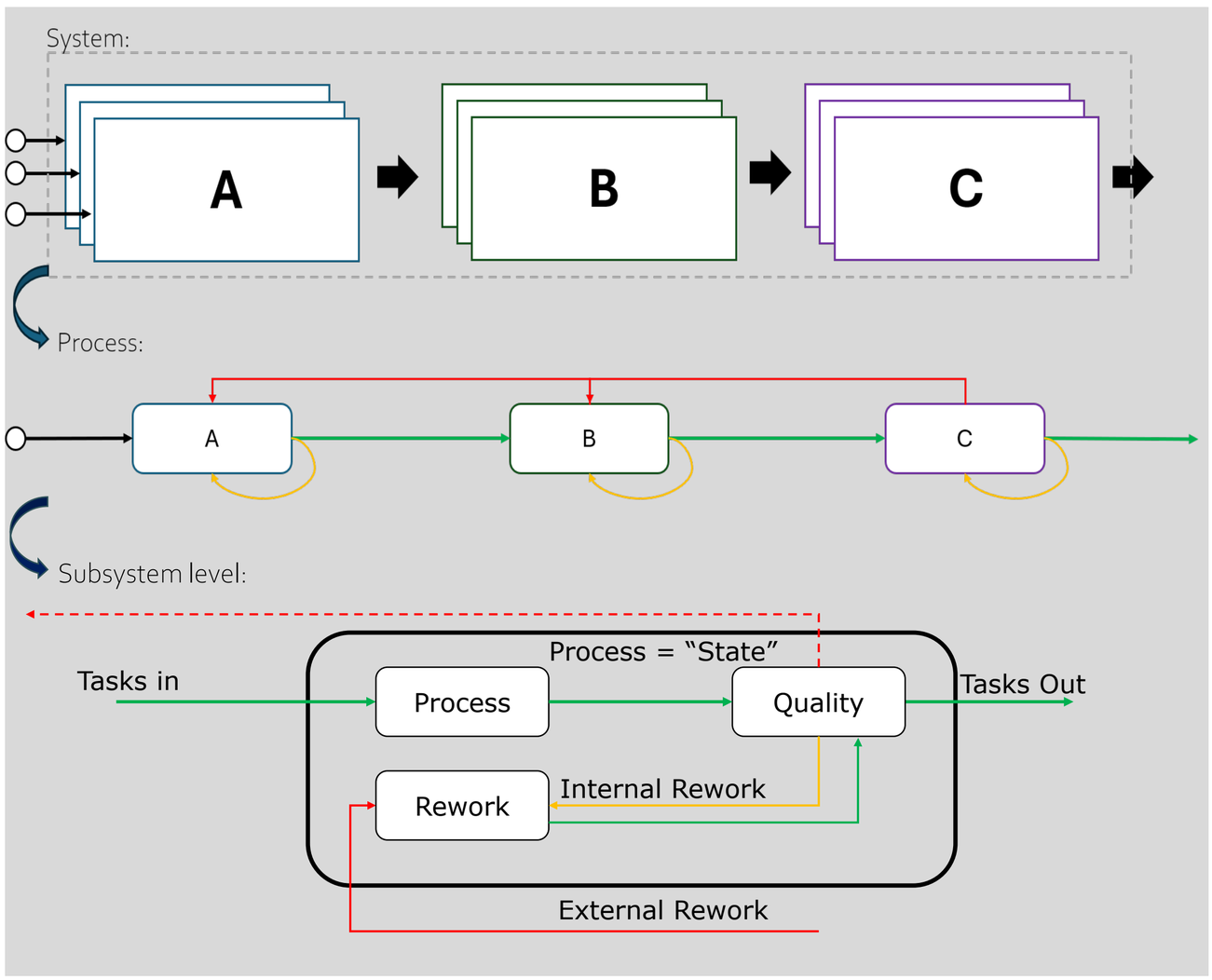
HSLU Hochschule Luzern

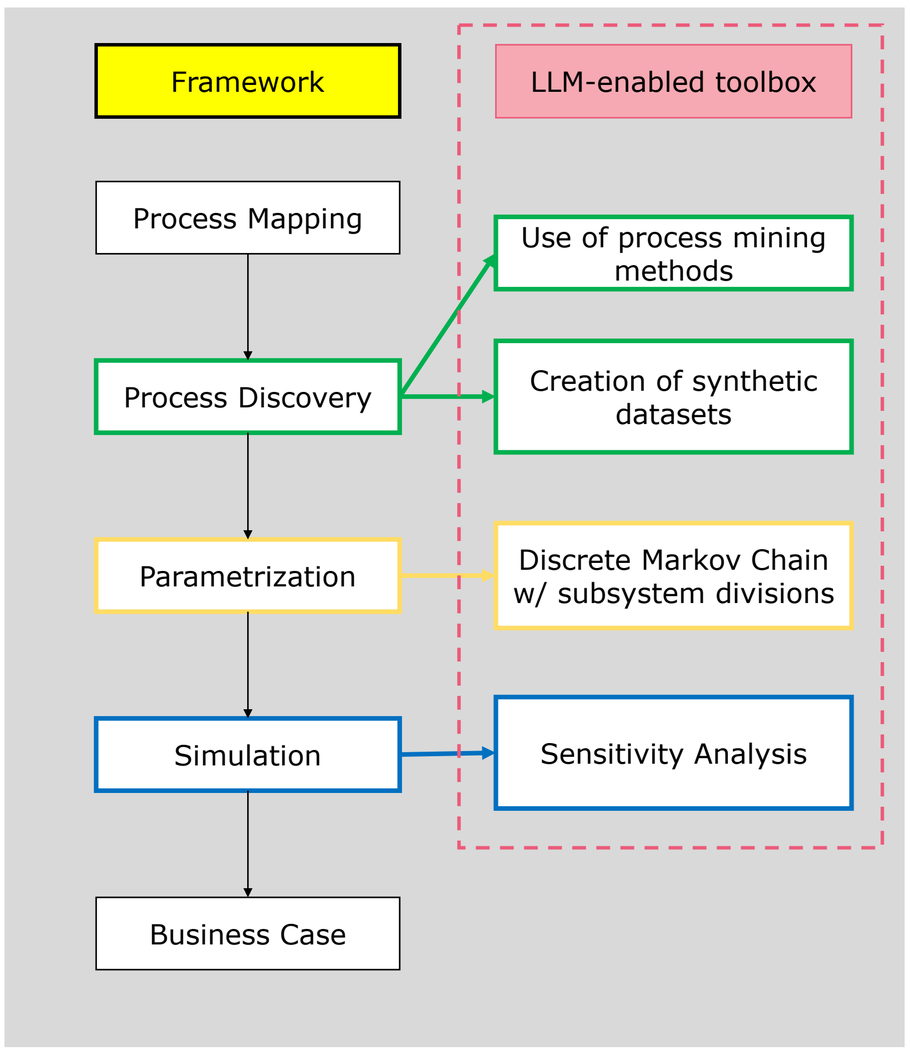
Engineering & Architecture

Master-Thesis – Business Engineering

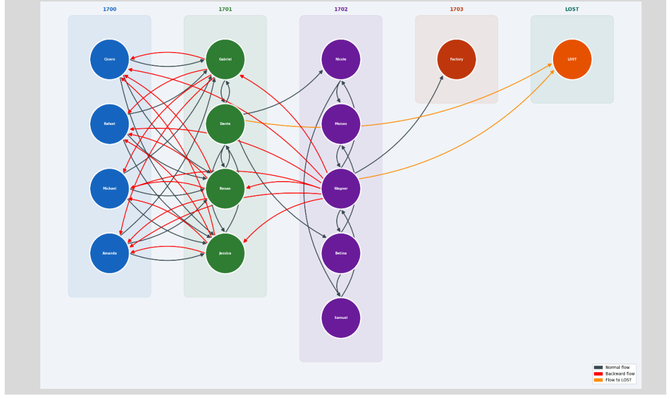
Cost-Benefit Analysis of Process Optimization through Probabilistic Models with Applications



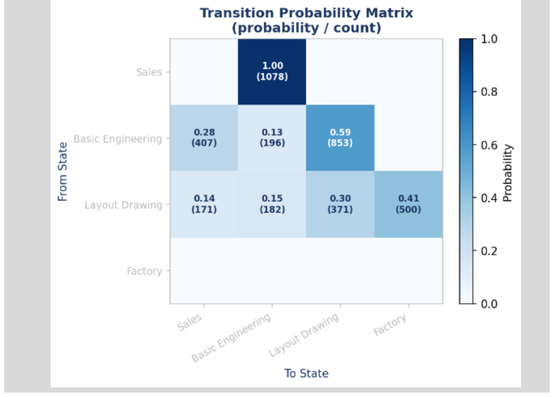
Division of process chains in subsystem levels



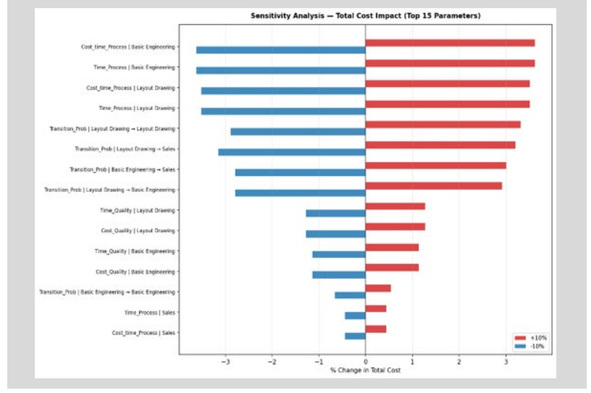
Framework with developed LLM-Toolbox



Mapped task flow with LLM-Toolbox



Transition Matrix created with LLM-Toolbox



Sensitivity Analysis created with LLM-Toolbox

Problem Statement

Deterministic approaches to process modelling fail to capture rework, feedback loops, and variability inherent in human-executed processes. The hidden parameters driving these dynamics hold key insights into digitalization opportunities within the process chain.

To address this, a Discrete Markov Chain combined with Monte Carlo Simulations was developed in prior work, modelling each process state through three subsystems: Process, Quality, and Rework.

No established methodology bridges this model with real data flows inside an enterprise, and closing this gap is the central contribution of this thesis.

Industry input from ServiceNow consultants further grounded the framework in current process modelling practice.

Solution Concept

The framework comprises five stages (Process Mapping, Process Discovery, Parametrisation, Simulation, and Business Case), supported by an LLM toolbox enabling users without coding expertise to conduct complex analysis.

Results

The Framework was fully applied to an elevator commissioning case study using the designed LLM-Toolbox. The application of a Discrete Markov Chain to model the process provided two key outputs: the impact of feedback loops in the process chain and potential deviations in ROI. The sensitivity analysis showed that, besides costs and time spent in each activity, rework cycles in the chain played a pivotal role in increasing process cost, which was targeted by an RAG-based AI solution.

All scenarios presented a positive ROI, with mean savings after 3 years of R$141K and a variability of ±R$28K.

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