



# PROCESS MODEL FOR BIM-BASED MEP DESIGN

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Integrated Building Systems



# Importance of mechanical, electrical and plumbing (MEP) systems in construction projects

- MEP-systems play an important role in complex buildings<sup>1)</sup>
  - They account usually up to 50% of the project value in high technology, healthcare and biotech industries<sup>2)</sup>
- Heating, ventilation and air-conditioning systems (HVAC) consumes typically 40 – 60% of a building's total energy use<sup>3)</sup>
- The complexity of MEP-systems is continuously increasing and the coordination is crucial to project success<sup>1)</sup>

Source 1): Boktor, J.; Hanna, A.; Menassa, C. (2014): State of Practice of Building Information Modeling in the Mechanical Construction Industry. Volume 30. Hg. v. American Society of Civil Engineers (Issue 1).

Source 2): Riley, D. R., Varadan, P., James, J. S. and Thomas, H. R. (2005) 'Benefit-Cost Metrics for Design Coordination of Mechanical, Electrical, and Plumbing Systems in Multistory Buildings', *Journal of Construction Engineering and Management*, vol. 131, no. 8, pp. 877–889

Source 3): Teicholz, E., ed. (2001) *Facility design and management handbook* [Online], New York, NY, McGraw-Hill

# Research need in the field of MEP

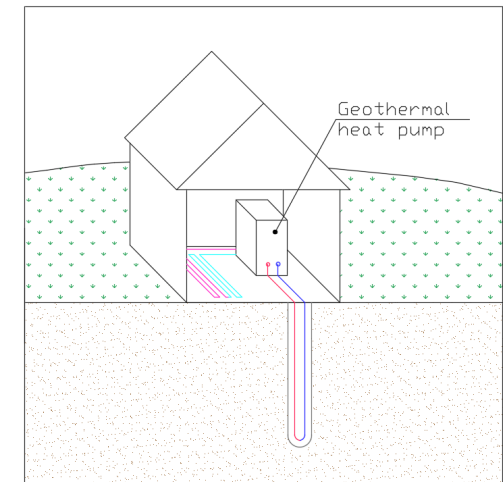
- There is a lack of well-defined process models for BIM collaboration. Moreover, there is a need for practicable descriptions of project requirements and MEP components<sup>1)</sup>
- Especially for MEP-components in BIM, the requirements of data models is not adequate for open file formats such as Industry Foundation Classes (IFC)<sup>2)</sup>
  - Enumeration in IFC → IfcUnitaryEquipment - Consists of singular components e.g., evaporator, compressor, throttle, condenser etc.
    - This description is unusual and not practical in the MEP planning process
- **A systematic approach on how to describe data and process models for MEP systems is missing**

Source 1) Azhar S 2011 Building Information Modeling (BIM) Trends, Benefits, Risks, and Challenges for the AEC Industry *Leadership and Management in Engineering* 11 no 3 pp 241-252

Source 2) Yang, X.; Ergan, S. (2014): Towards a Formal Approach for Determining Functions of HVAC Components Represented in International Conference on Computing in Civil and Building Engineering

# Objective

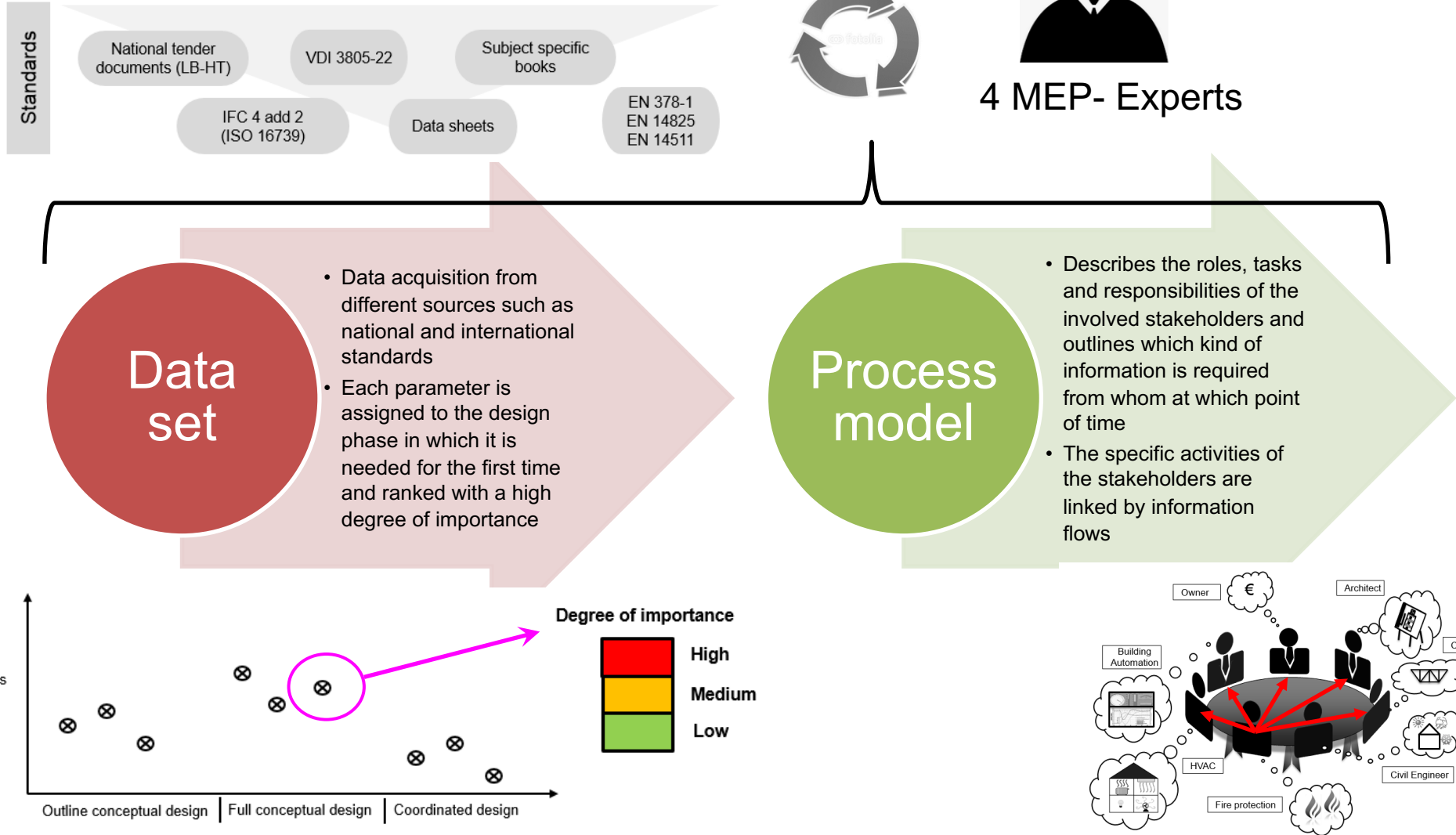
- 1) Data set of design relevant parameters
  - 2) Process model that outlines the BIM-based design in different design stages
- Example - geothermal heat pump with a vertical closed-loop borehole heat exchanger





# Methodology

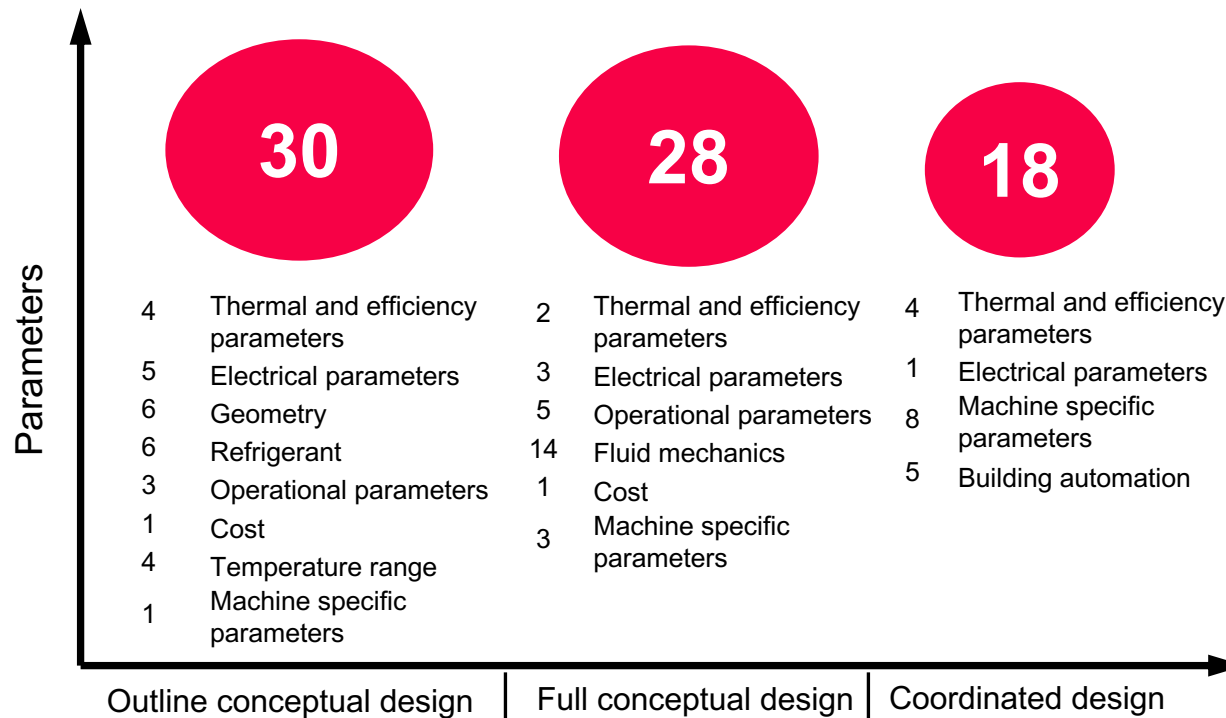
## Evaluation



# Result of the data collection




- Overall, 76 parameters relevant to the design phase were identified

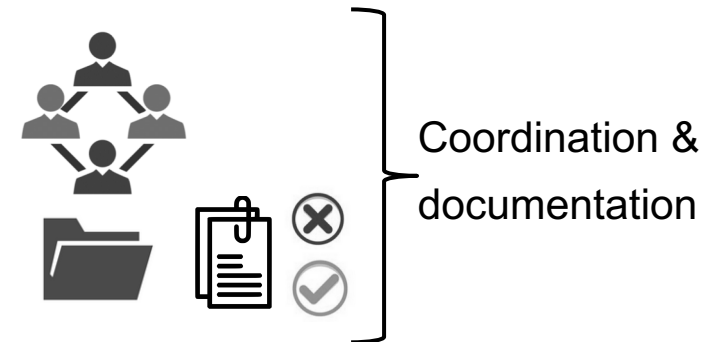


# Definition of the three importance categories



- The rating should help to establish a common sense between all project participants about the priority specific parameters



Importance category	Criteria for parameters
High 	<ul style="list-style-type: none"> <li>• Determine the basic requirements for the planning task with the client</li> <li>• Required to fulfil the planning task and which are essential for other involved project participants.</li> <li>• Relevant for building permission process and important to check the technical equality in the tendering and award process</li> </ul>

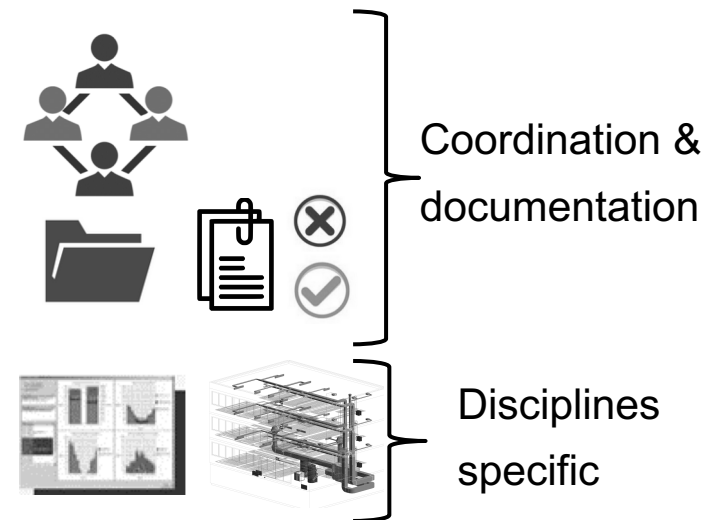


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Medium 	<ul style="list-style-type: none"> <li>• Important for planning tasks and essential for the work progress of a specific project participant (e.g., parameters required by HVAC engineers to dimension a specific component)</li> </ul>

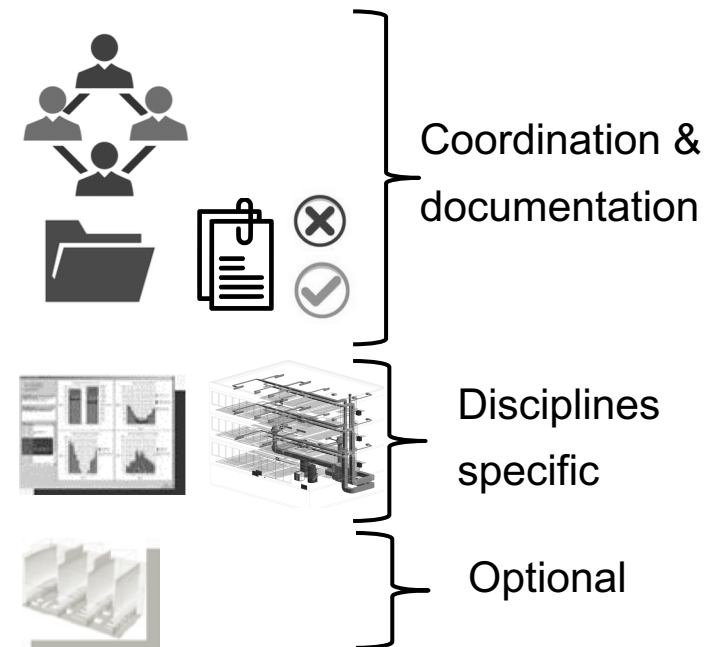


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Medium 	<ul style="list-style-type: none"> <li>• Important for planning tasks and essential for the work progress of a specific project participant (e.g., parameters required by HVAC engineers to dimension a specific component)</li> </ul>
Low 	<ul style="list-style-type: none"> <li>• required for optional or special tasks (e.g., additional or more detailed simulations, additional documentation etc.).</li> </ul>



# Results of the degree of importance

Data  
set

- Parameters with a 'high' degree of importance are predominant in the outline conceptual design phase
  - Impact on the final solution in early design stages

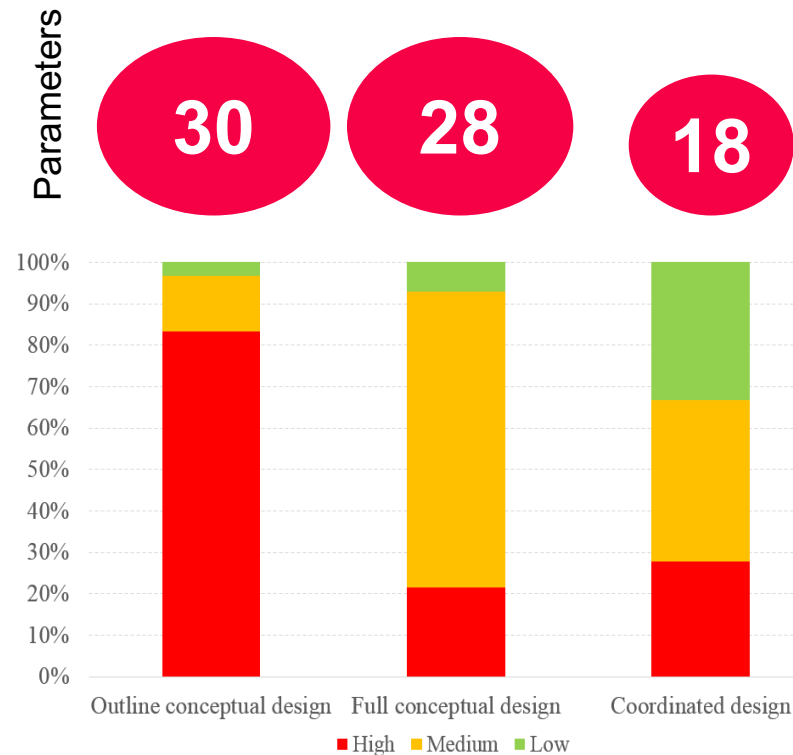
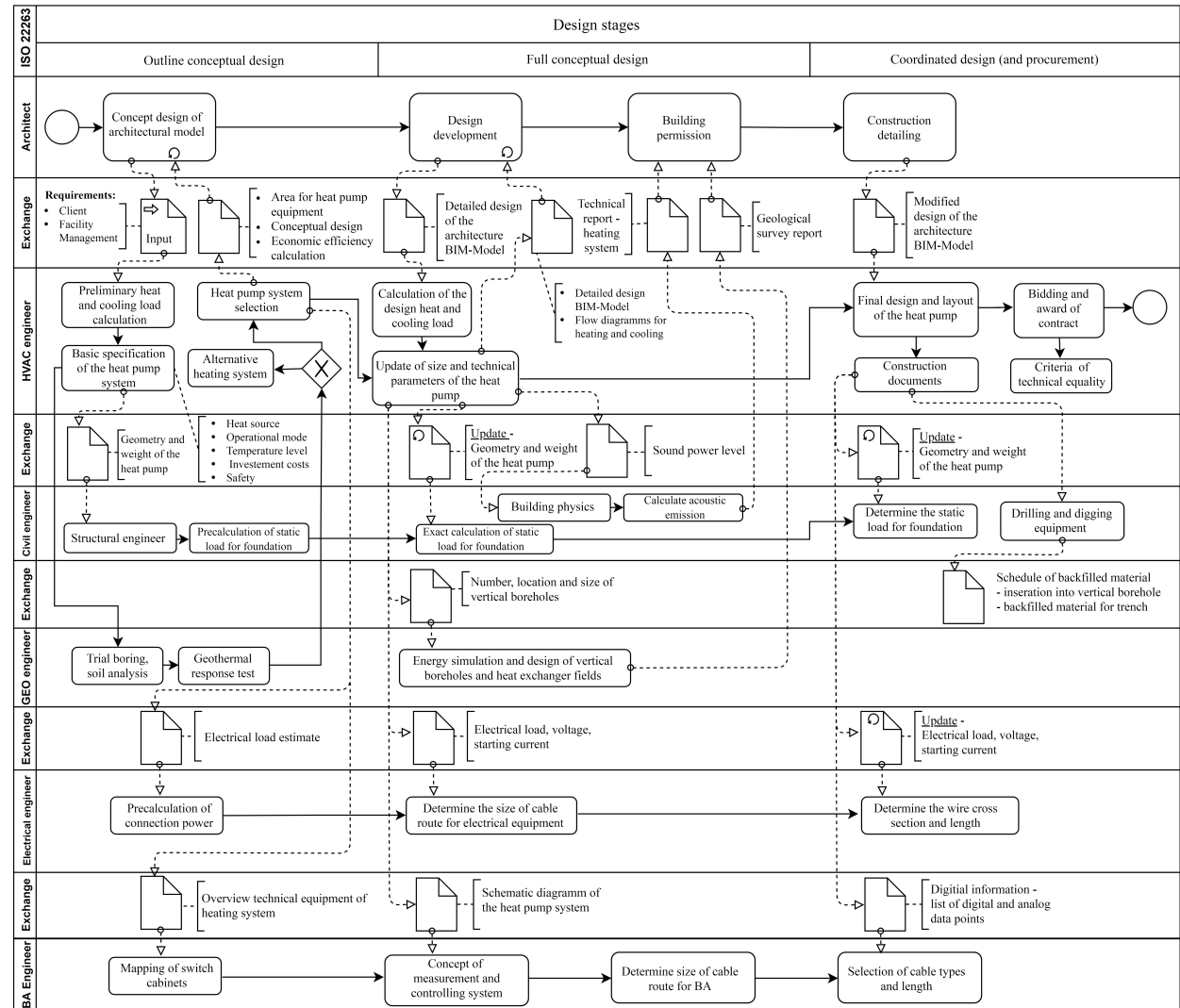


Figure – Distribution of the degree of importance of parameters in each design stage

# BPMN model of a heat pump for different design stages

- Information flow for the heat pump unit during the planning phase
- Interaction between MEP engineer and the other project participants

Process model

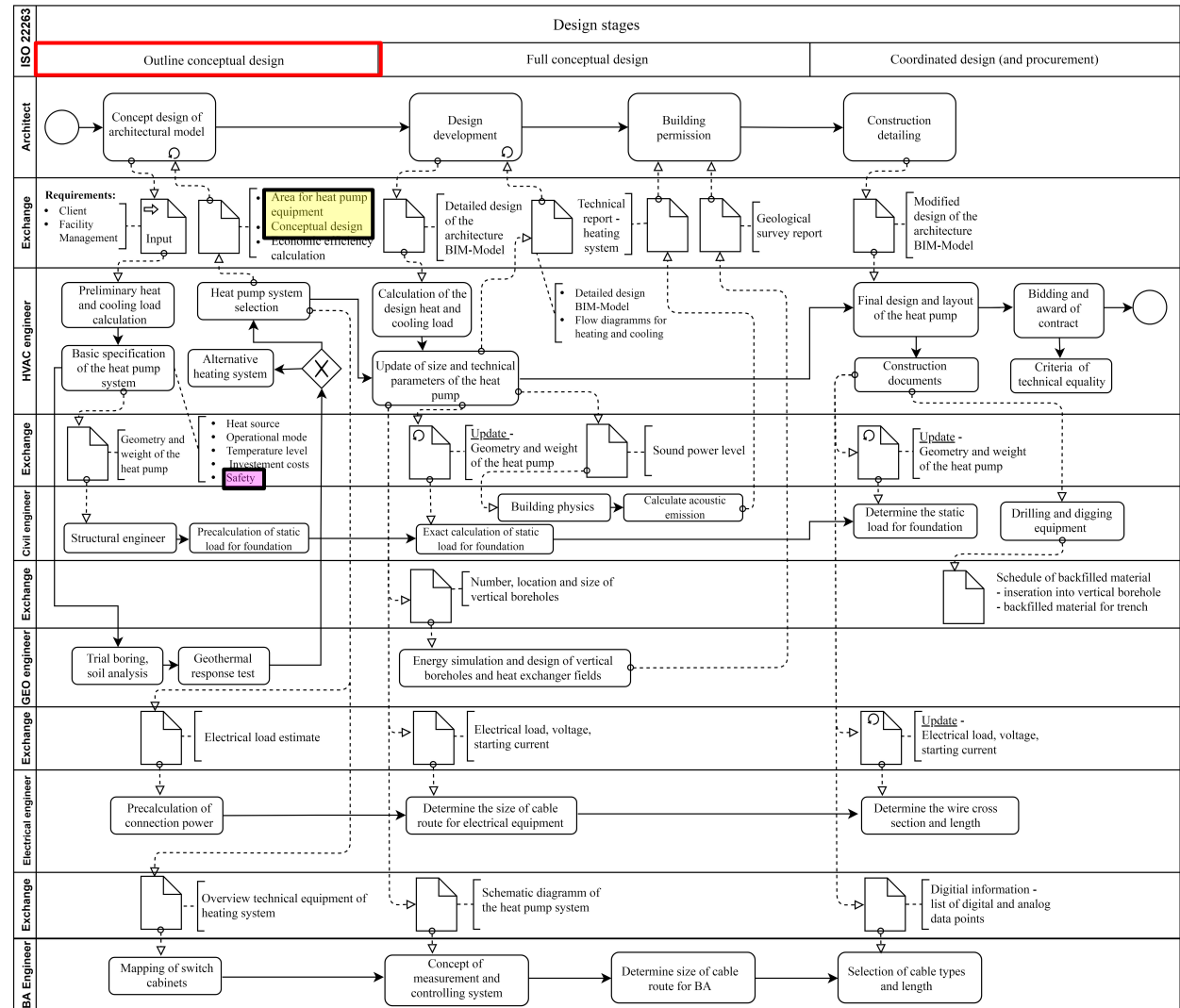


# Impact of 2 parameters with a 'high' degree of importance

- Outline conceptual design

- Geometry
- Refrigerant

Process  
model





# Summary and conclusion

- A data set with 76 geothermal heat pump parameters was compiled by analyzing different information sources.
- BPMN-model of a geothermal heat pump to describe the roles, tasks and responsibilities of involved stakeholders for different design stages
- The results should improve the collaboration and coordination management of BIM projects in which a geothermal heat pump is used as heating system for the building
  - Relevant for BIM documents (EIR, BEP, IDM etc.)

# Acknowledgement

[www.metatga.org](http://www.metatga.org)

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## Partners

