HSLU Lucerne University of Applied Sciences and Arts

Engineering and Architecture
BSc. Energy and Environmental Systems Engineering
Bachelor-Thesis

Human-centric behaviour-based modelling for operational planning in a Distribution System Operator (DSO) as the basis of a decision support tool

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1. Background, Challenge & Objectives

Context

- Digitalisation of electricity grid operations & increasing integration of Distributed Energy Resources (DERs)
- ERA-Net funded AISOP project:
  AI-assisted Decision **S**upport for **O**perational **P**lanning
- Consideration of human factors are vital to success of digital transformations

Aim

Initiate the behavioural groundwork research into a human-centric behaviour-based model for a DSO decision support tool that control room operators will use to achieve operational planning tasks.

Research questions

1. What areas of current operational planning procedures would most benefit from a decision support system/tool?
2. How could/would a decision support system/tool be integrated into operational planning workflows in the most effective way?

Expected outcomes

1. Enhanced understanding of control room interface challenges
2. Initial recommendations for suitable use cases for application of an AI Assistant for Operational Planning
3. Initial recommendations for how to integrate an AI Assistant into a control room

2. Methodology

Methodology

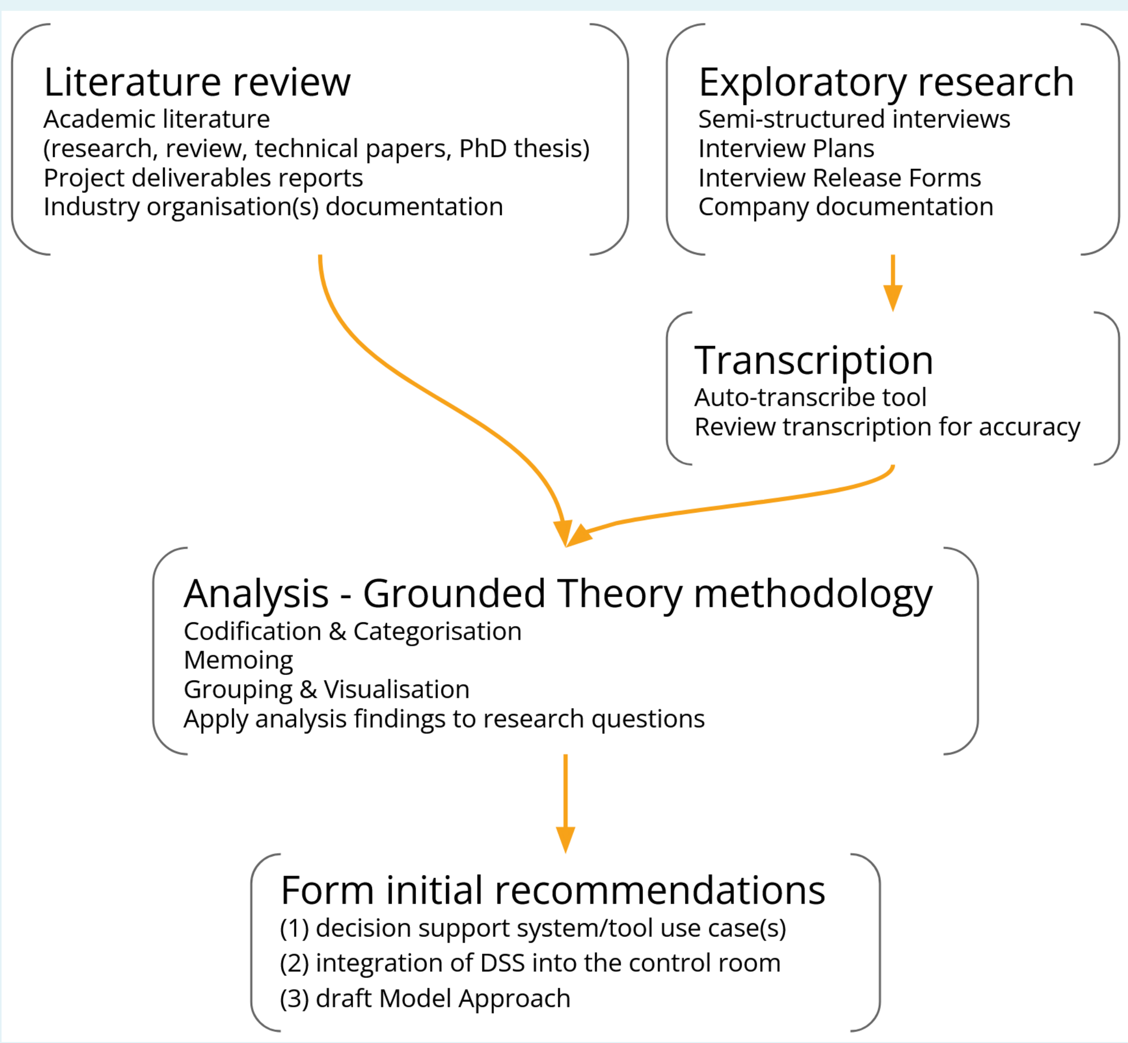

Figure 1: Application of the research methodology

Literature

- Marot, A., Kelly, A., Naglic, M., Barbesant, V., Cremer, J., Stefanov, A., & Viebahn, J. (2022). Perspectives on Future Power System Control Centers for Energy Transition. Journal of Modern Power Systems and Clean Energy, 10(2), 328–344. https://doi.org/10.35833/MPCE.2021.000673
- Swaminathan, B. P. (2017). Operational Planning of Active Distribution Networks—Convex Relaxation under Uncertainty [PhD Thesis, Université Grenoble Alpes]. https://theses.hal.science/tel-01690509
- Jones, L. E. (2012). Strategies and Decision Support Systems for Integrating Variable Energy Resources in Control Centers for Reliable Grid Operations (No. 0001375). Areva Federal Services LLC, Charlotte, NC (United States). https://doi.org/10.2172/1032531

3. Results & Recommendations

Terms

Operational Planning (OP)
Process of planning maintenance and switching events and managing network constraints such as voltage violations and line congestion using forecasts of future grid situation up to +1 year in advance

Decision Support System (DSS)
Interactive software-based system designed to assist in decision-making using advanced data analysis and prediction algorithms to create actionable intelligence

Recommendations

Use case	Why	Value
Optimal outage request scheduling at long, medium, short-term* timescales	Current planning procedures are manual → slow → prone to error → require multiple layers of validation But fully knowable → possible to automate & add intelligence	Reduce manual, time-consuming nature of current planning procedures Ability to consider network stability at planning phase (increasingly important at low voltage grid level with increasing DERs) Ability to allow for more efficient usage of grid infrastructure by not needing to follow the N-1 criterion in all scenarios Better dimensioning of grid during network planning due to higher awareness of grid usage gained through knowledge of optimal outages planned over time
Integrated into current tooling suites where decision is actioned		

* priority

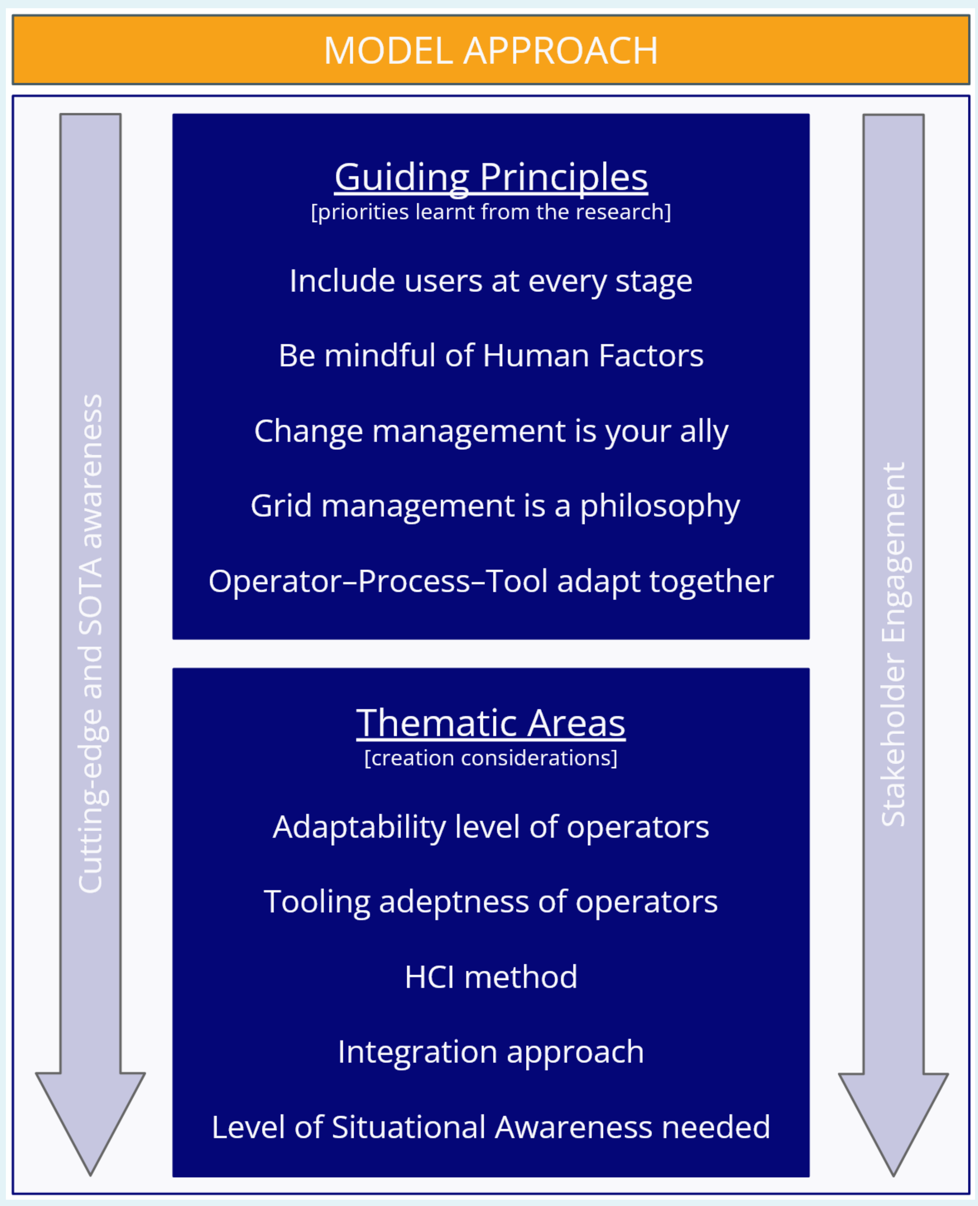

Figure 2: Draft Model Approach

4. Discussion & Outlook

Next steps

1. Continue DSO interviews to extend breadth of knowledge of OP procedures & tooling → validate / invalidate initial recommendations
2. Expand literature & exploratory research into the Human-Computer Interaction (HCI) & interface design aspects to inform AISOP tool & Model Approach
3. Market research into control room tooling already integrated with AI DSS to gain insight into the applied use cases & HCI approaches to inform Model Approach

Further research

1. Ethics of using AI in critical infrastructure management + Trust in AI in critical infrastructure
2. Effects of increased stress of operator (due to emergency situations) on usability & effectiveness of tooling

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