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INITIATIVE URBANE LOGISTIK HANNOVER
USEfUL
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Towards Extending USEfUL-ness for Urban Logistics with Service-orientation

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Bio

Richard Pump, M.Sc.

- B.Sc. & M.Sc. in computer science
  - Software design & security

- Working in Urban Logistics since 2018
  - IT-process- & quality-management
  - Support in simulation development and cloud-based execution
  - Visualization of research results & web-development

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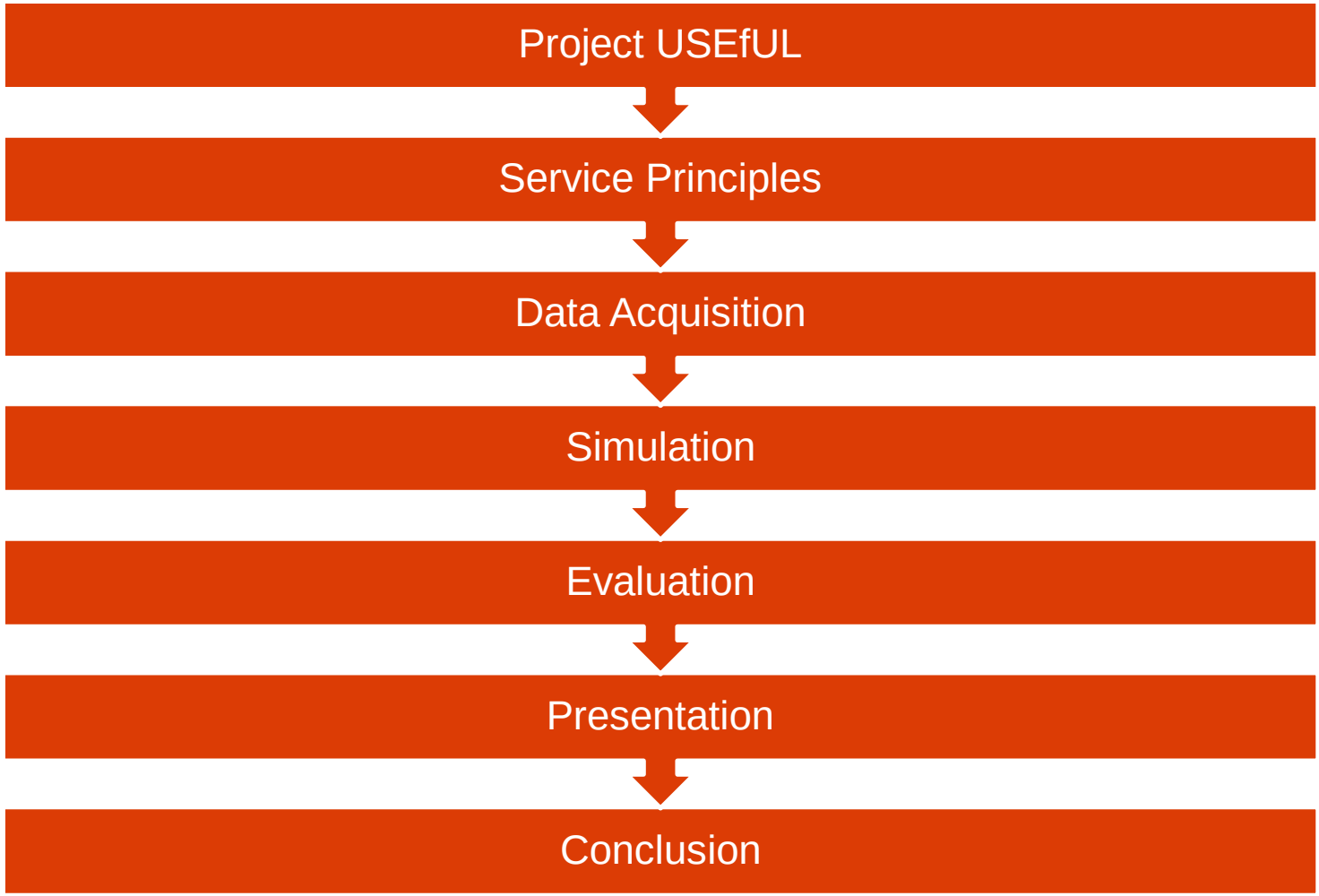
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Project USEfUL

Creating decision support tools for urban logistics

Project Goal: Help decision makers understand the impacts of novel logistic concepts

- Build a model of the current traffic situation
- Simulate different logistic concepts
- Evaluate key performance indicators of urban traffic
- Present research results to a broad user spectrum

To achieve the goal of USEfUL many different domain experts need to collaborate in the same workflow.

- Every domain team has a specific task
- Data exchange between teams requires standardized data formats

→ Similar to a service oriented architecture!

Principles of Service-Orientation

Rules for Workflow-Design

While the structure of the project would be well suited to a complete service-oriented implementation, budgetary constraints prohibit complete automation.

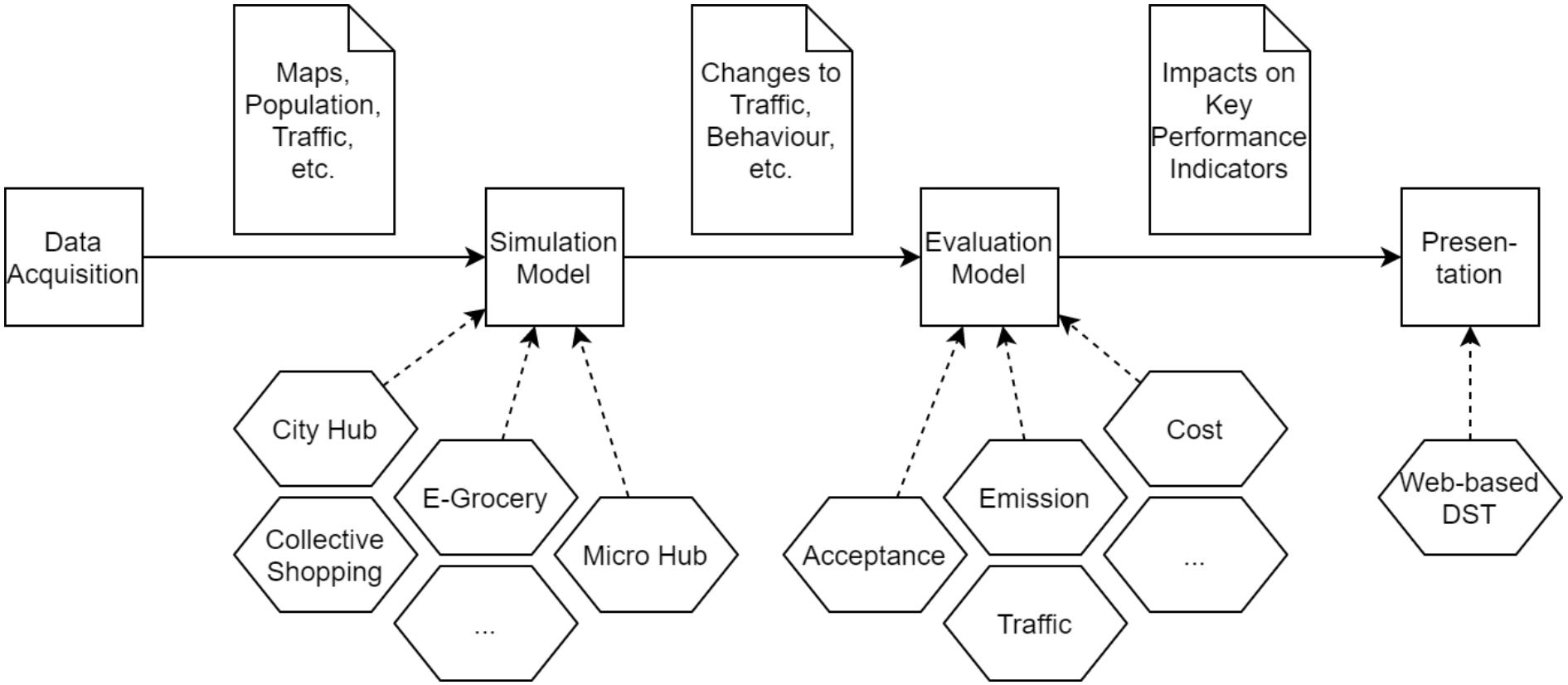
How can the principles of service oriented software development be applied to partially automated workflows?

Main principles of service orientation include:

- Isolation of responsibilities
- Loose coupling
- Encapsulation
- Modularity
- Statelessness

Workflow

Project USEfUL



Workflow of the project USEfUL

Data Acquisition

Modeling the current state of traffic

Multiple points of data needed to properly model traffic.

Category	Key Data
Traffic	1. Road maps 2. Velocity limits 3. Number of vehicles 4. Level of service 5. Modal split
Area usage	1. Category: Public/living/industrial/retail
Public transportation	1. Network
Districts	1. Borders 2. Number of buildings/inhabitants 3. Demographics

Data was provided by the city of Hannover or collected from other available studies and collected in a central database, providing data to all steps of the workflow.

A central service providing data concentrates all responsibilities of data management on a single domain expert team.

Simulation

Agent-based simulation of novel logistic concepts

Overall, six concepts were simulated using Agent-based simulation within the java-based tool AnyLogic.

Scenario	Description
Micro-Hub	The population is supplied by micro-hubs in the inner city area. A supply chain is created across different logistics levels.
White Label	The population is supplied by bundling orders from several CEP service providers in a common distribution center on the outskirts of the city.
City Hub	A stationary, inner-city transshipment point will be built, which will be used by several CEP service providers for last-mile distribution.
Parcel Pickup Locations	CEP service providers only deliver via unattended services, in which orders are delivered to customers exclusively at drop-off locations.
Online Grocery Shopping	Customers order consumer goods such as food and drugstore items from a local supplier with a specific delivery window to their desired location.
Neighborhood Logistics	Neighborhoods organize their mobility-triggering activities by linking and optimizing their routes through division of labor. Preferably, one neighbor does several activities for another neighbor (e.g. shopping activities).

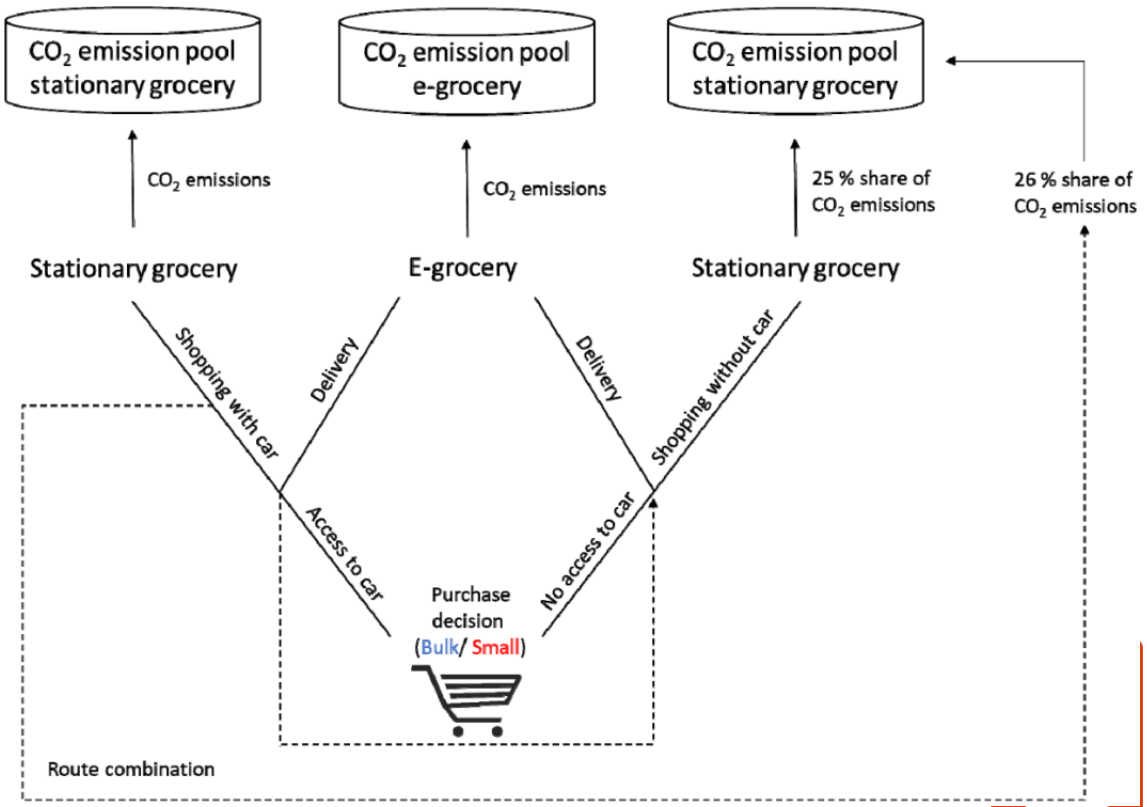
Simulation

Example: E-Grocery

The simulation model E-Grocery compares the concept of online grocery shopping with traditional in-store-shopping.

Shopping behavior was determined through public questionnaires and modeled as agent behavior in AnyLogic.

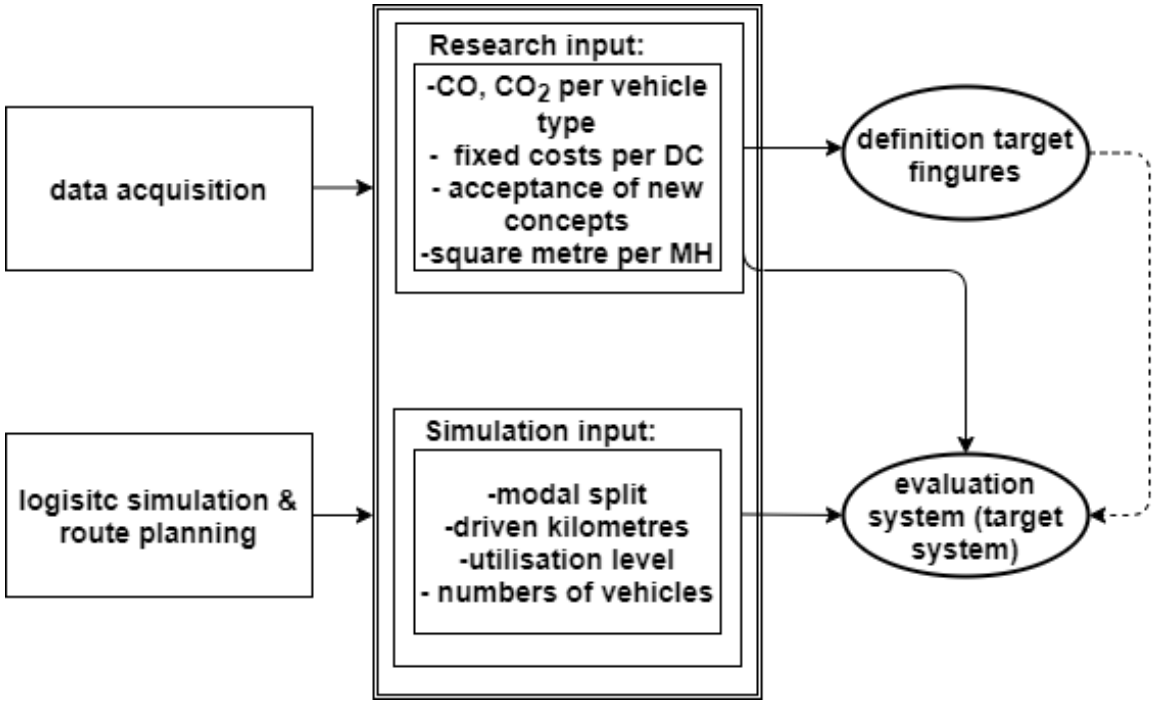
The model calculates multiple outputs like agent routes differentiated by modal split, order fulfillment rates, etc. which can be converted into different KPIs.



Evaluation

Generating concise results

For the results, simulation output as well as other research inputs were considered.



Each evaluation model was created independently, using different inputs, allowing modular composition of key performance indicators.

Evaluation

Generating concise results

Four major key performance indicators as well as derived indicators were considered:

Core KPI	Derivation 1st degree	Derivation 2nd degree
Emissions (CO^2 equiv.)	Ecological break-even-point (CO^2 equiv./day)	Implementation potential ({CO^2/€;€;m^2;avg. speed})
Costs (€ per day)	Economic efficiency (profit per day)	Acceptance ({CO^2/€;€;m^2;avg. speed)
Area savings (m^2)		
Traffic (avg. speed km/h)		

Each indicator was evaluated via a specialized model using standardized inputs and generates an output scaled to three distinct values: improvement, neutral and deterioration.

Web-based Decision Support Tool (DST)

Presenting research to the open public

The final goal of the project was the creation of a public decision support tool, which allows users the exploration of research results.

Main Requirements:

- Present Information about…
  - the project USEfUL.
  - research areas (districts).
  - novel logistic concepts.
- Allow users to view and export the evaluations of the concepts.
- Allow the modulation of concepts through the selection of different parameters.
- Compare the evaluation results of multiple concepts within a research area/across research areas.

Web-based Decision Support Tool (DST)

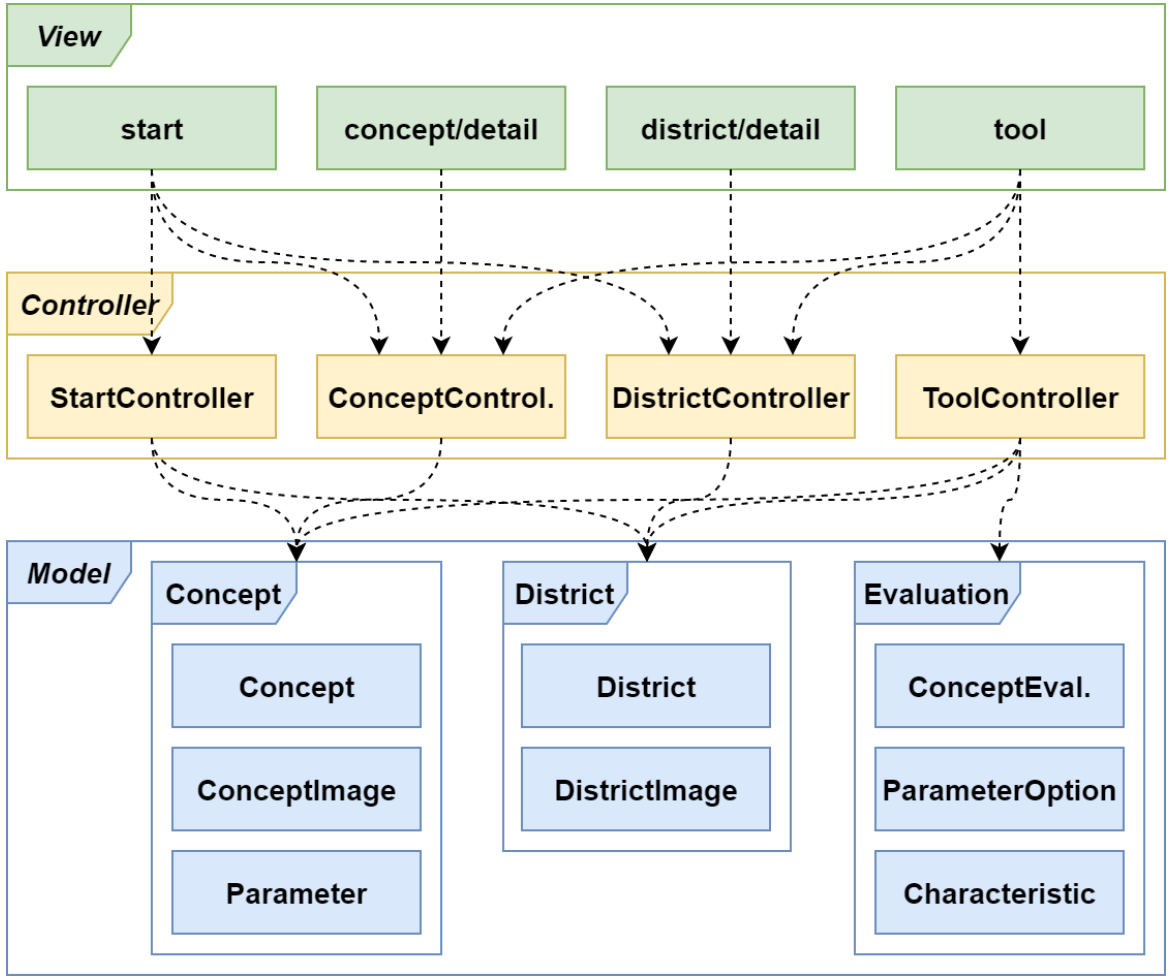
Technical design

Main architectural pattern: MVC

Built using php, Laravel, javascript, Node.js and MySql.

Hosted on containerized webserver.

Currently in internal Beta state.



Conclusion

Future Work

- The Process was well suited to the implementation of service principles.
- Using clearly defined boundaries for different steps of the process, pipelining could be used to evaluate different logistic scenarios in parallel instead of serializing the complete evaluation of the concepts.
- Furthermore the encapsulation of responsibilities along organizational boundaries increased productivity of domain expert teams.
- However not all principles could be applied, e.g. statelessness was not possible within some steps.

Future work includes the complete automation of the workflow, combining the different domain software-solutions within a service oriented architecture.

Thank you for your attention!

If questions arise contact richard.pump@hs-hannover.de