

Modelling the outage duration of power transformers

Challenge and objective

- Transformer failures can cause long power outages with high costs to society.
- Transformer failures are rare and there is limited available generalizable data on transformer outage durations.
- The objective of the work is to construct a transformer outage duration model which can be conditioned on relevant asset management input variables to support risk assessments and asset management decisions for these critical assets.

What have we learned?

- Information about transformers failures (time of failure, component technical condition, availability of spares, and accessibility to the fault site) influences the associated outage duration due to a permanent failure.
- It is possible to construct a logical model based on available data and expert judgements to alleviate challenges related to lack of data on transformer outages.
- The developed model was applied in an asset management decision context, which showed that the choice of spare strategy could have a significant impact on the expected- and tail-end risk of the system.
- Structured expert elicitations can help predict duration of outages in situations which has previously not been observed before.
- The Bayesian Network structure and elicitation process helps incorporate uncertainty in the analysis and communicate this to the decision maker.

Implications and recommendations

- The model has application in risk assessments and as decision support and can be incorporated in both new and existing resilience and reliability analysis tools (e.g. Statnett's MONSTER tool).
- There are potential applications of the model within system development which could be explored further.
- The model construction approach is generalizable and can be applied to other power system components. It is recommended that similar models are developed where necessary.
- A functioning Python-code of the model is available as open-source code and can be used by potential users.

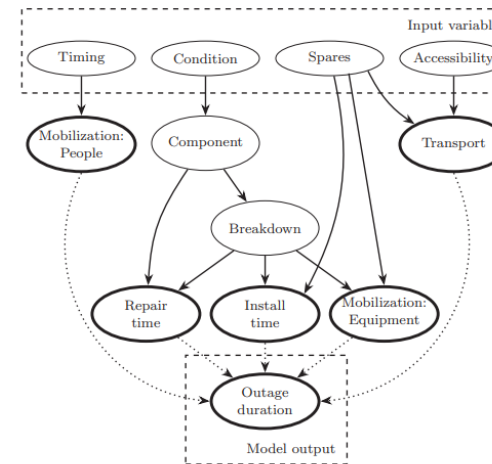


Fig. 1. Final model structure. Continuous variables illustrated by ellipses with a bold outline.

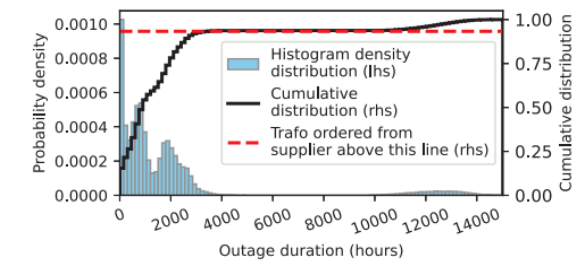


Fig. 4. Illustrative example of outage duration model output. 10 000 samples.

[1] Kiel, E. S., Catrinu-Renstrøm, M. D., & Kjølle, G. H. (2023). A transformer outage duration model with application to asset management decision support. In *The 33rd European Safety and Reliability Conference (ESREL)*, doi: [10.3850/978-981-18-8071-1_P078-cd](https://doi.org/10.3850/978-981-18-8071-1_P078-cd)

[2] Kiel, E. S. Transformer outage duration model (t_odm). Available: https://gitlab.sintef.no/power-system-asset-management/t_odm.