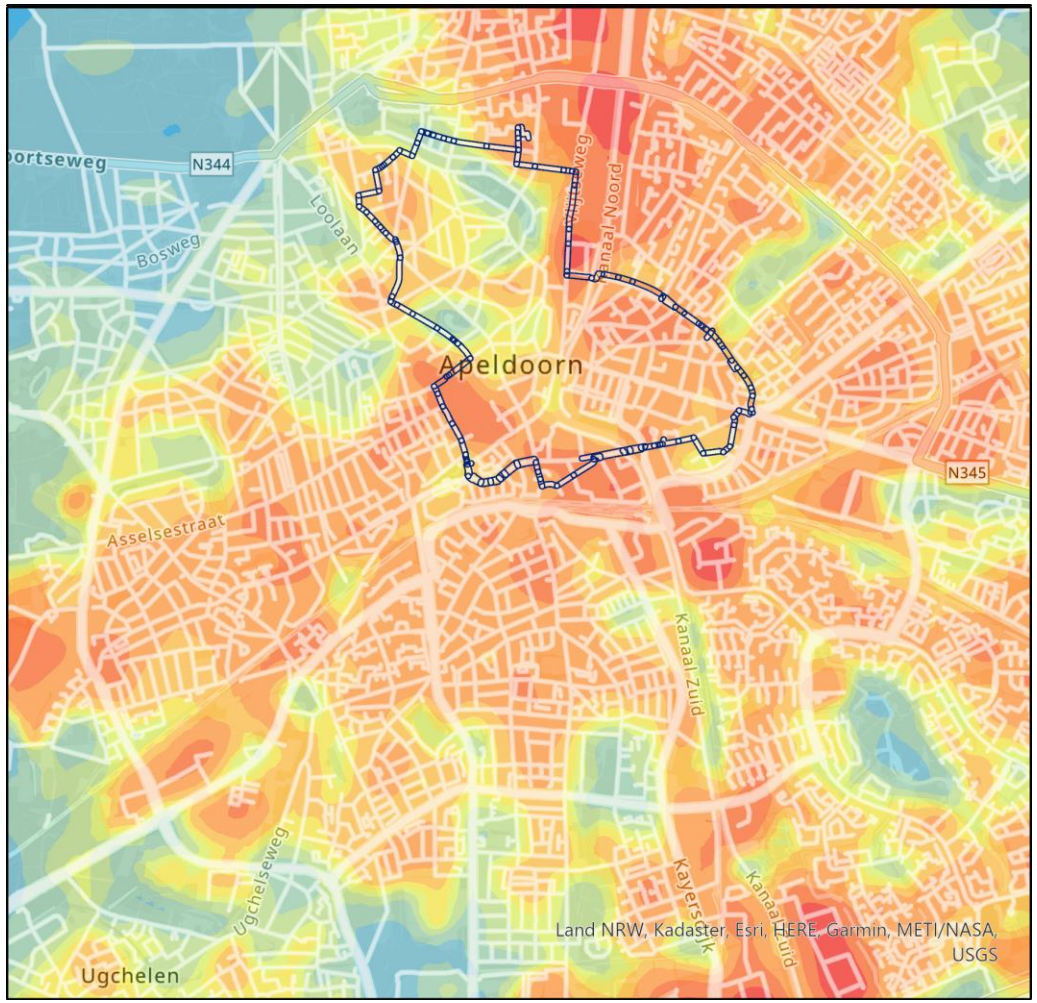
Future work on generalizability

- To deepen the study of generalizability, is important to take a closer look at cities in the same country/regions

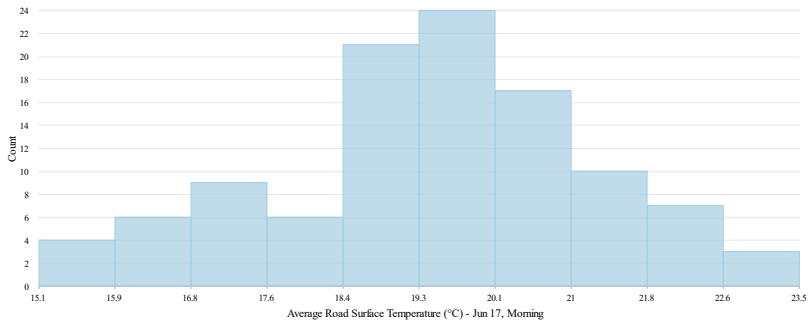
- To what extent could the model developed for one city represent cities within a similar context?

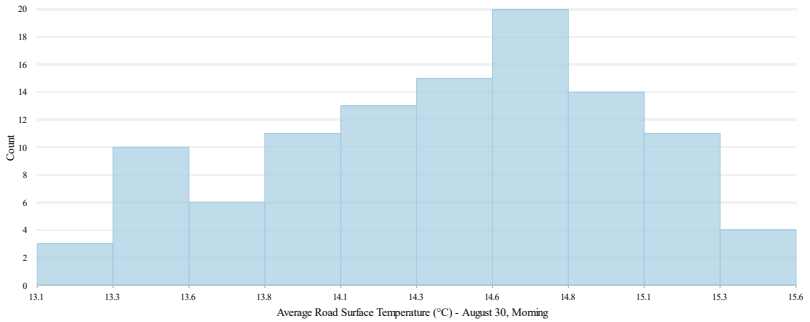
Current work

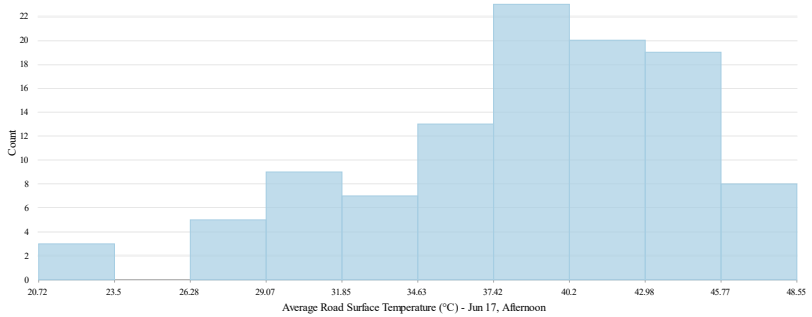


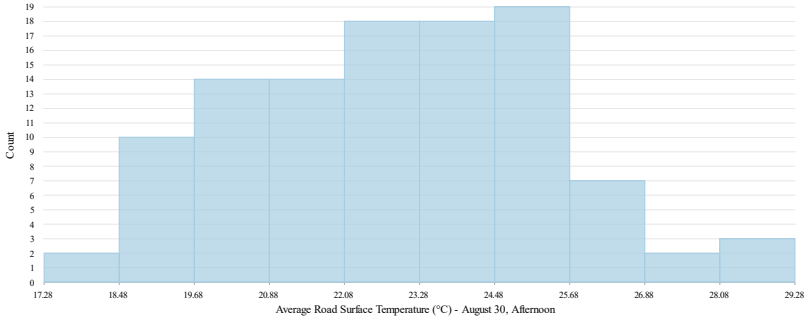


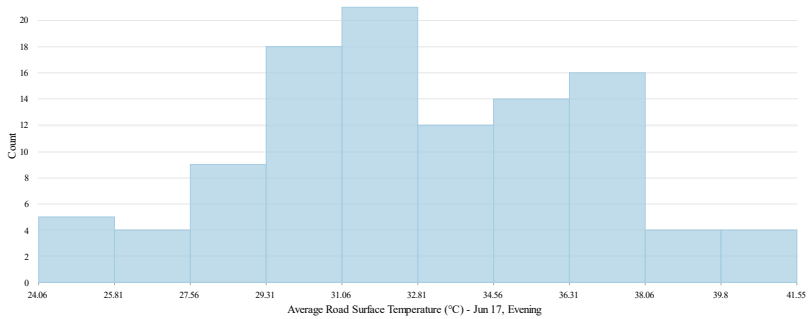
Current work

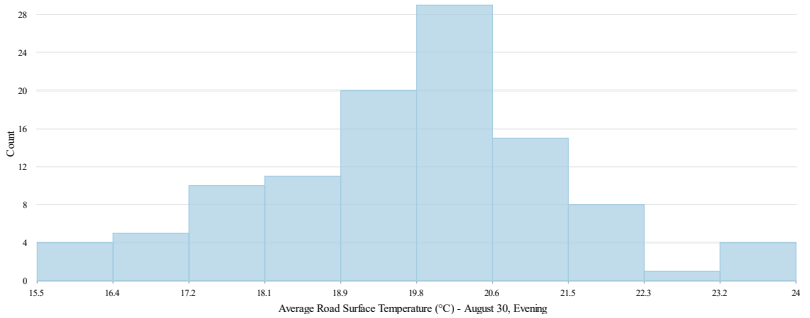












ASPARi
Paving the way forward

UNIVERSITY OF TWENTE.

Discussion and conclusions

- The current trend in the built environment is gravitating towards the use of digital twins and data-driven methods
- Governments have a different strategies for storing and representing urban data, making difficult to develop an universal framework to assess UHI
- An ontological approach is needed to get the most out these sources from both global and local scale
- In the context of global warming, we need a global approach towards data management!

Q&A

Thank You!

Any questions?

Towards an Autonomous Asphalt Construction an overview of the research

from concept to the future implementation

ASPARi symposium 2021

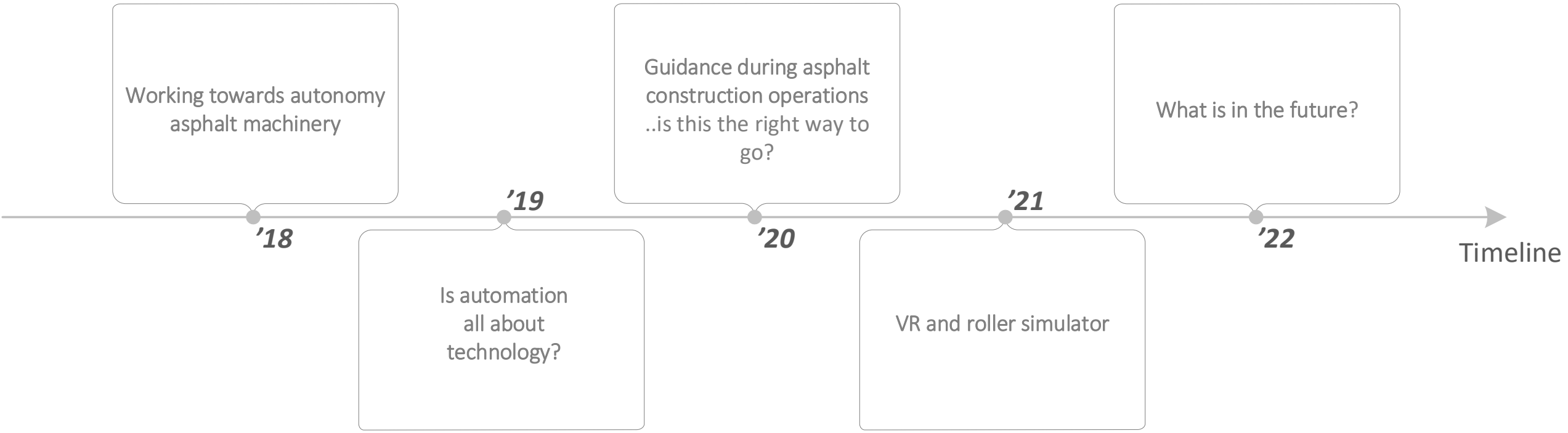
Denis Makarov

ASPARi

Paving the way forward

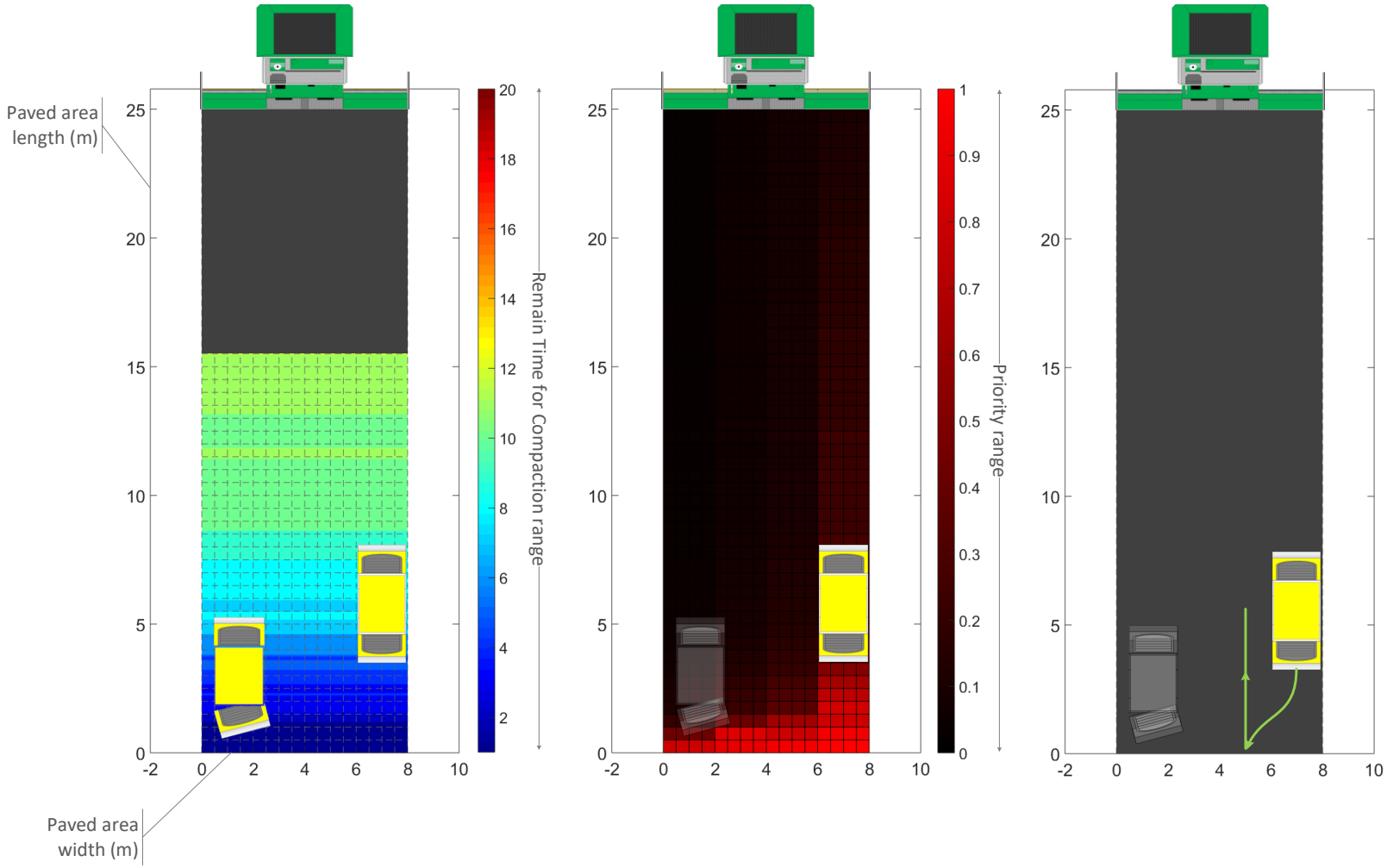
UNIVERSITY OF TWENTE.

Agenda



ASPARi
Paving the way forward
UNIVERSITY OF TWENTE.

Working towards autonomy asphalt machinery



2018

Timeline

Is automation all about technology?

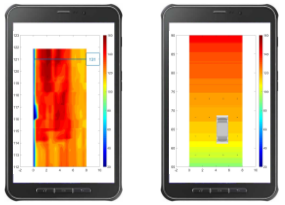
Level 0

No automation

Transition

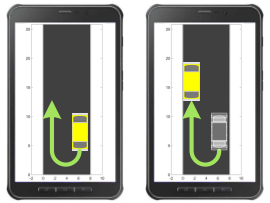
Level 1

Operator assistance with raw process related information (no guidance, engaged control)



Level 2

Operator guidance during paving and compaction operations



Level 3

Semi-autonomous construction operations, disengaged control of machine operators

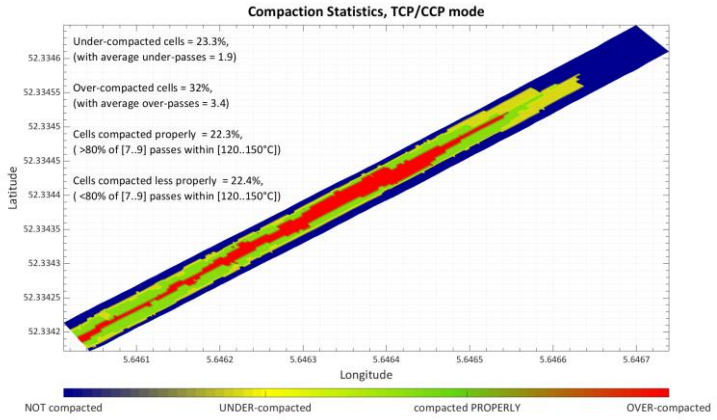
Level 4

Autonomous construction operations, disengaged monitoring of machine operators

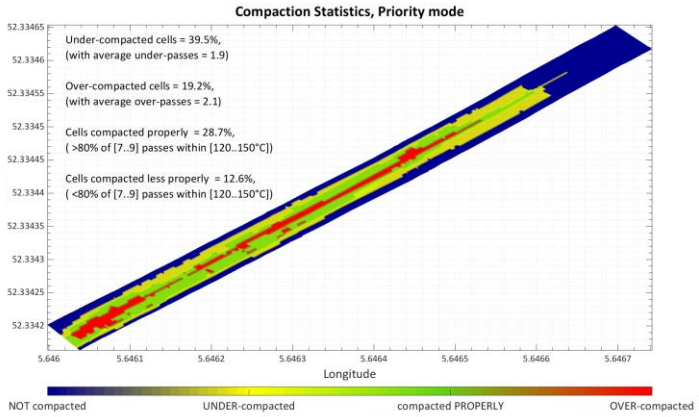
2019

Timeline

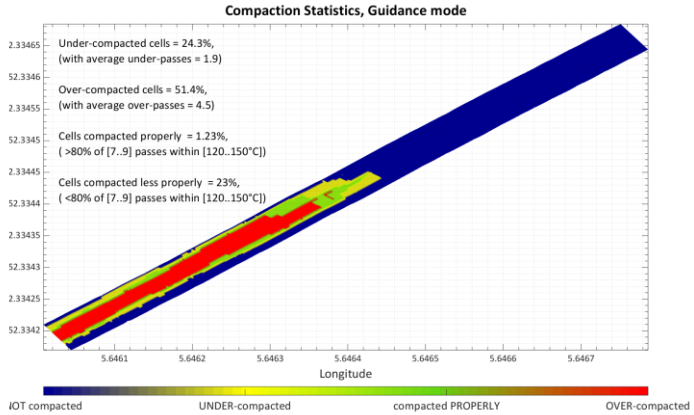
Guidance during asphalt construction operations



Temperature and Compaction Contour Plots



Priority maps

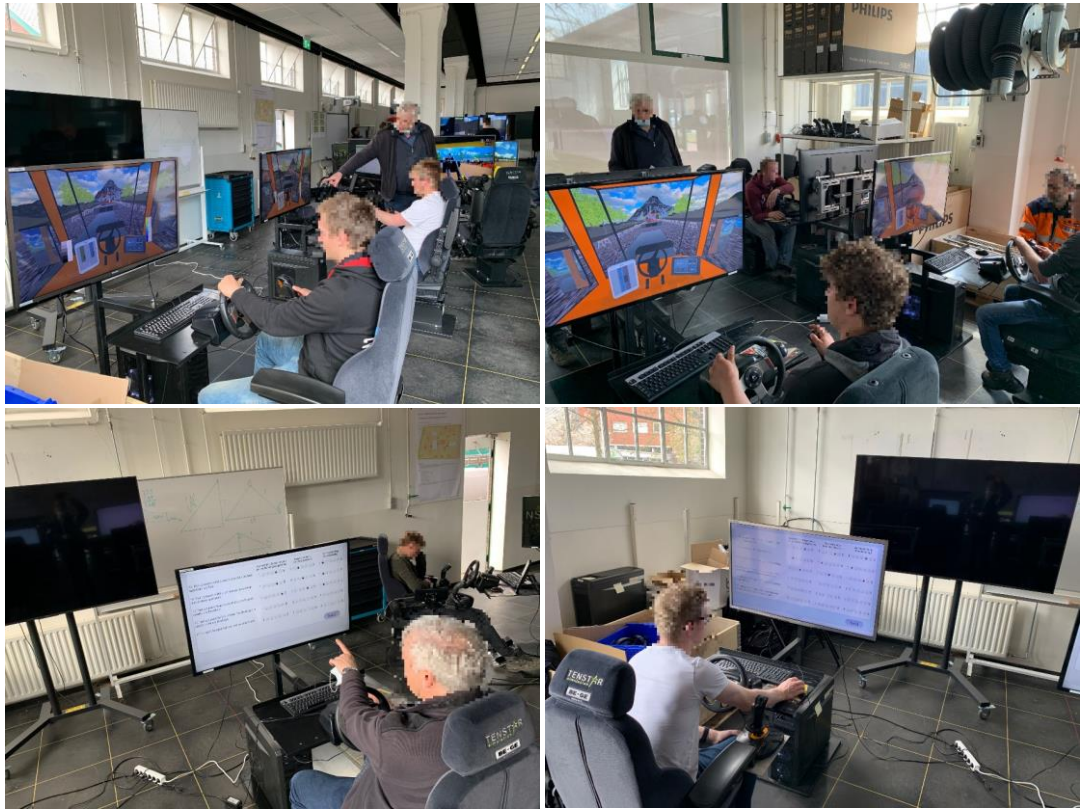


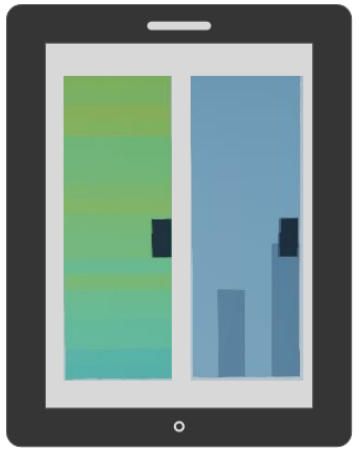
Guidance

2020

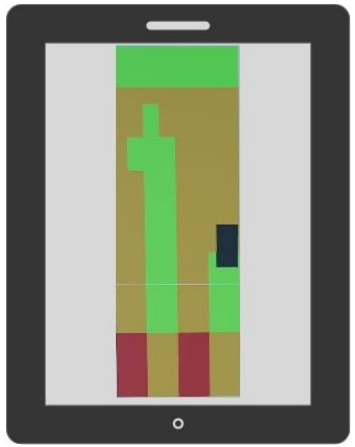
Timeline

Roller simulator

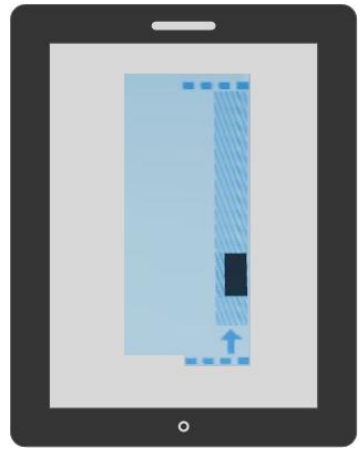




Temperature
&
Compaction
Contour Plots



Priority maps



Guidance

2021

Timeline

..what is next?

- As we are aiming to build more TRUST in tech-s and OSS, we need to have more sessions with operators and practitioners

Thank you for your attention!