This research study deals with a structuring approach to Digital Twins in industrial systems. A Digital Twin is a virtual replica of a physical counterpart that allows the management, simulation, optimization, and automation of the underlying real-world processes. The concept enjoys great popularity in the illustration of industrial processes. The research study provides a morphological taxonomy that displays design options for Digital Twins. The taxonomy describes Digital Twins in the three meta-dimensions: Data Collection, Data Handling and Distribution, and Conceptual Scope, which contain twelve dimensions and 27 characteristics. Hereof, five archetypes are derived that sort Digital Twins along their functional scopes, starting with the Basic Digital Twin and ending with the Exhaustive Digital Twin. Besides intensive literature analysis, 15 interviews and two case studies include aspects from practice in the definitions.

Further theoretical and practical input prescribes a requirements catalog for Digital Twins in industrial systems. This catalog contains 34 requirements concerning, i.a., the architecture, the capabilities, and data governance aspects of a Digital Twin. The reference model originates from the archetypes and the requirements. On the highest level of abstraction, it splits into four submodules: Virtual Representation, System Interface Layer, Internal Data Processing, and Data Handling Unit. These are then further detailed for the final reference model of the Digital Twin. For the reference model's design, this study delivers a new research method incorporating up-to-date data analysis, structuring processes, e.g., for taxonomy development, and a new approach for archetype derivation.

The reference model is accompanied by a process model for Digital Twin implementation, providing ample guidance on realizing a Digital Twin based on the reference model. The process model includes a Digital Twin Implementation Canvas and gives a structured flow of operations aligning two VDI norms on modeling for simulation and implementing cyber-physical systems. The reference model is evaluated by an exemplary implementation using the process model and the implementation canvas. Additionally, the fulfillment of the requirements and the principles of orderly modeling are confirmed.

To summarize, the research study brings numerous descriptive and prescriptive results that are simultaneously usable for scientists and practitioners advancing the canon of knowledge about Digital Twins.

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