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CONCEPTUAL FRAMEWORK FOR ALGORITHM DEVELOPMENT IN SUSTAINABLE ASSET MANAGEMENT OF DISTRICT HEATING NETWORKS

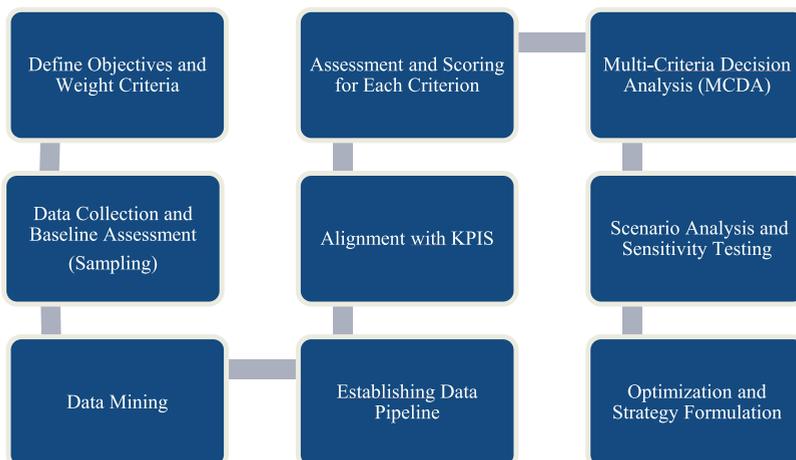
Pakdad LANGROUDI^{1*}, Ingo WEIDLICH²

^{1,2} *HafenCity Universität Hamburg, Henning-Voscherau-Platz 1, Germany*

* **Corresponding author.** Email address: pakdad.langroudi@hcu-hamburg.de

Abstract – The sustainable asset management of district heating networks (DHNs) presents a complex challenge, integrating ecological, economic, and social sustainability dimensions. To address this, we developed a structured methodology for an algorithmic framework that supports sustainability assessments in DHNs. The proposed framework follows nine systematic phases, including defining objectives and weights, data collection and mining, establishing a data pipeline, aligning with key performance indicators (KPIs), conducting multi-criteria decision analysis (MCDA), and performing scenario-based sensitivity analysis. These phases enable the algorithm to assess both operational and strategic aspects of asset management. By incorporating six distinct sustainability scenarios – ranging from stricter environmental regulations and economic constraints to climate resilience and circular economy transitions – the framework evaluates potential outcomes and optimal strategies. Each scenario provides insights into the trade-offs and synergies between different sustainability objectives, guiding decision-makers in balancing efficiency, cost-effectiveness, and environmental impact. The results from scenario analyses inform tailored strategies, such as infrastructure reinvestment plans, predictive maintenance schedules, or adaptive regulatory compliance measures, ensuring resilient and future-proof DHN operations. This research establishes a foundation for data-driven, scenario-based sustainability management in DHNs, offering practical guidance for decision-making based on defined criteria and KPIs. The structured approach enhances flexibility and adaptability in asset management, paving the way for empirical validation and real-world implementation.

Keywords – *Asset Management; conceptual framework; District Heating Networks; KPIs; Multi-Criteria Decision Analysis; scenario analysis; sustainability*



The nine phases of conceptual algorithm development for sustainable asset management in district heating networks

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