DEFINITION OF A BUILDING DESIGN PROCESS AS GUIDANCE FOR AN APPROPRIATE CHOICE OF TECHNOLOGIES INCLUDING INNOVATION AND RISK MANAGEMENT

Peter Noisten

Aude Tan, Thomas Kirmayr, Gunnar Grün

Fraunhofer Institute for Building Physics, Valley

Gefördert durch: Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages

Lake Constance 5D-Conference 2015

AGENDA

- Introduction and Background
- Prerequisites
- Description of a decision-making process and its advantages
- Example / BIMiD
- Summary and outlook

Introduction and Background
Building sector

- Blamed to be **much less innovative** than other technology sectors because of risk limitation
- **Long-proven technology** usually used
  - planners and construction companies have already **gained sufficient experience**
- **Risks** in terms of probability of occurrence and of possible level of damage are **reduced**

- **No suitable methodology** available combining risk and innovation management
- Mostly **trial-and-error method** between the architect and the client (iterative process)
- Structured approach not frequently used

Introduction and Background
Owners and planners

- Owners are often laymen in the construction area
- Lack of understanding of plans provided by planners

- Extensive know-how on the side of the owners and **a precise definition of their needs** needed in advance
- **Structured requirement management**
  - Could provide valuable services and could lead to higher customer satisfaction
  - Highly recommended to involve users

- The side of the customers can be divided into several positions

Introduction and Background
New process needed

- Building a **design process** including components of
  - Innovation management and
  - Risk management

  could act as an **innovation driver** in the building sector

- This process is mainly based on the transformation of the combination of
  - European Operational Concept Validation Methodology (E-OCVM) and
  - Quality Function Deployment (QFD)

  to the building sector.

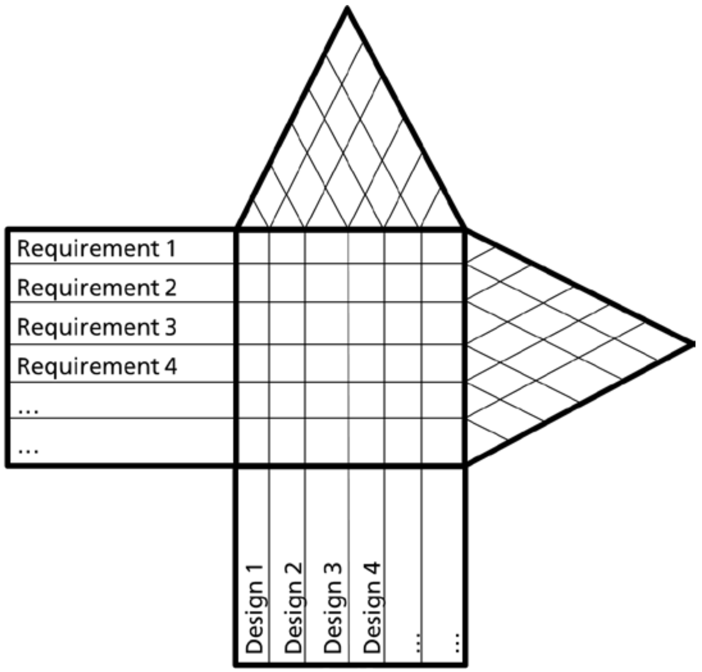
- The method is applied to **complex buildings in early planning phases** only

Prerequisites

- QFD
- E-OCVM (Validation & Verification)

Quality Function Deployment (QFD)

- Quality Function Deployment is a *"method to transform user demands into design quality, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts, and ultimately to specific elements of the manufacturing process"*
  Dr. Yoji Akao

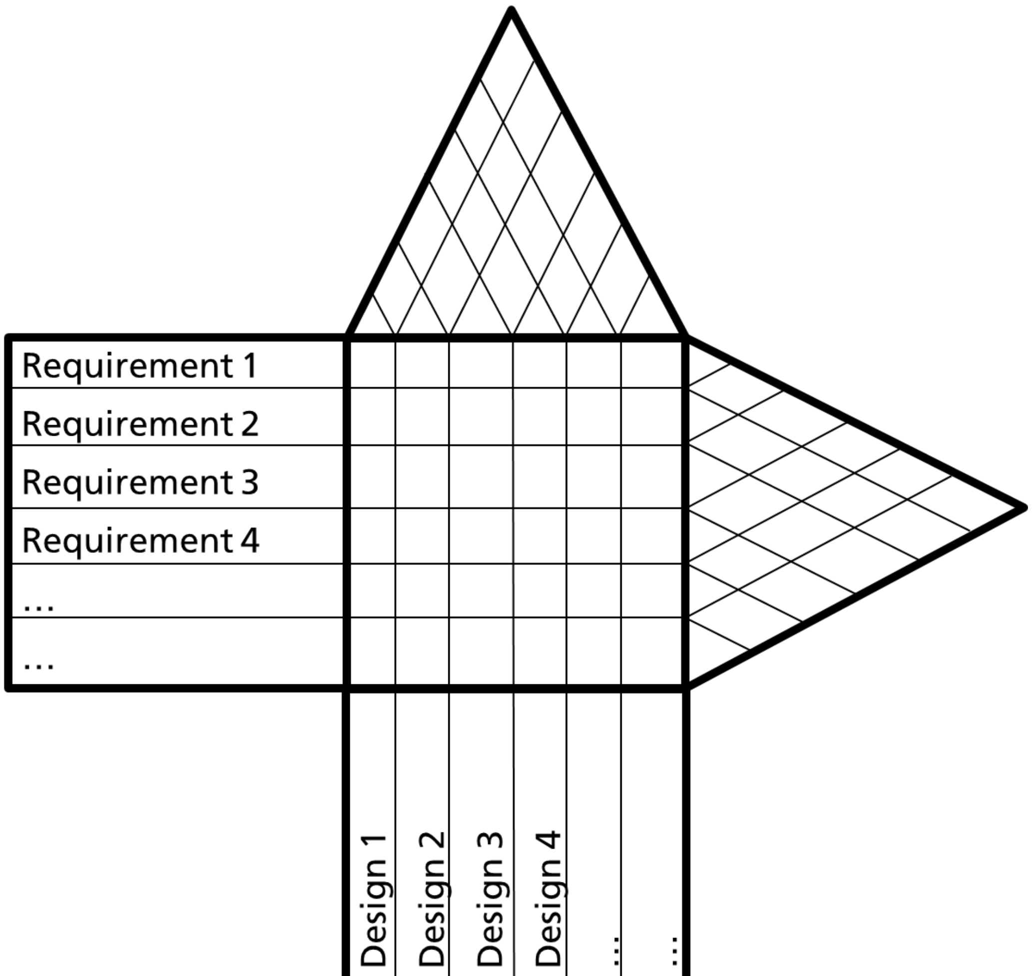


- A listing of **all requirements and technologies and their interdependencies** in all stages of development often results in **gigantic** and thus **confusing matrices**

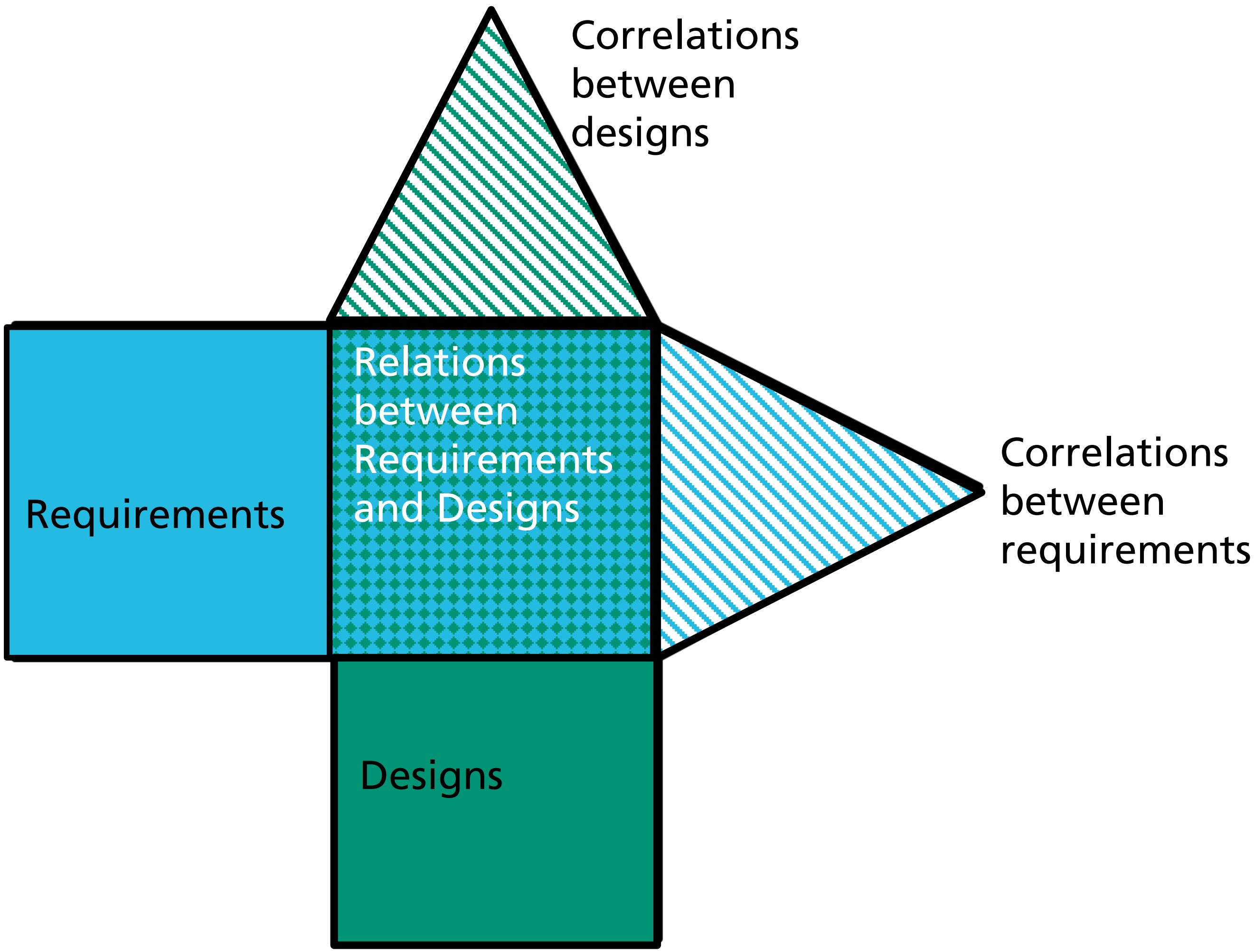
Quality Function Deployment (QFD)

- One **frequent mistake** is the lack of prioritizing requirements, which leads to an increase in the data complexity
- New approach: "**forced decisions**" based on the Analytic Hierarchy Process invented by Thomas L. Saaty
- **Reduction of the QFD matrices**
  - First, divide the indicators into groups
  - Second, allocate them to cases
  - Third, rank them
  - Advantage: allows a faster requirement classification process

Quality Function Deployment (QFD)
House of Quality



Quality Function Deployment (QFD)
House of Quality

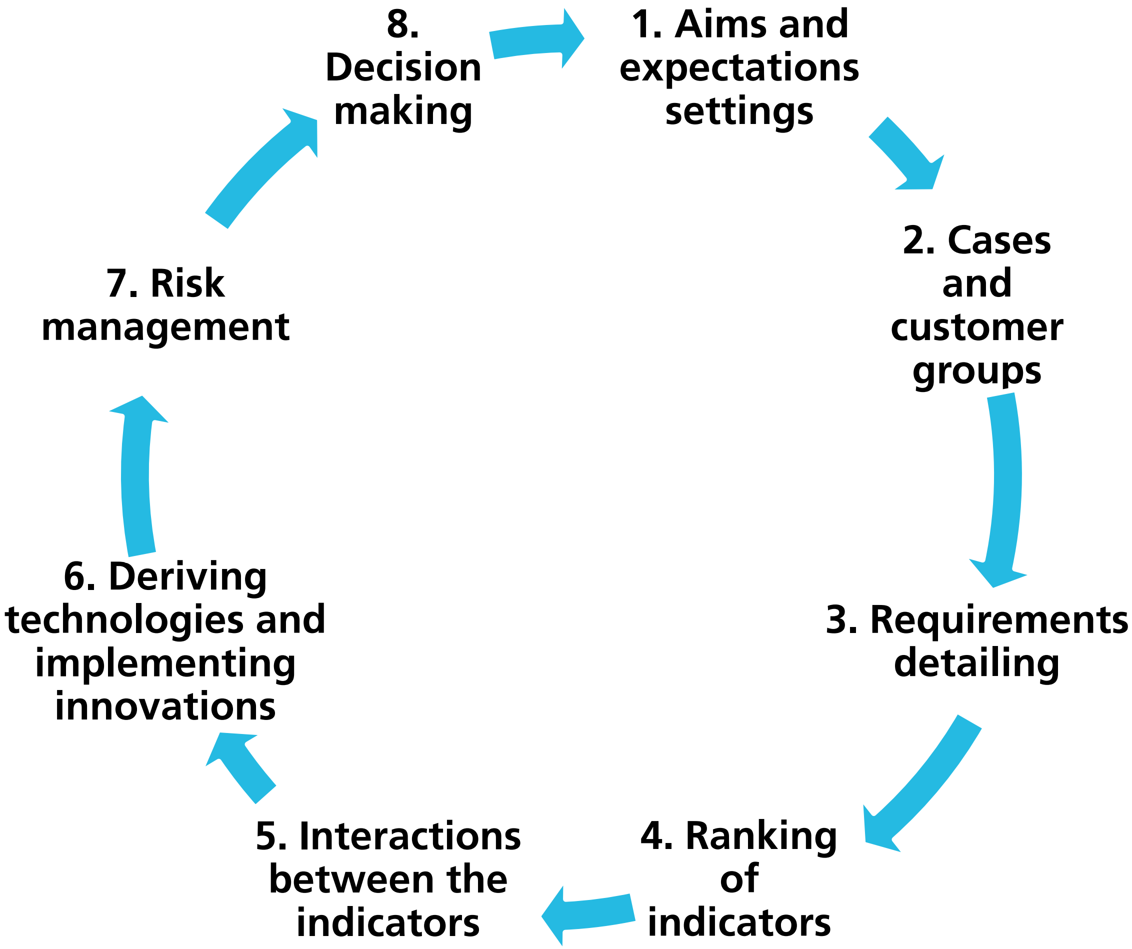


The European Operational Concept Validation Methodology (E-OCVM)

- Guideline for R&D projects
- Provides a **framework** for validation and verification of the concepts developed during the research phase of a project (cases and exercises)
- Gives answers to the following questions:
  - 'Are we building the right system?' (Validation)
  - 'Are we building the system in the right way?' (Verification)

- **Validation:** The **concepts** are tested **against the requirements.**
- **Verification:** The **Quality control process** and concept are tested **against external conditions such as regulations.**

Description of a decision-making process and its advantages

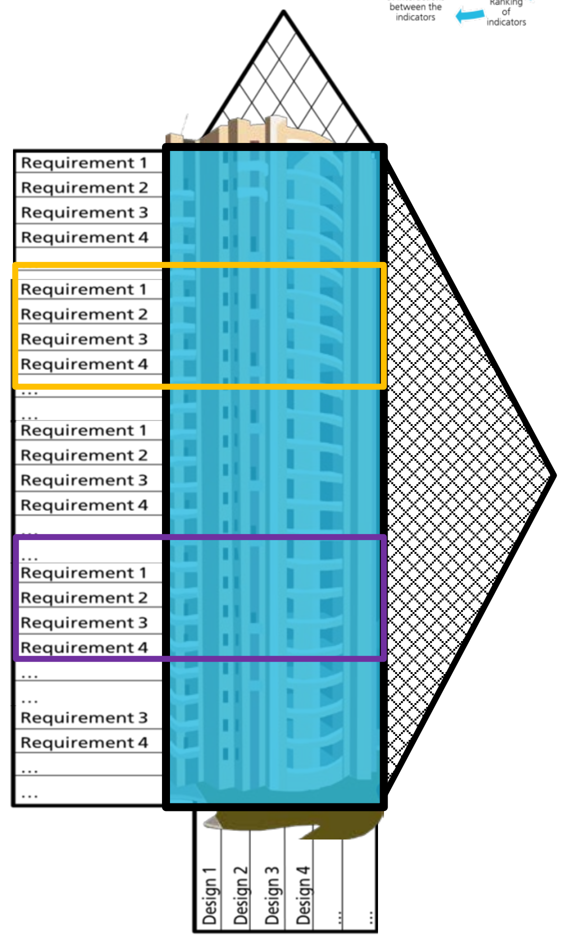


Step 1 - Aims and expectations settings

- Ask all involved parties using QFD about their
  - Expectations
  - Personal aims
  - Project aims

  and **cluster** their answers

- The **aims** in general and specifically to each stakeholder can be very different and **contradictory**



5Dinitiative
HOCHSCHULE KONSTANZ UNIVERSITY OF APPLIED SCIENCES
BIMiD
Fraunhofer IBP

Step 2 - Cases and customer groups

As described by E-OCVM:

- Organize all stakeholders into different groups
- Assign one special case for each of them

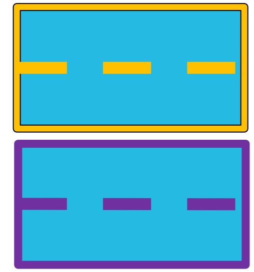
➡

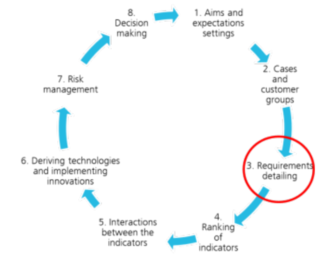
- More structured expectations
- Reduced QFD matrices

- First list of requirements for each group can be derived

- Approximately same level of detail for all requirements needed

Step 3 - Requirements detailing



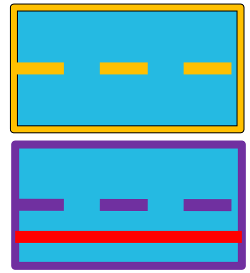


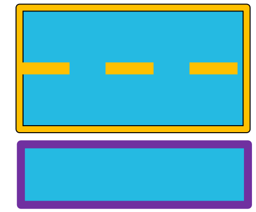
- Separate the requirements into **two groups**:
  - those that **must be met** (i. e. standards or boundary conditions)
  - those **desired by** the different **stakeholders** (also exceeding standards)

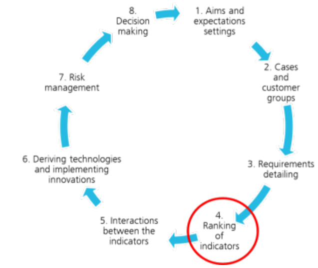
No further discussion needed!

- Assign key performance indicators to the requirements
  - References for comparison in order to help set qualitative, measurable or calculable values
- **Indicators** as **single dimension objects** and **independent** from each other
- **Indicators** should be **weighted in each defined case**
- **Check** at each iteration step if all indicators still provide a **correct projection of the more detailed requirements**.

Step 4 - Ranking of indicators





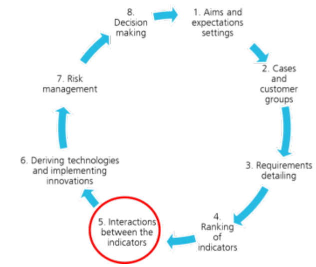


- Ranking by using the “**forced decisions**” process
- Stakeholders to decide between each of the two indicators which one is of higher level of importance in reference to predefined cases
- By summarizing for each case, **ranked lists** are derived
- Presentation of the outcome of the assessment and one very **last chance to change the list of indicators** considered in the following steps

- More focus on the most important wishes and requirements of the customer

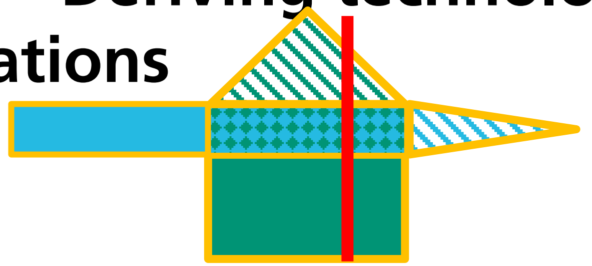
- With this, **transparency** is **provided** with regards to the goals of the project, and the list of **requirements** is **better accepted** by all parties.

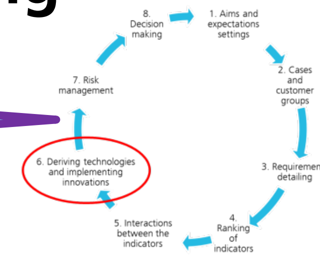
Step 5 - Interactions between the indicators



- To depict the **interactions** between the different indicators, QFD can be used
- In general, there are only the following three possibilities:
  - No influence
  - Positive influence: If the value of one indicator rises, the other one rises, too
  - Negative influence: If the value of one indicator falls, the other one rises
- This step has to be executed by a technical expert with high expertise and experience, for instance the **architect**
  - Currently, done unknowingly
- The **comprehensive matrix** of interactions can further be used for the next steps, especially for **implementing a virtual building model**

Step 6 - Deriving technologies and implementing innovations



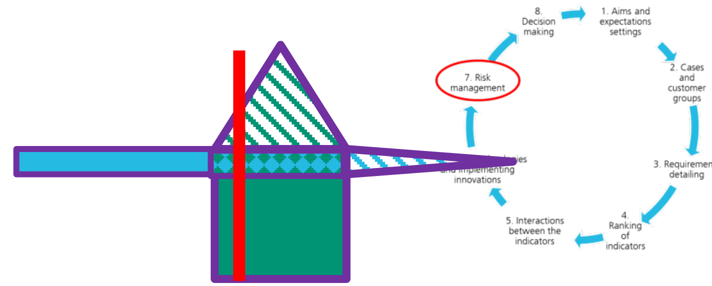


- Architects and planners translate the customers' needs into **technical solutions**
- All proposed technical solutions need to be associated to **measured or calculated indicators** to check their fitness to the requirements
- All involved planners are asked to do a **self-assessment** of all proposed technologies and solutions according to the indicators and requirements

- **Independent review** by a technical expert **needed**
- Risk assessment is excluded in this step

→ **Innovative technologies can be implemented** without concerning their risks and consequences

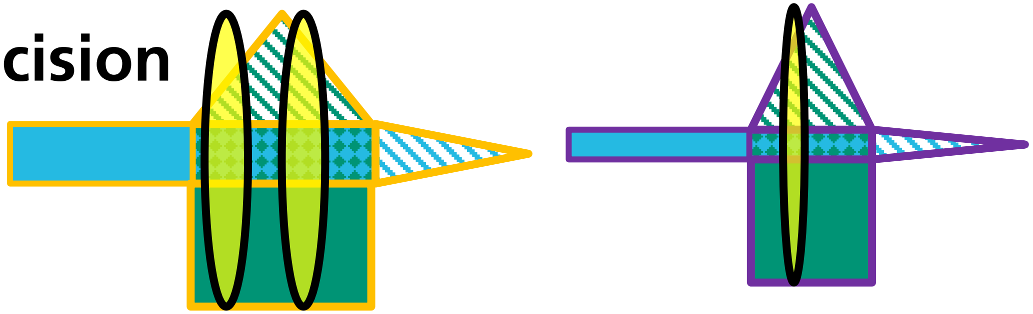
Step 7 - Risk management



- Consider every innovation implemented in the last step
- Write down all chances and risks
  - **Technical risks** having significant impacts on the other risk categories.
  - Other risk categories
- Both, the probability and the impact level of each single risk must be estimated
- A **strategy to handle** each single risk must be mapped out
- Accountable persons must be ascertained and documented for each risk

- Separating innovations from risks in a first step is a chance to get more innovations implemented in the building industry sector

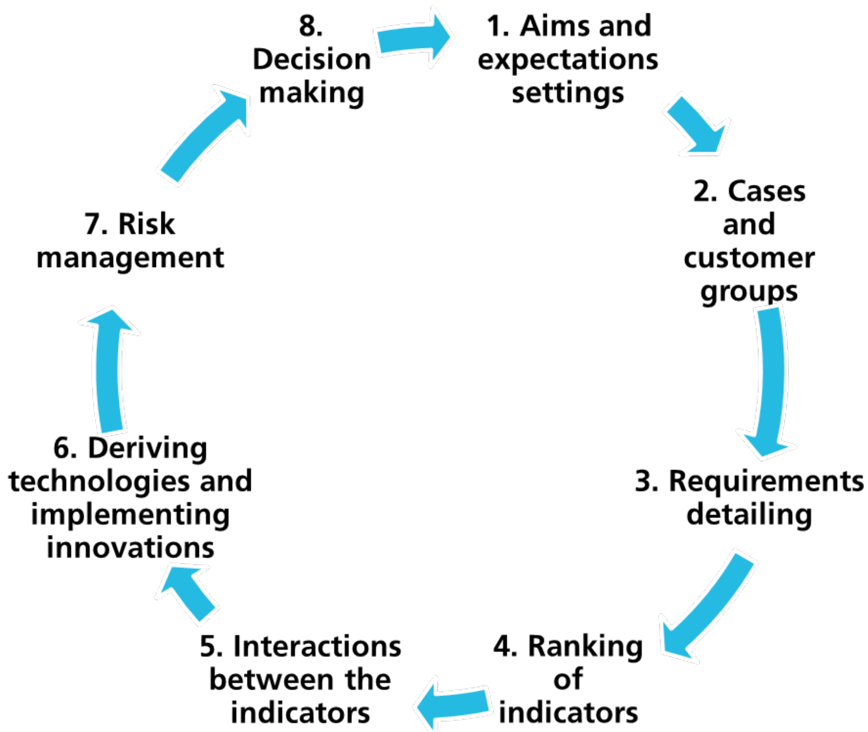
Step 8 – Decision making



- Outcome of the steps:
  - a few combinations and suggestions for choosing technical solutions fitting optimally to the requirements
- All proposed technical ideas and their consequences must be presented to and discussed with the customer
- The conformity to the requirements has to be proven and all consequences for the stakeholders must be drawn up
- The concluding decision for one and against another technology can be done with **less uncertainty** thanks to more and **more precise information at any given point**
- **Management risks** (wrong decision) can be **reduced**
  - Savings in time and costs
  - Higher satisfaction of all participants

Ongoing process

- This described process is iterative and has **to be repeated during all design phases** while detailing both the requirements and the technical solutions.



Advantages of using BIM

- The **assessment** can be done **efficiently** and **cost-effectively**
- The customer gets a **virtual optical impression**
- **Changes** can be **integrated** in a **very fast** way and the decision-maker receives direct feedback thanks to the relationships between the elements implemented in the model

Summary

- The enormous **costs savings** gained by reducing management risks can be **invested in** trying to implement even **more challenging innovations and new technologies**
- The **BIM** technology can provide **help to reduce** these **technical risks**
- **Virtual assembling** during the planning phase and training can be done to reduce the current assembly risks or costs at the building site.
- The next step is to integrate time registration of every single assembly step and to optimize the virtual construction model.
- **BIM** is a **key technology to enable the integration of innovation and risk management** into the design process while it is supported by proper methods for decision making.

Example / BIMiD

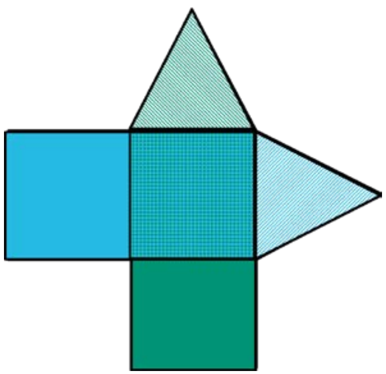
- **Publicly funded project** aims to exemplify how BIM works in practice in order to help promoting BIM in the SME-dominated construction and real estate industry in Germany
- **Planning and building processes** will be **supervised**
- Need for a **well-structured process** especially **in the early planning phases**
- Most **decisions** are **taken within a group of stakeholders** after analyzing the consequences for technical quality, time and costs (such as life cycle costs)
- Assessment of the technical solutions with regard to a detailed requirement management not common
- Introducing **BIM** and illustrating the different solutions in a virtual building-prototype with photorealistic renderings leads to many advantages including **more certainty in decisions**

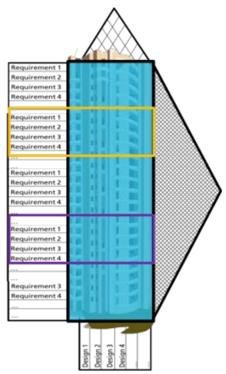
Summary and outlook

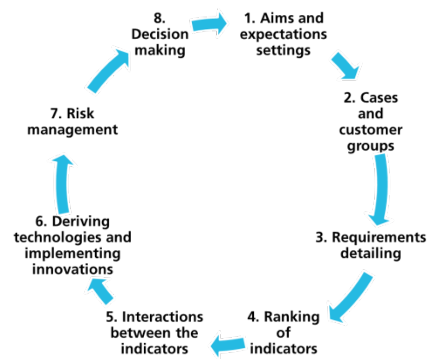
- A **new design process** is **built**, which integrates BIM and also innovation and risk management, thus supporting the stakeholders in **choosing the right technology** with a higher certainty
- Consequences of the different alternatives are illustrated in a better way when using the virtual building prototyping (BIM)
- The **building owner and user** are **more satisfied**

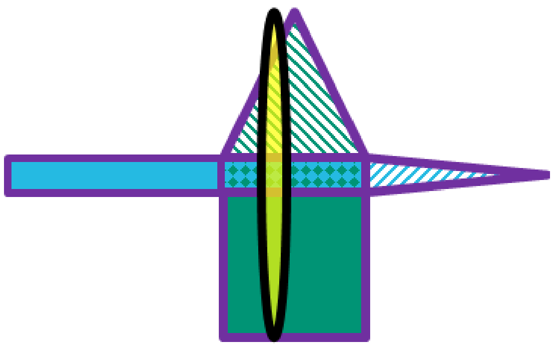
- Planned to implement several parts of this process in different building projects for validation
- **BIMiD** could be an **appropriate platform for validation**
- The transfer to the examples within BIMiD will be used to prove this advanced design process.

QUESTIONS?









Contact:

Peter.Noisten@IBP.Fraunhofer.de