MANAGING AI-BASED SYSTEMS

Session 6: Identification and evaluation of AI use cases

Managing AI-based Systems

Prof. Dr. Nils Urbach

Frankfurt University of Applied Sciences,
Research Lab for Digital Innovation & Transformation

FIM Forschungsinstitut für Informationsmanagement

Fraunhofer-Institut für Angewandte Informationstechnik FIT,
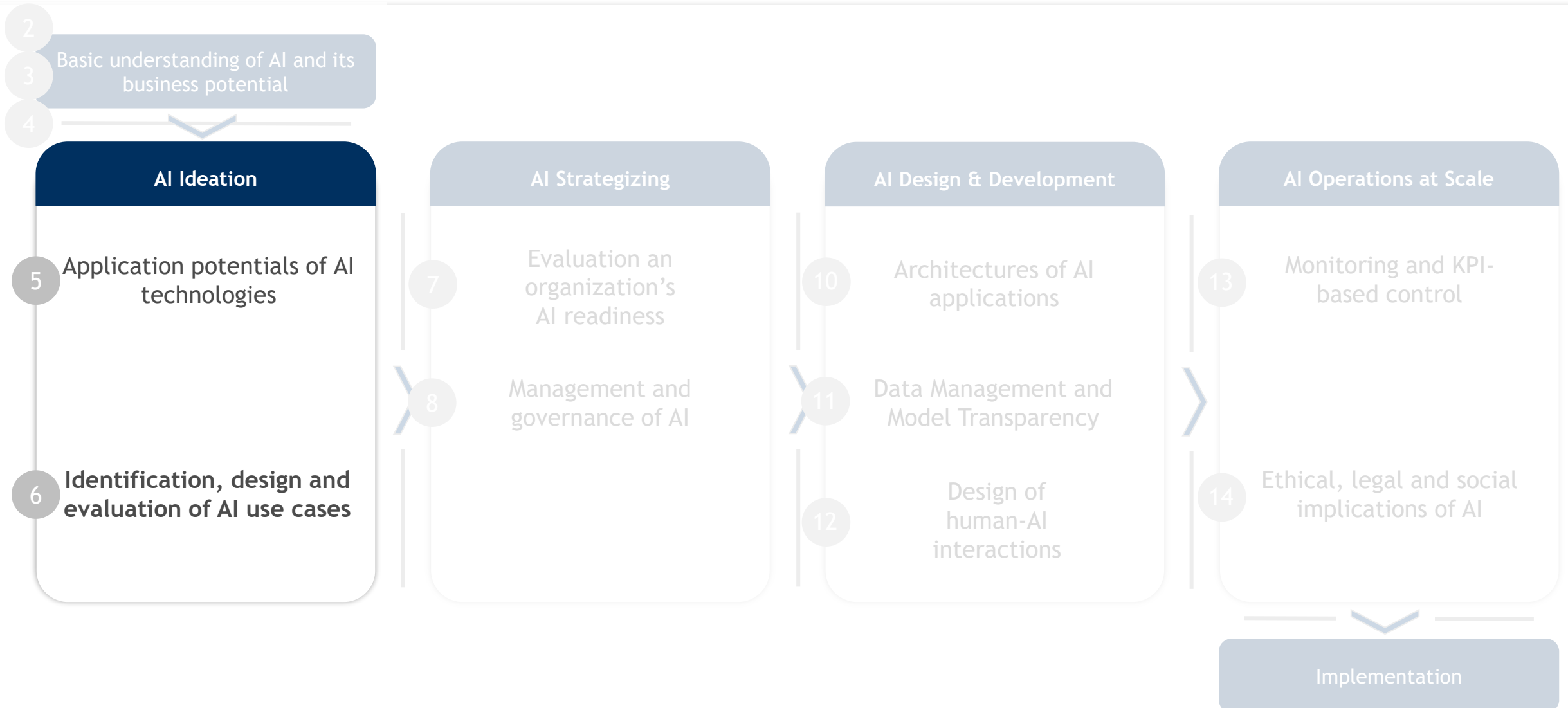Institutsteil Wirtschaftsinformatik

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www.fim-rc.de
www.wirtschaftsinformatik.fraunhofer.de

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Course navigator

Basic understanding of AI and its business potential

AI Ideation

5 Application potentials of AI technologies

6 **Identification, design and evaluation of AI use cases**

AI Strategizing

7 Evaluation an organization's AI readiness

8 Management and governance of AI

AI Design & Development

10 Architectures of AI applications

11 Data Management and Model Transparency

12 Design of human-AI interactions

AI Operations at Scale

13 Monitoring and KPI-based control

14 Ethical, legal and social implications of AI
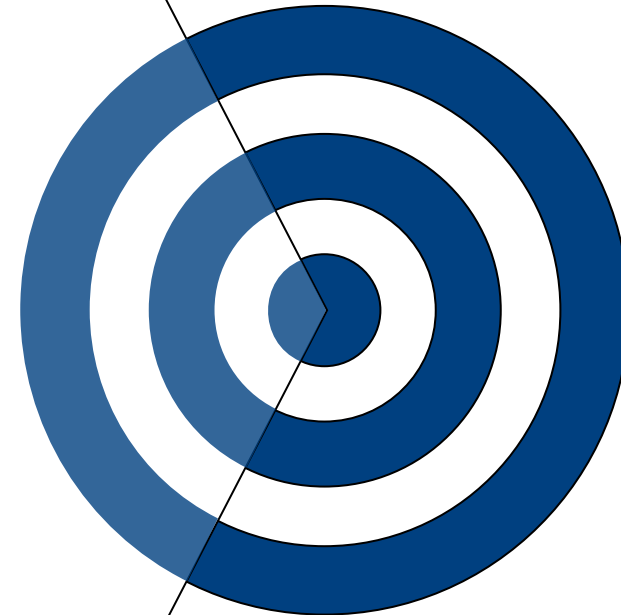
Implementation

Image: https://makeit.com/the-ideation-process/

Objectives of today's lecture

1. Understand the principles and frameworks of AI use case identification

2. Get to know the AI Service Canvas to design AI use cases

3. Learn to use the effect path method to evaluate AI use cases

01 | Identifying AI use cases

02 | Designing AI use cases

03 | Evaluating AI use cases

04 | Techno-economic decisions

01 | **Identifying AI use cases**

02 | Designing AI use cases

03 | Evaluating AI use cases

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PROBLEM

SOLUTION

Image: https://www.faithchoiceohio.org/blog/why-senate-bill-208-is-a-solution-in-search-of-a-problem

Why are organizations considering the identification of AI use cases?

Gain competitive advantages

Fear to fall behind the competition

Danger to miss innovative use cases

Danger to tackle less valuable use cases

Hofmann et al. (2020)

Challenges when identifying AI use cases

Lack of understanding the business potential of using AI

Overestimation and underestimation of the potential

Specific background needs to be considered

- Technical feasibility
- Economic efficiency
- Individual corporate context

Problem-related use case identification required

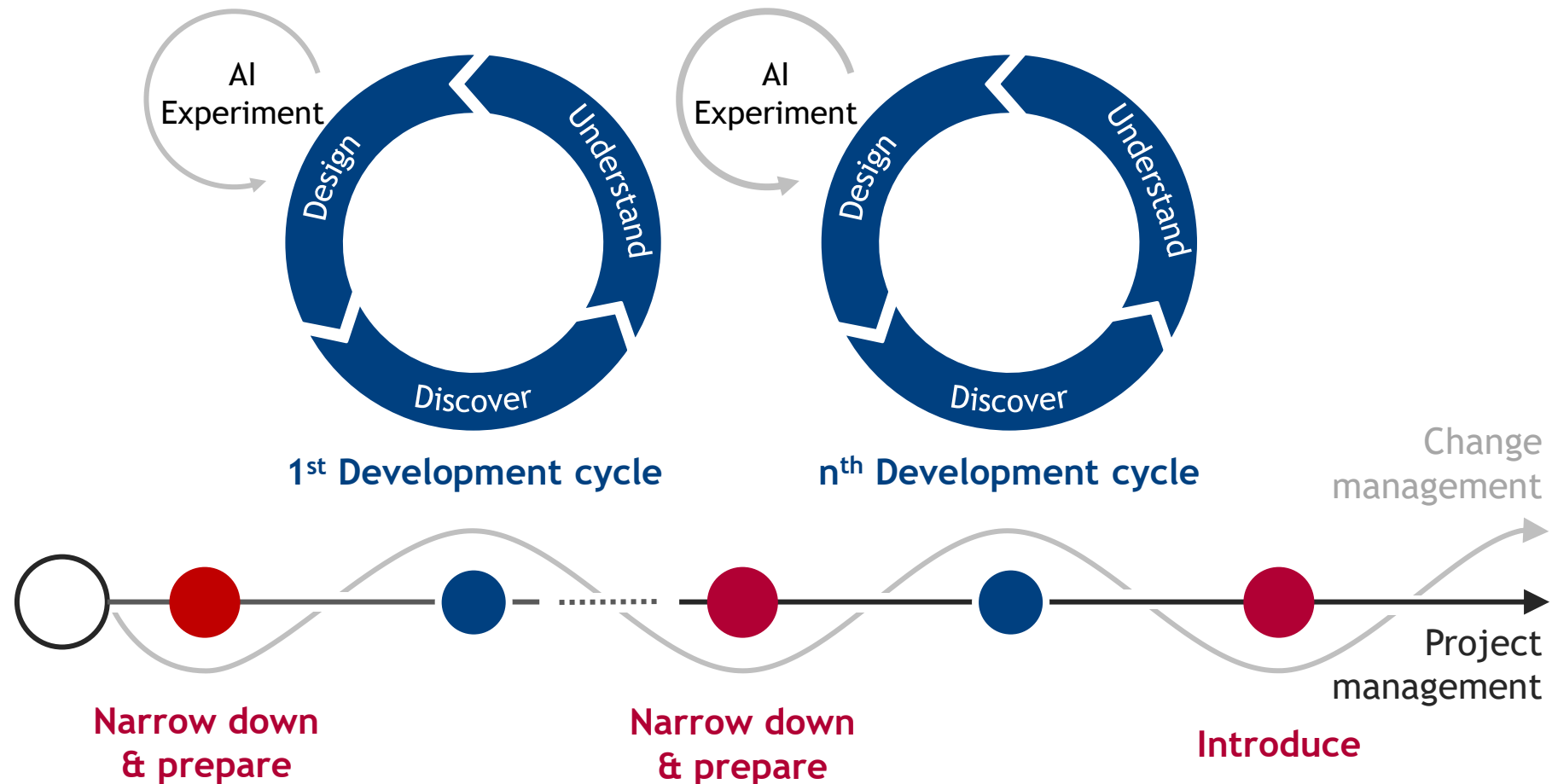Finding AI solutions that fit the individual problem best

Almost infinite scope of possibilities

AI solutions create new opportunities for gaining competitive advantages independent of a specific problem

Hofmann et al. (2020)

Iterative method to identify AI use cases

AI Experiment

Design · Understand · Discover

1st Development cycle

AI Experiment

Design · Understand · Discover

nth Development cycle

Change management

Project management

Narrow down & prepare

Narrow down & prepare

Introduce

Hofmann et al. (2020)

Activities for identifying AI use cases in a structured way

1. Narrow down
Define the main focus and boundaries of method execution

2. Prepare
Gather and structure information about company related context factors

3. Discover
Identify relevant problems and chances

4. Understand
Understand the root cause of the problems

5. Design
Find approaches and experiment with them

6. Introduce
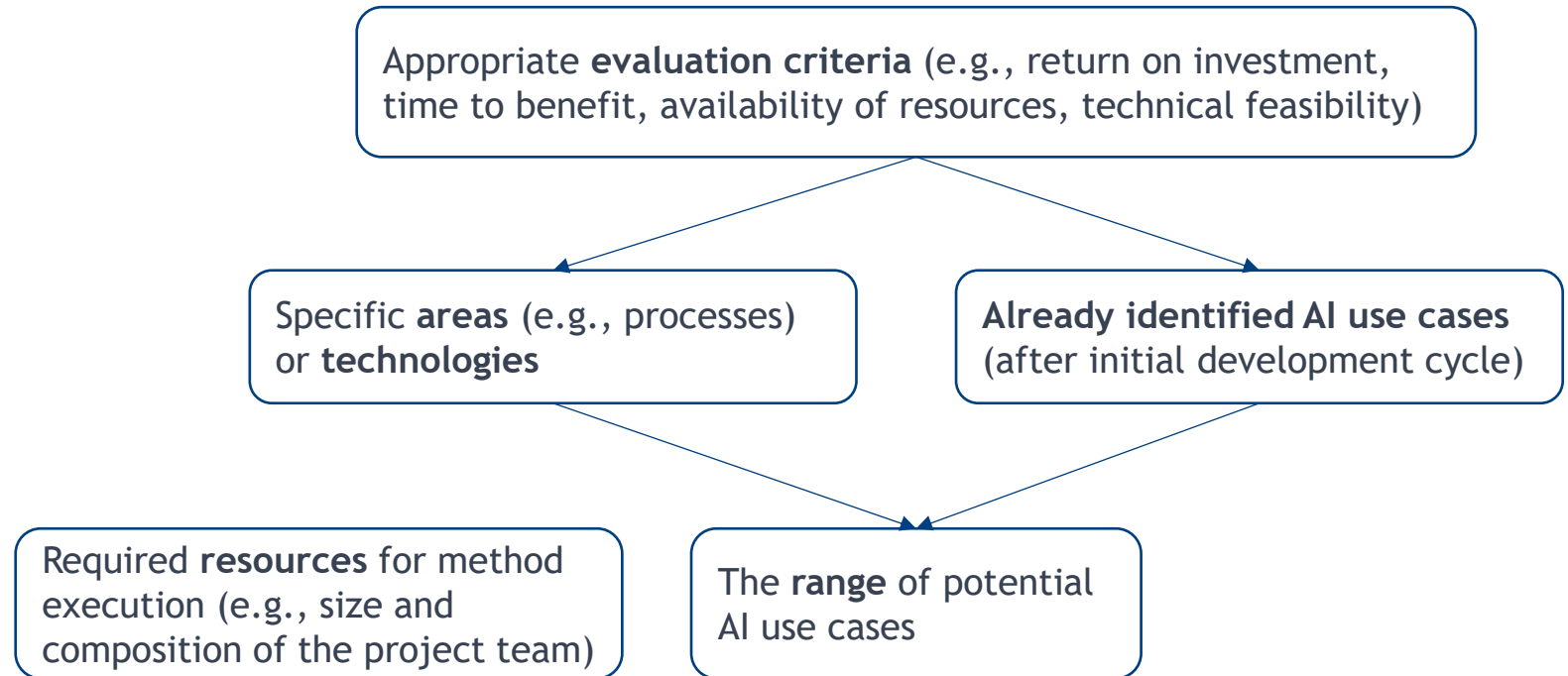Derive the prerequisites for a successful implementation of selected AI use cases

Hofmann et al. (2020)

1. Narrow down

Define

Appropriate **evaluation criteria** (e.g., return on investment, time to benefit, availability of resources, technical feasibility)

Prioritize and exclude

Specific **areas** (e.g., processes) or **technologies**

Already identified **AI use cases** (after initial development cycle)

Establish

Required **resources** for method execution (e.g., size and composition of the project team)

The **range** of potential AI use cases

» **The activity "narrow down" helps the company to execute the method in a targeted manner by defining the necessary resources and the range of possible use cases at an early stage**
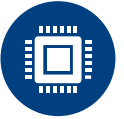
Hofmann et al. (2020)

2. Preparing and gathering information

TOE Framework

Describes the influence of technology, organization and environment on the adoption of technologies

Organization

T O E

Technology

Environment

Collection and structuring of relevant information about the company-specific context before each development cycle

Hofmann et al. (2020)
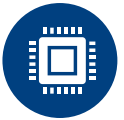
TOE: Technology
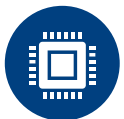
Introduction of new technologies requires **understanding the existing technology landscape** and its **interaction with new technologies**

Importance of **understanding the functionality of AI**
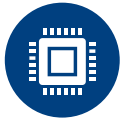
Consideration of the **own IT strategy** for the implementation of AI

Inclusion of previous experience and the **company's know-how** regarding the application of AI

Hofmann et al. (2020)

TOE: Organization

Align technology decisions **with overarching corporate strategy**

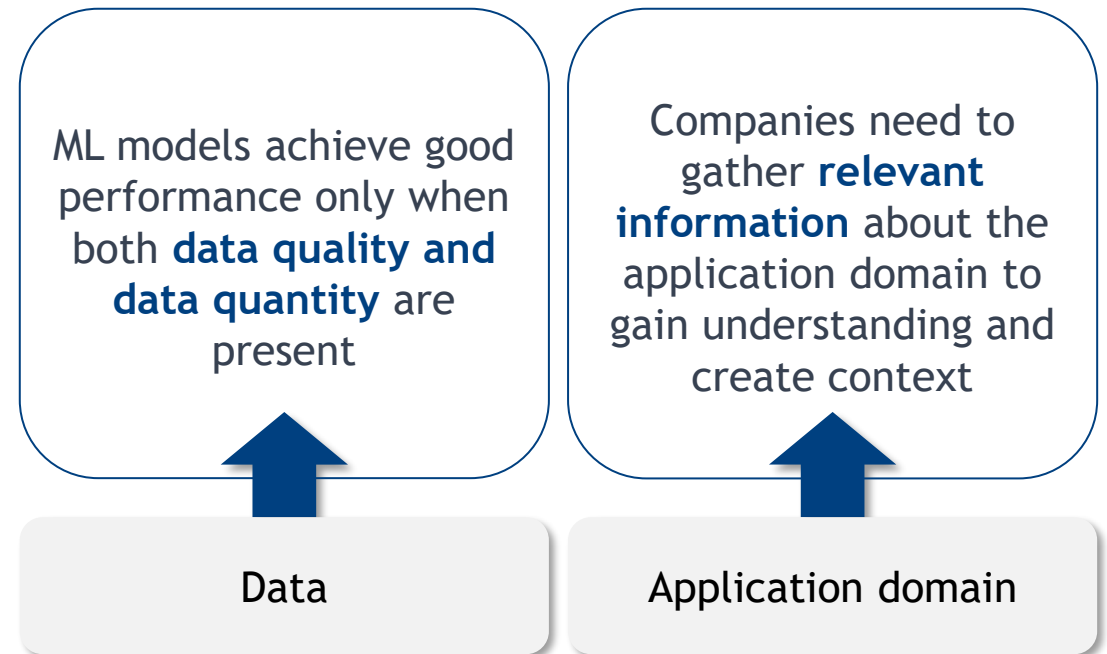**Strategic goals and ongoing transformations** must be considered in the planning of AI projects

Need of **support** from top management, an innovation-friendly **culture,** and adequate **resources**

AI use case identification can only be successful if its **scope is properly structured**

Hofmann et al. (2020)

TOE: Environment

Evaluation of requirements

Industry	Competitors
Customers	Regulation

Enabling and inhibiting environmental factors

ML models achieve good performance only when both **data quality and data quantity** are present

Data

Companies need to gather **relevant information** about the application domain to gain understanding and create context

Application domain

Hofmann et al. (2020)

Development Cycle: Discover, Understand, Design
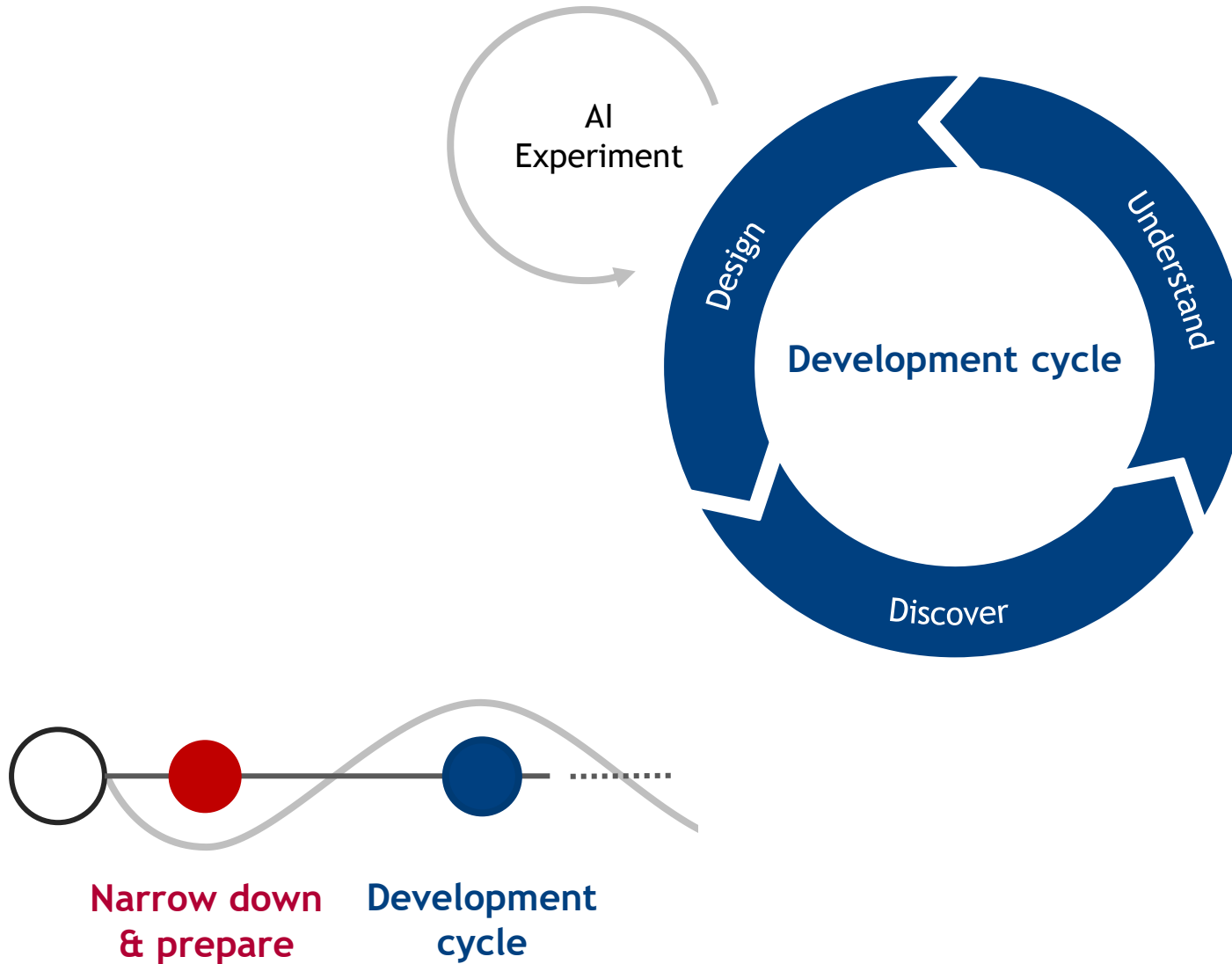
Hofmann et al. (2020)

Development Cycle: 3. Discover

Domain Perspective

Identify areas of activity based on **problem orientation**

Identify and detect existing or undiscovered problems in the application domain

Use a **stakeholder-oriented** approach

Technology Perspective

Identify areas of activity based on **opportunity orientation**

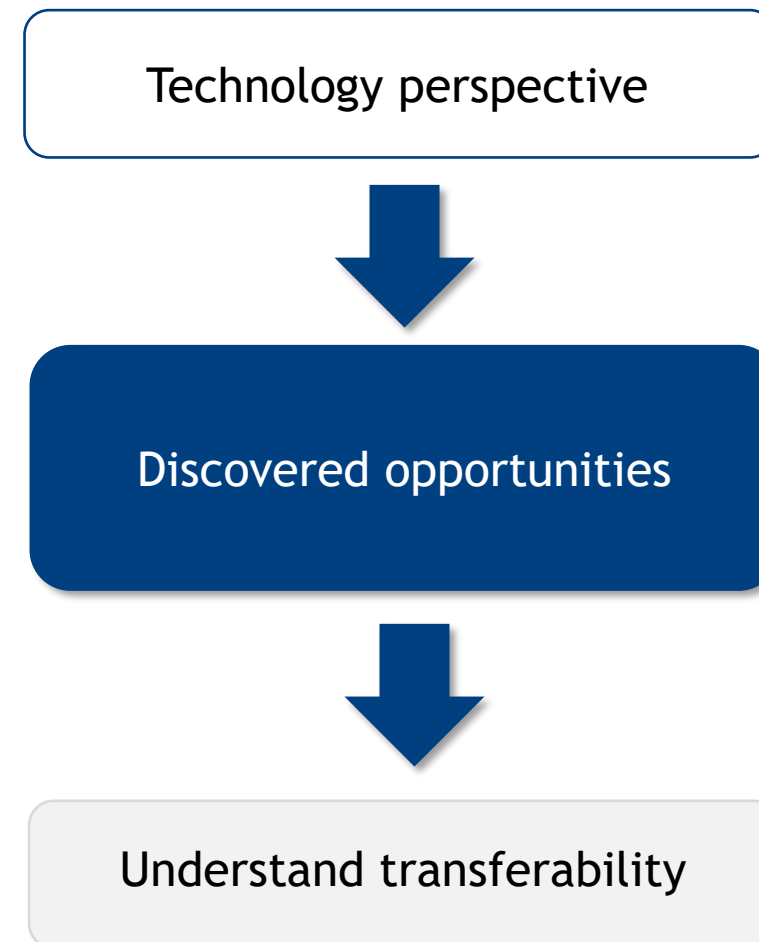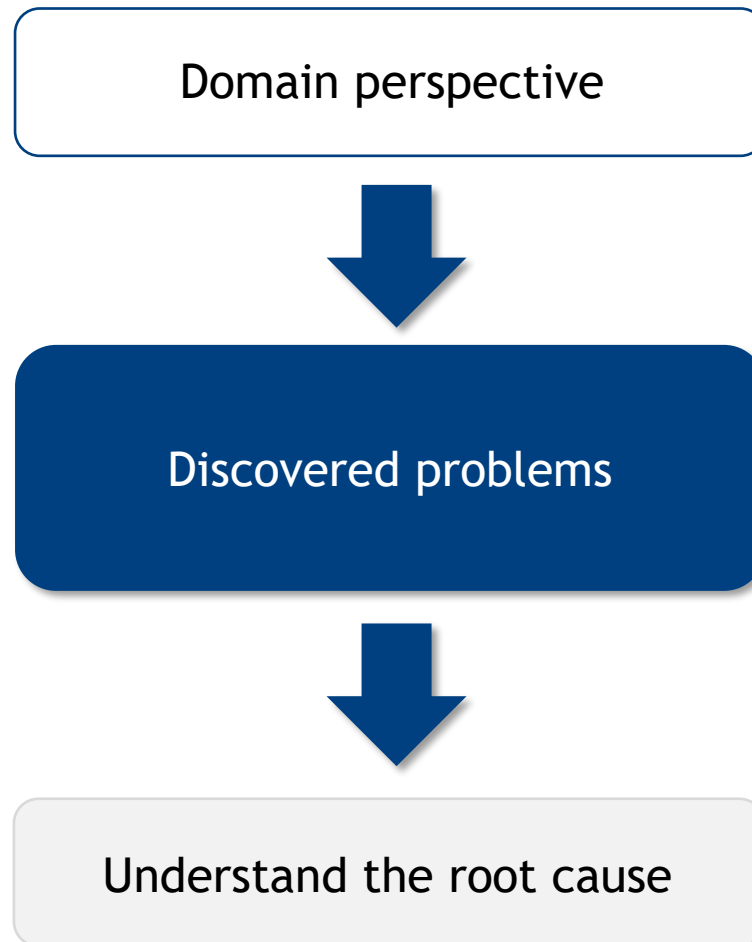Search for technology-driven opportunities within the domain

Conduct a comprehensive **market analysis**

Use products and services outside the domain as inspiration

Development Cycle: 4. Understand

Domain perspective	Technology perspective
⬇	⬇
Discovered problems	**Discovered opportunities**
⬇	⬇
Understand the root cause	Understand transferability

Hofmann et al. (2020)

Development Cycle: 5. Design

To design concrete AI use cases, companies need to **match problems with solutions**. To do so, bring together both domain-specific problems and solutions within each cell of the matrix.

Domain structure

	Process A	Process B	...
Perceive	Problem / Solution	Problem	Problem
Recognize	Solution	AI use cases	Problem
Explain	Solution	Solution	Problem / Solution
...	Problem / Solution	Problem / Solution	Problem / Solution

AI functions
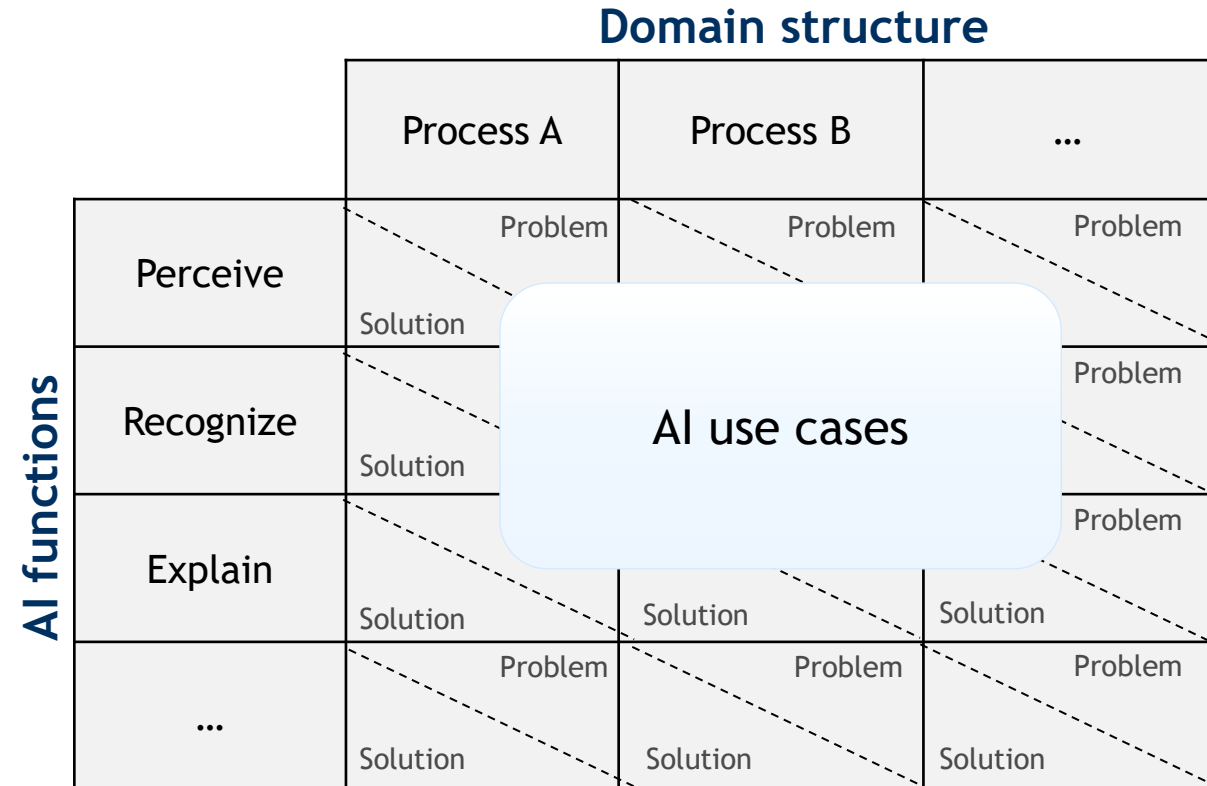
Extract AI use cases from the different fields in the problem-solving matrix. Then compare contextual factors, identify dependencies and evaluate the added value of the use cases.

Hofmann et al. (2020)

Design: What if it doesn´t work?

If there is no match between problem and solution one can look at it from two perspectives

Problem-oriented

Focus on a column of the problem-solving matrix and develop new AI solutions using technology selection and creative problem solving

Solution-oriented

Focus on a row of the problem-solving matrix and check if any problem has been overlooked

Hofmann et al. (2020)

6. Introducing the technology

Critically evaluate if other technologies
are cheaper or more suitable

Clarify the cornerstones of the implementation

Make or buy

Aspired maturity level
(PoC, MVP, Production
Ready Application)

Ensure proper integration into the current IT Infrastructure and
assess if the required know-how is readily available

Introduction into practice
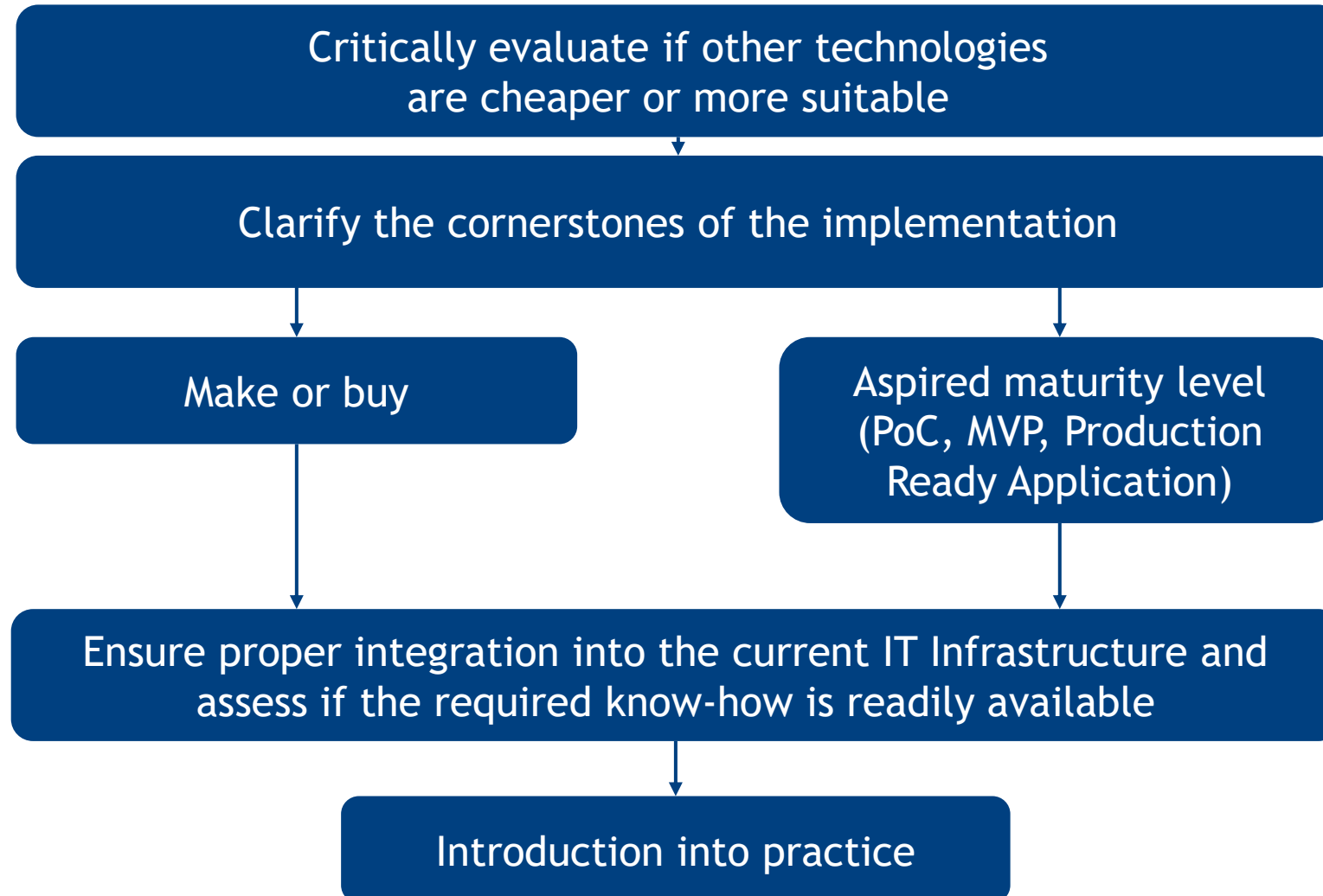
Hofmann et al. (2020)

Project and change management

Change management
Project management
Introduce

Project management

There is a need to coordinate the implementation of the method

Particular attention should be paid to ensuring that all project members are familiar with the methodological approach and are synchronized about the intended scope of application

The different professional backgrounds of the project team members should be taken into account

Change management

A company should accompany the identification of AI use cases with change management

The aim should be to increase awareness and appreciation of the project and the motivation of those involved to participate in the project

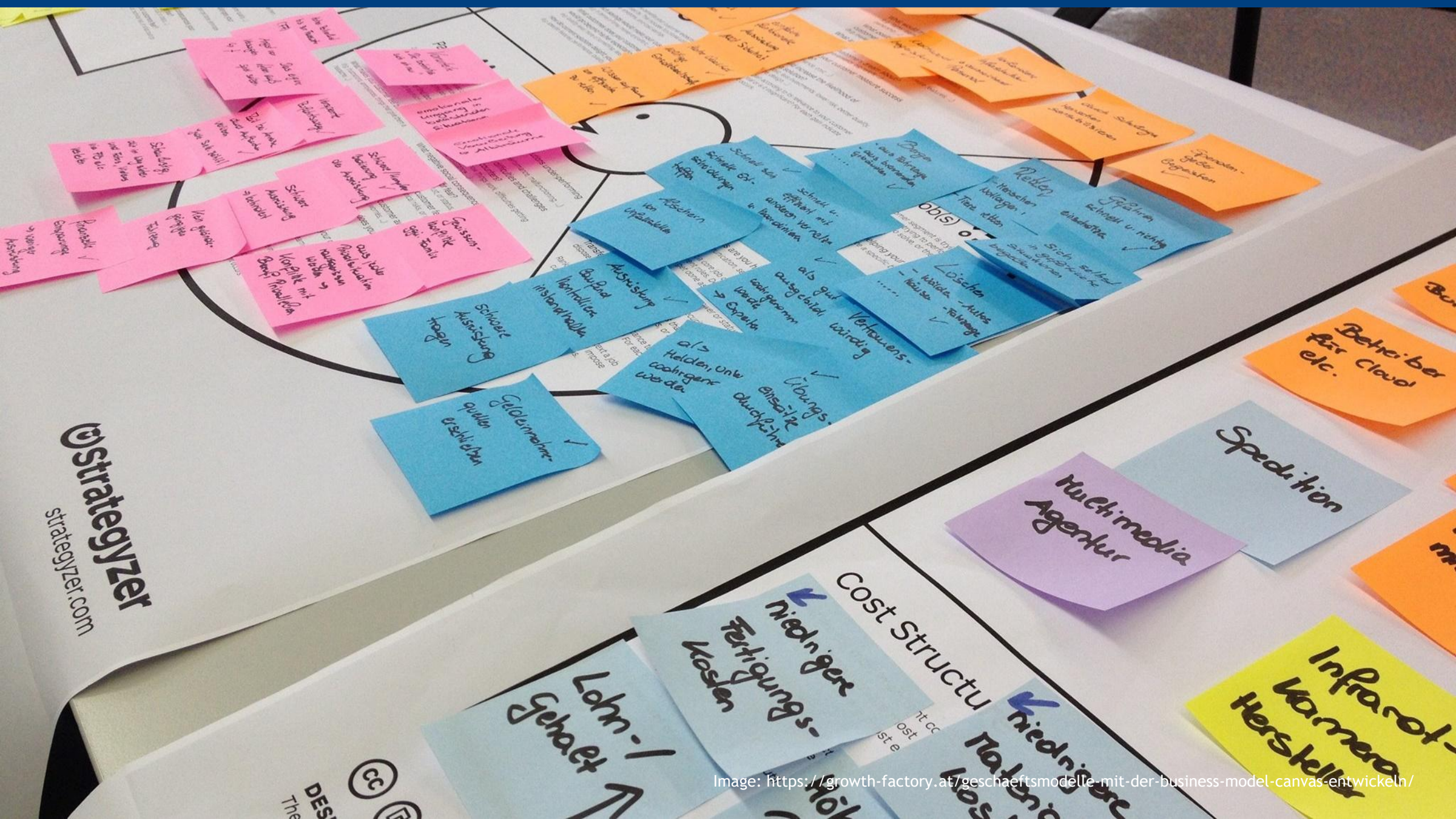To increase appreciation for the project, great importance should be attached to appropriate communication

01 | Identifying AI use cases

02 | **Designing AI use cases**

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The AI Service Canvas serves as a tool to support organizations when designing AI applications

Integration into the organization

Organisational readiness
Am I ready for it?

Business alignment
Does it fit my business?

AI-enabled service

Benefits
Which problem do I solve and how?

Societal topics
Am I allowed to do that?
Is that ethically appropriate?

Pipeline
How to integrate data and AI methods to create an AI-based service?

Input

Data
Which data do I need?

Output

Business potential
How and where does the business potential emerge?

Partners
Who are my key partners?

Value creation system
How to integrate it into the value creation system?

Customer
Who is my customer?

Integration into the value creation system

Urbach et al. (2021)

AI Service Canvas

Allows companies to describe AI services from a technology and innovation perspective
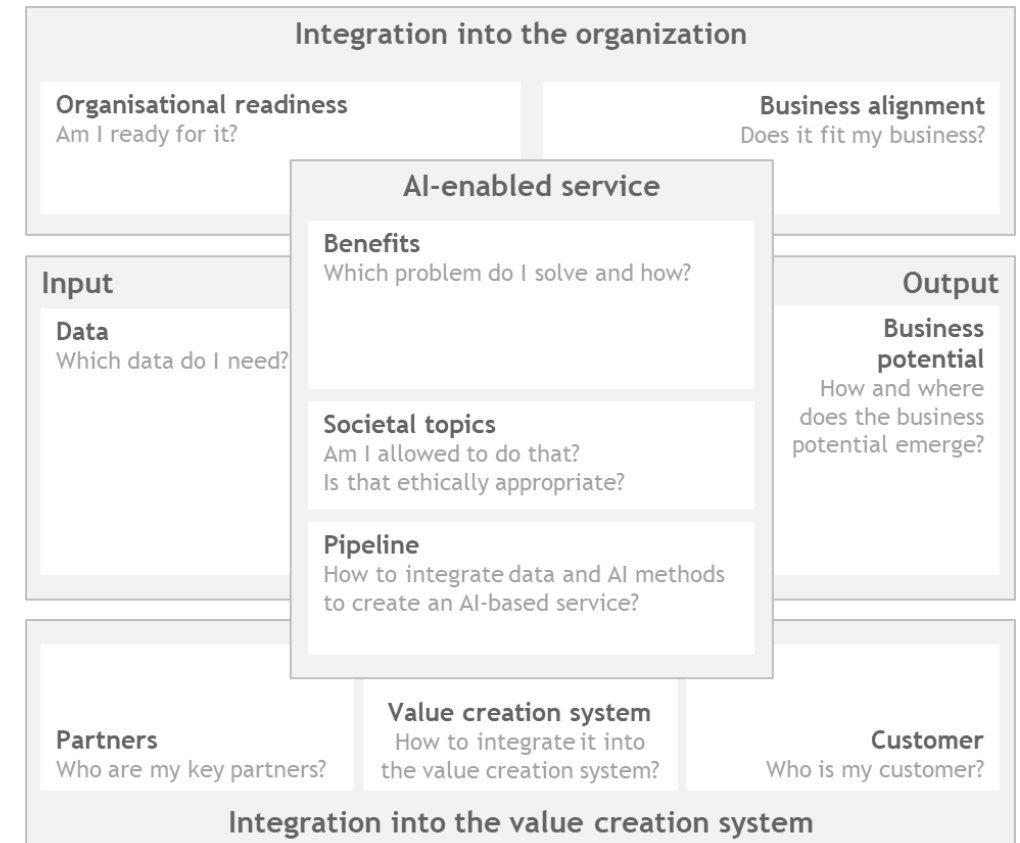
Provides common language for addressing problems and clarify questions

Provides bridge between

Data → AI service → Business potential

Integration into the organization

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Urbach et al. (2021)

Input: Data

Data forms the foundation of an AI service

Data availability and composition determines functionality of AI services and resulting business potentials

Typical steps

1. Identifying data sources
2. Evaluating data sources
3. Designing a data governance framework
4. Developing a data strategy

Input

Data
Which data do I need?

> **Uncontrolled data collection leads to high costs and neglect of strategically relevant data!**

Urbach et al. (2021)

AI-enabled service: Benefits

Which problem do I solve and how do I solve it?

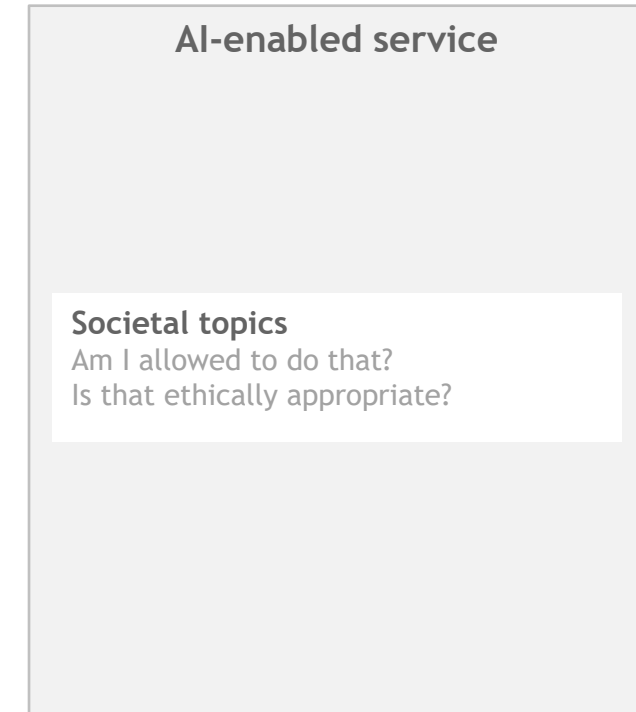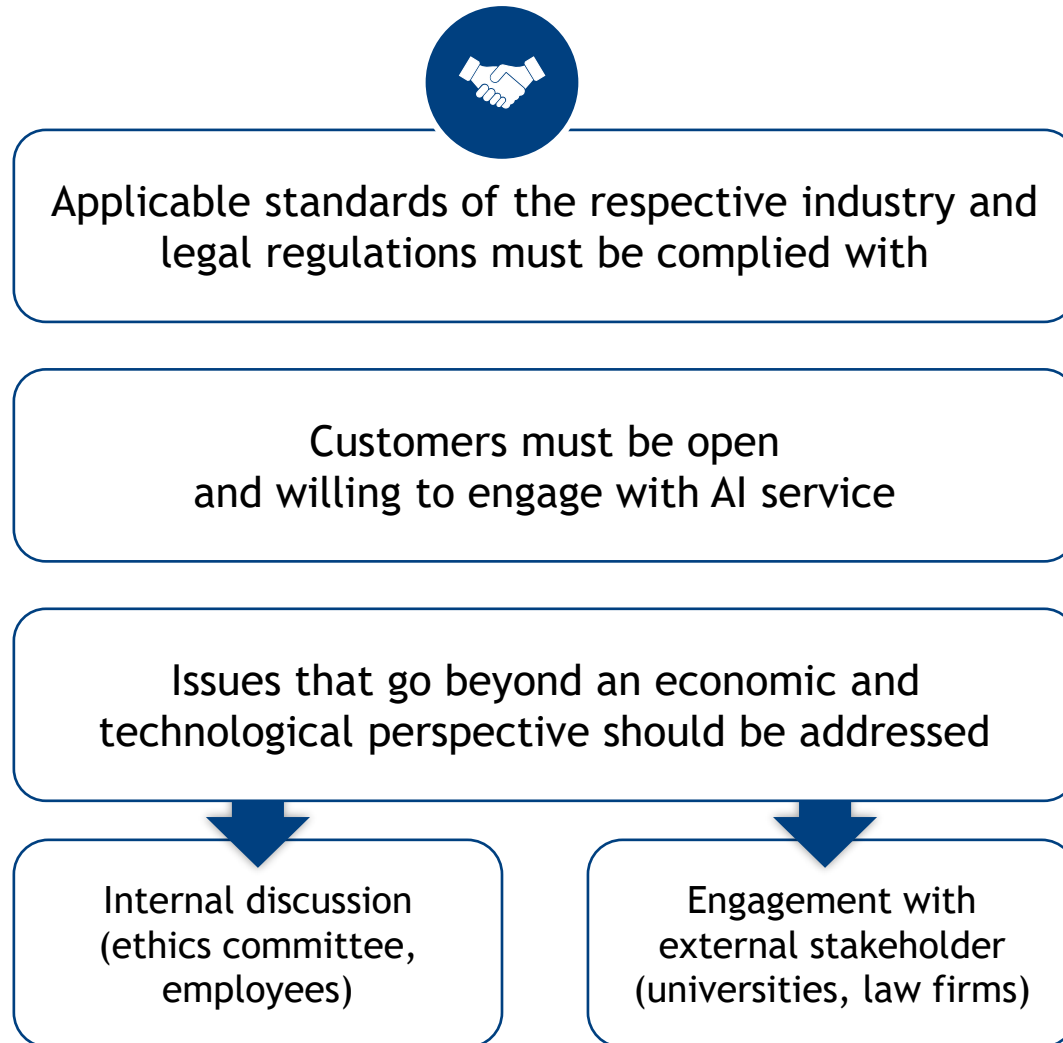Translation of technical functionalities into economic benefits in a success-critical manner

Use of a problem-solving matrix is encouraged

AI-enabled service

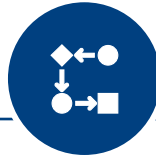**Benefits**
Which problem do I solve and how?

Urbach et al. (2021)

AI-enabled service: Societal topics

Applicable standards of the respective industry and legal regulations must be complied with

Customers must be open and willing to engage with AI service

Issues that go beyond an economic and technological perspective should be addressed

Internal discussion (ethics committee, employees)

Engagement with external stakeholder (universities, law firms)

AI-enabled service

Societal topics
Am I allowed to do that?
Is that ethically appropriate?

Urbach et al. (2021)
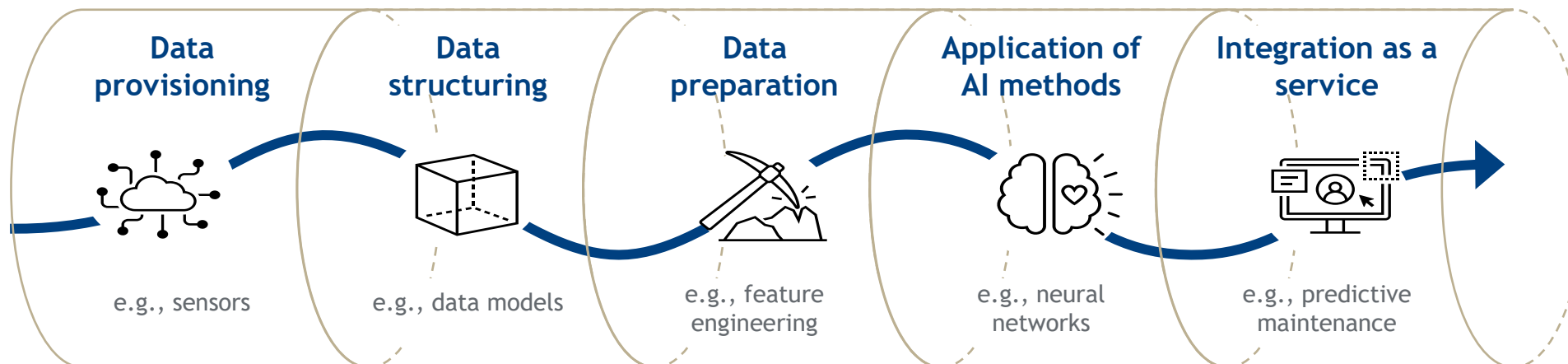
AI-enabled service: Pipeline

How do I integrate data and AI methods into an AI-based service?

Specifying the pipeline requires a consideration from conceptual, security-related, and economic perspectives
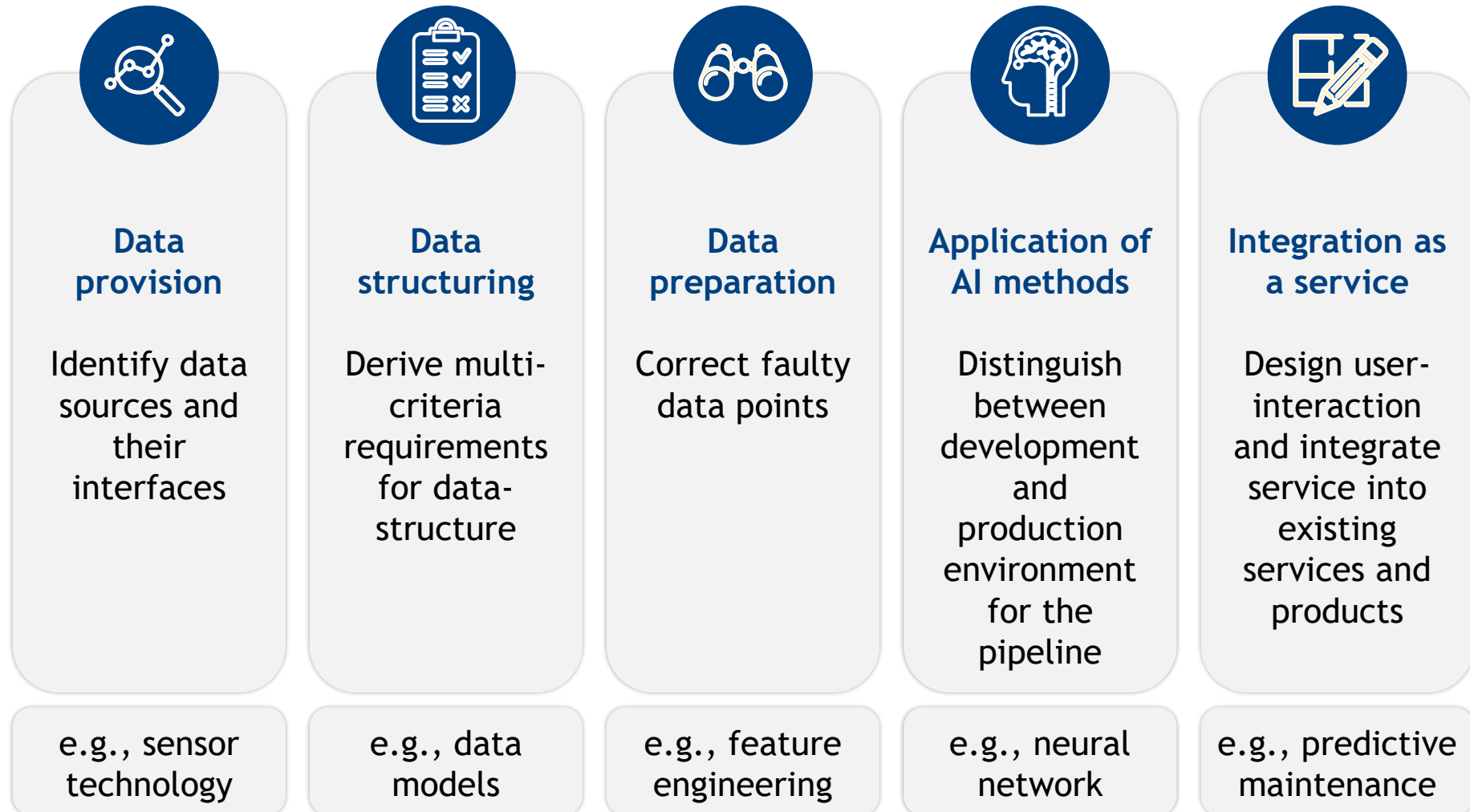
AI-enabled service

Pipeline
How to integrate data and AI methods to create an AI-based service?

Data provisioning	Data structuring	Data preparation	Application of AI methods	Integration as a service
e.g., sensors	e.g., data models	e.g., feature engineering	e.g., neural networks	e.g., predictive maintenance

Urbach et al. (2021)

AI-enabled service: Pipeline

Data provision	**Data structuring**	**Data preparation**	**Application of AI methods**	**Integration as a service**
Identify data sources and their interfaces	Derive multi-criteria requirements for data-structure	Correct faulty data points	Distinguish between development and production environment for the pipeline	Design user-interaction and integrate service into existing services and products
e.g., sensor technology	e.g., data models	e.g., feature engineering	e.g., neural network	e.g., predictive maintenance

Urbach et al. (2021)

Output: Business potential

Business potential is only generated through AI applications if the functionality is not decoupled from the competitive factors of a company

The output field considers the generation of business potential while taking the associated risks into account

Description of expected success

Output

Business potential
How and where does the business potential emerge?

Urbach et al. (2021)

Organizational integration

Successful AI integration is not only based on technical factors but also tailored to the specific characteristics of the company

Organizational readiness must be taken into account and readiness checks are recommended

AI-based services need to be specifically aligned with the organizational context

Integration into the organization

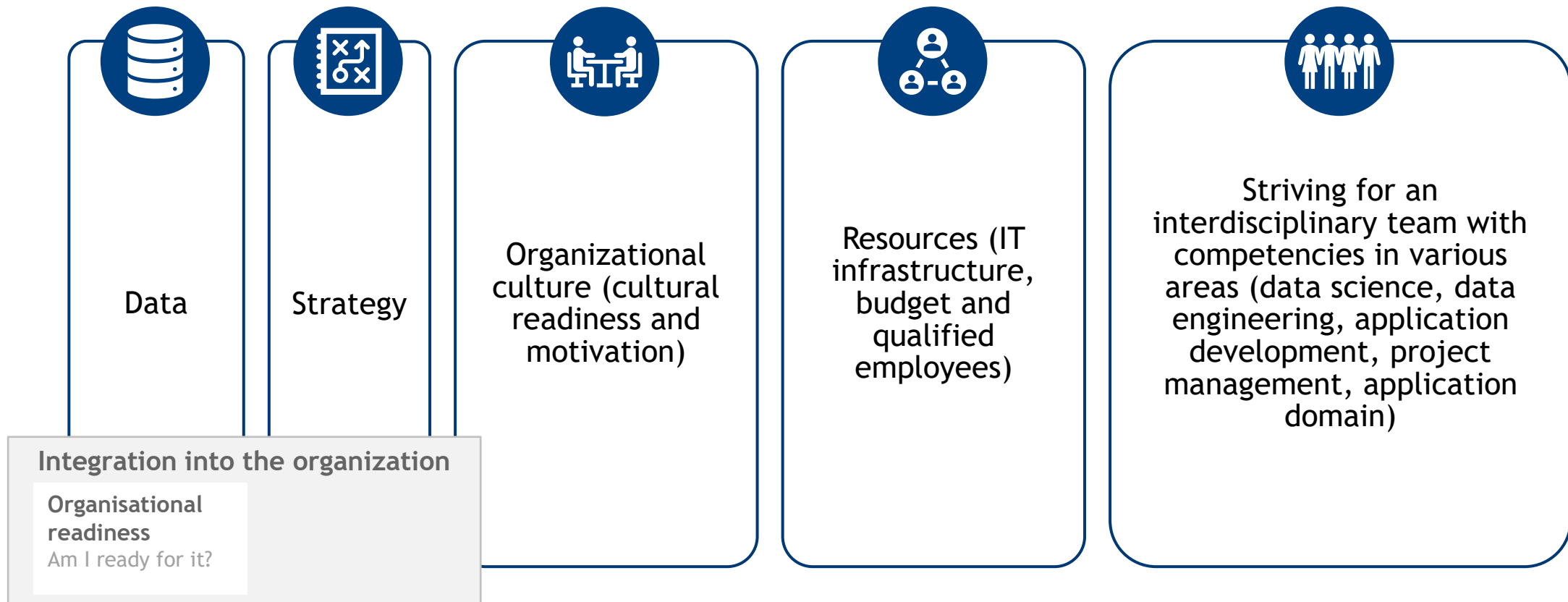**Organisational readiness**
Am I ready for it?

Business alignment
Does it fit my business?

AI-based services cannot simply be copied!

Organizational integration: Readiness

Assessment of the extent to which a company is ready to develop or integrate the AI-based service from an organizational perspective. **Readiness focuses on five areas:**

Data

Strategy

Organizational culture (cultural readiness and motivation)

Resources (IT infrastructure, budget and qualified employees)

Striving for an interdisciplinary team with competencies in various areas (data science, data engineering, application development, project management, application domain)

Integration into the organization

Organisational readiness
Am I ready for it?

Urbach et al. (2021)

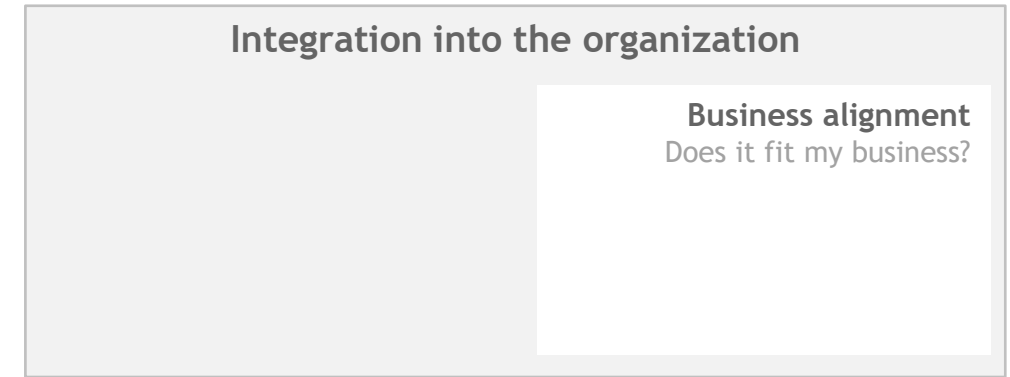# Organizational integration: Business alignment

Is the AI-based service aligned in terms of content and timing with the company's overall strategy or AI strategy?

Strategic fit

Assesses how well the infrastructure and processes can be integrated into the business or AI strategy
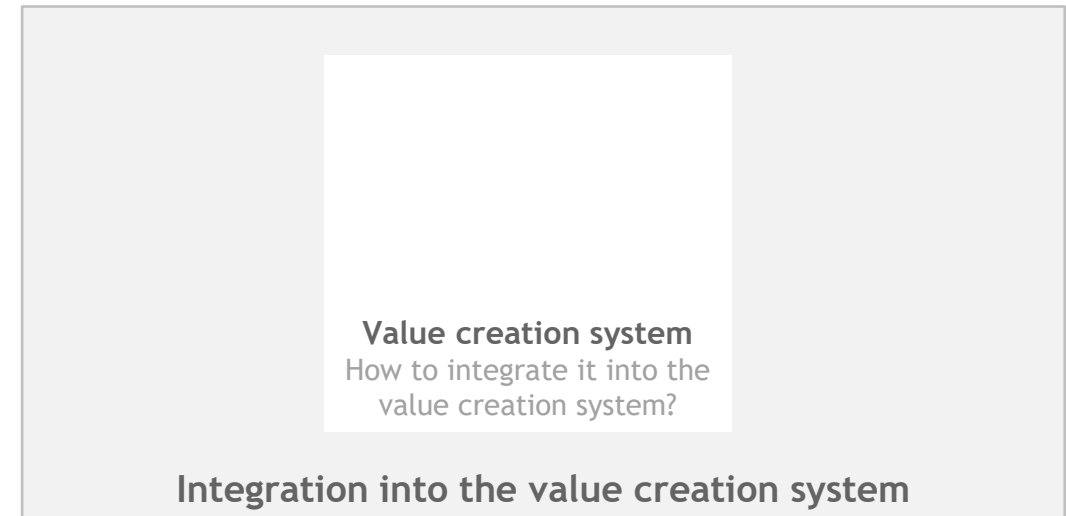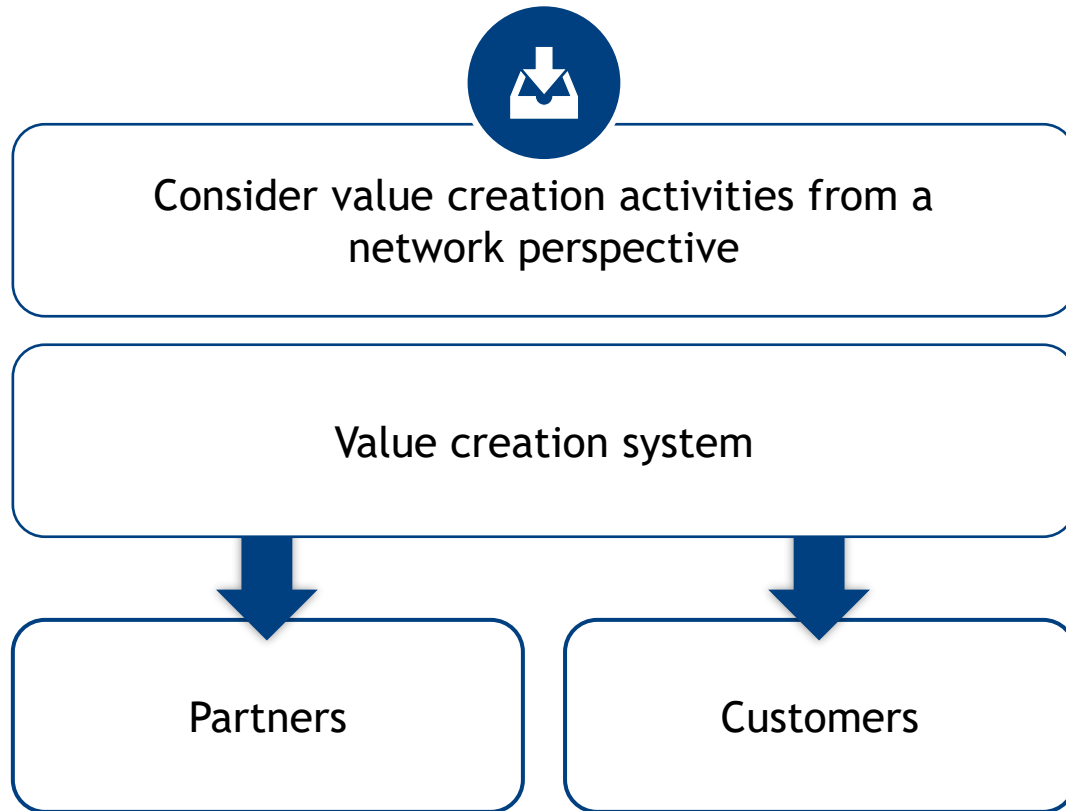
Functional integration

Describes the integration of the AI strategy into the business strategy

Integration into the organization

Business alignment
Does it fit my business?

Strategic fit

Business strategy	↔	AI strategy

Organizational infrastructure and processes	↔	AI-relevant infrastructure and processes

Functional integration

Urbach et al. (2021)

Integration into the value creation system

Consider value creation activities from a network perspective

Value creation system

Partners

Customers

Value creation system
How to integrate it into the value creation system?

Integration into the value creation system

Urbach et al. (2021)

Integration into the value creation system: Value creation system

Identify the specific points within the sociotechnical system where the technical capabilities can generate value and determine how the interfaces within this system should be designed

Reconfiguration of the value creation system may be necessary and beneficial

Value creation system
How to integrate it into the value creation system?

Integration into the value creation system

Adopt two-sided approach:

Gather the requirements of the value creation system for the AI-based service

Gather the requirements of the AI-based system for the value creation system
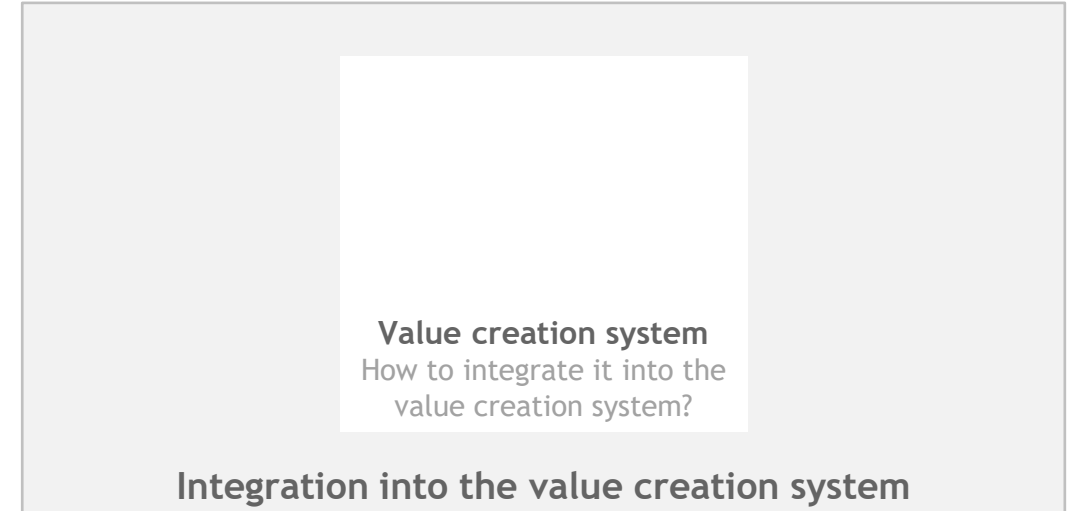
Achieve alignment:

Capture functional and non-functional customer requirements

Analyze the targeted and actual process

Integration into the value creation system: Partners

Find key partners

Engage with other departments and suppliers

Engage with AI platforms, companies, research institutions and start-ups

Identify the necessary resources, services and competencies in advance

Ensure that the problem is not outsourced as company-specific knowledge plays a crucial row

Partners
Who are my key partners?

Integration into the value creation system

Urbach et al. (2021)

# Integration into the value creation system: Customers

Customer-focused development helps prevent developing solutions that don't align with customer needs

Having a deep understanding of customers enables knowledge about the growth paths of AI services

Internal employees can also be considered as customers

Characterizing customers in the form of personas is recommended

Adopting a „jobs-to-be-done" mindset helps capture customers' tasks and goals

Customer
Who is my customer?

Integration into the value creation system
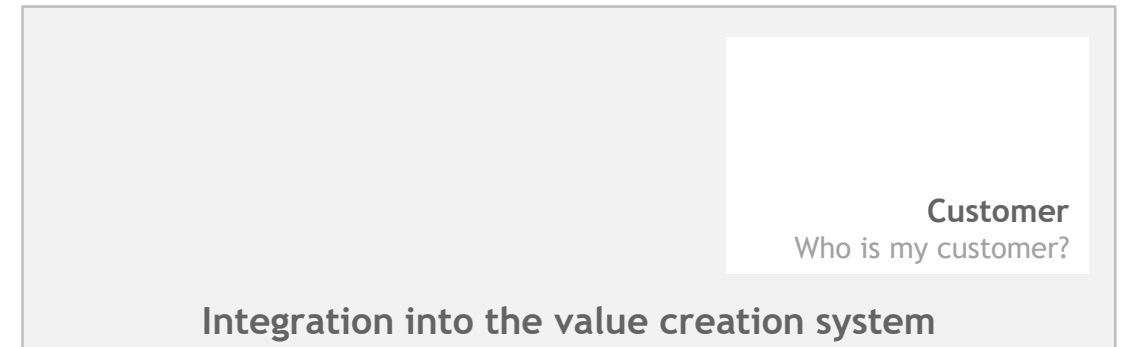
Urbach et al. (2021)

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Effect Path Method

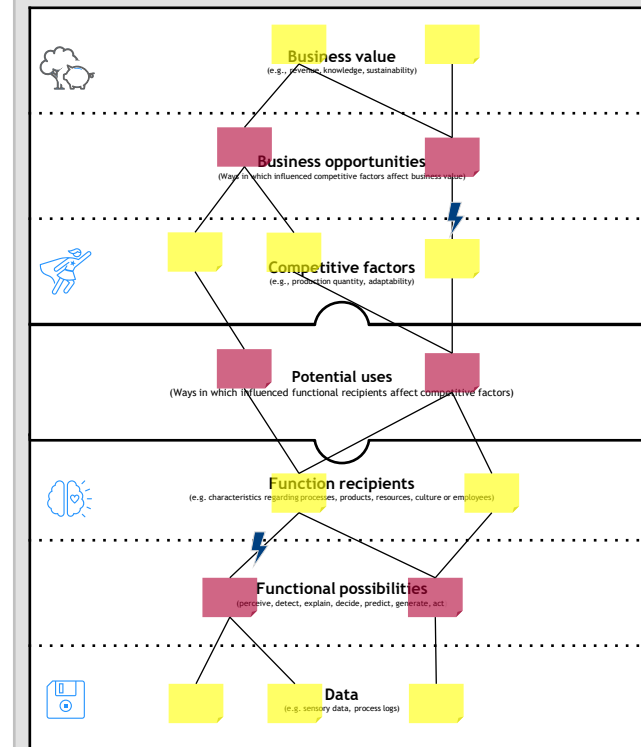A model for decoding the data-based creation of business value

Description and analysis of where AI applications in the company lead to business value and how
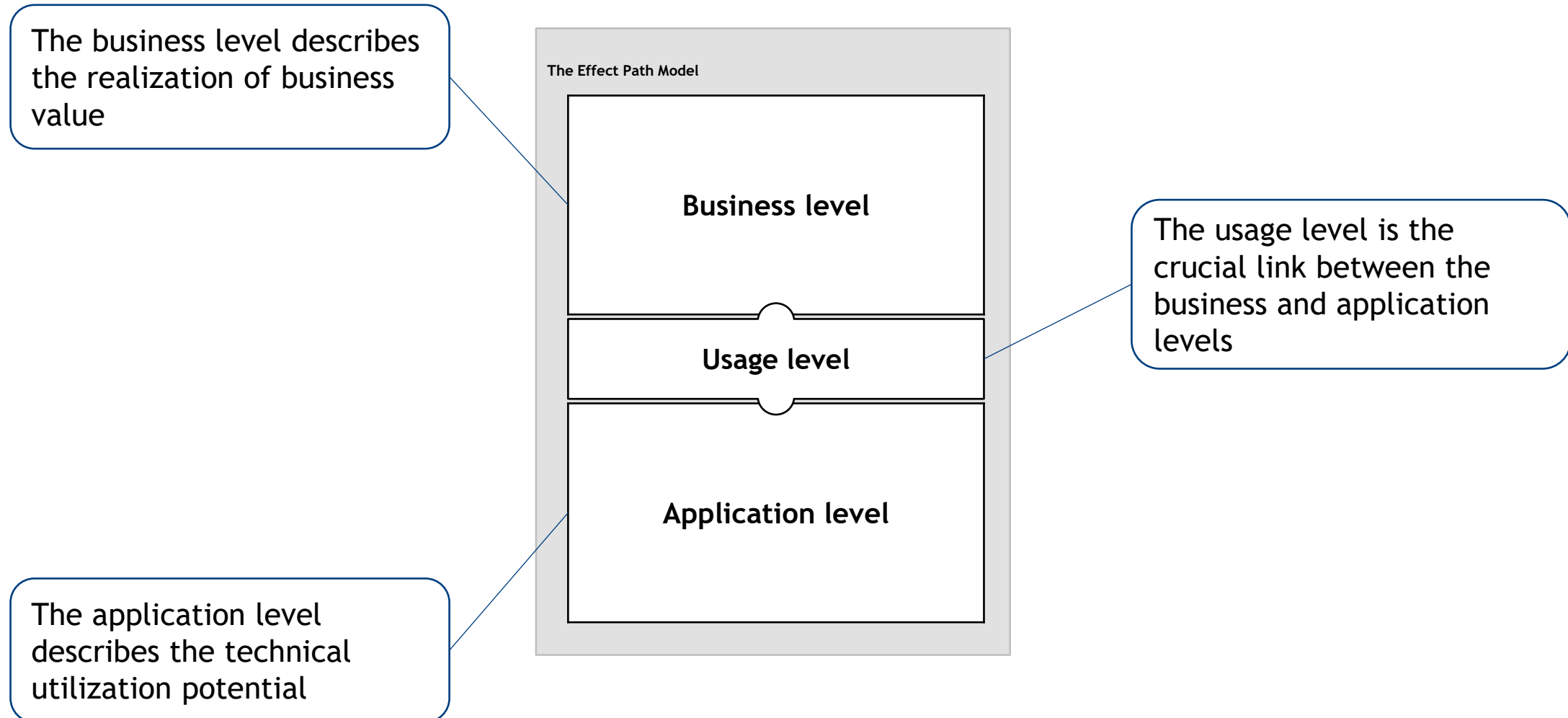
Identification and evaluation of relevant factors and their cause-effect relationship

The Effect Path Method

Business value
(e.g., revenue, knowledge, sustainability)

Business opportunities
(Ways in which influenced competitive factors affect business value)

Competitive factors
(e.g., production quantity, adaptability)

Potential uses
(Ways in which influenced functional recipients affect competitive factors)

Function recipients
(e.g. characteristics regarding processes, products, resources, culture or employees)

Functional possibilities
(perceive, detect, explain, decide, predict, generate, act)

Data
(e.g. sensory data, process logs)

Three levels: Application, Business and Usage Level

The business level describes the realization of business value

The usage level is the crucial link between the business and application levels

The application level describes the technical utilization potential

The Effect Path Model

Business level

Usage level

Application level

Core Idea:
Effect paths structure the creation of business value
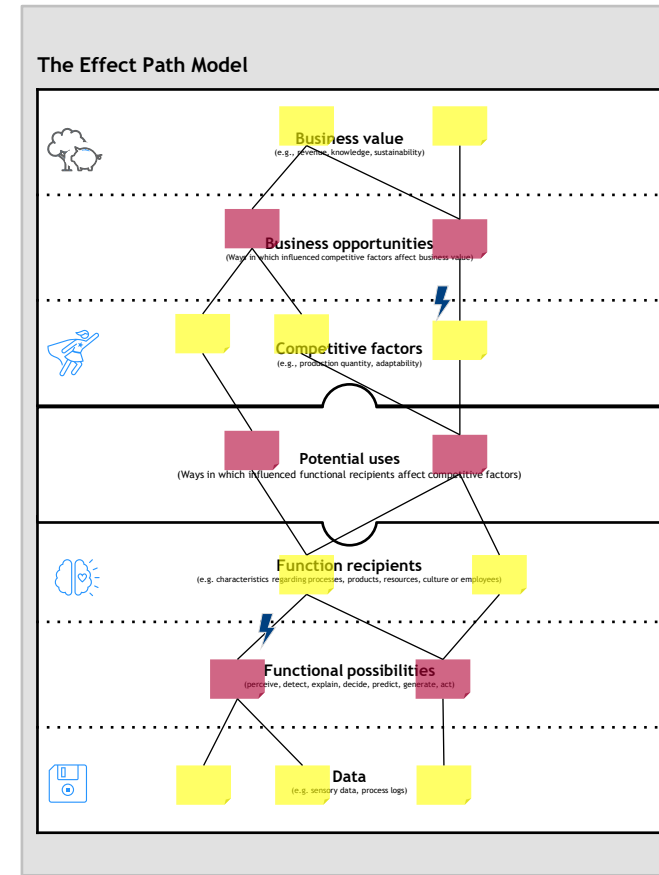
Effect paths follow the idea of stepwise decomposition of

| Effect sources and effect receiver | Possible actions |

Obstruction factors can complicate or end effect paths

The effect path network thus seamlessly describes the creation of business value from data to the actual business value

The Effect Path Model

- **Business value**
  (e.g., revenue, knowledge, sustainability)
- **Business opportunities**
  (Ways in which influenced competitive factors affect business value)
- **Competitive factors**
  (e.g., production quantity, adaptability)
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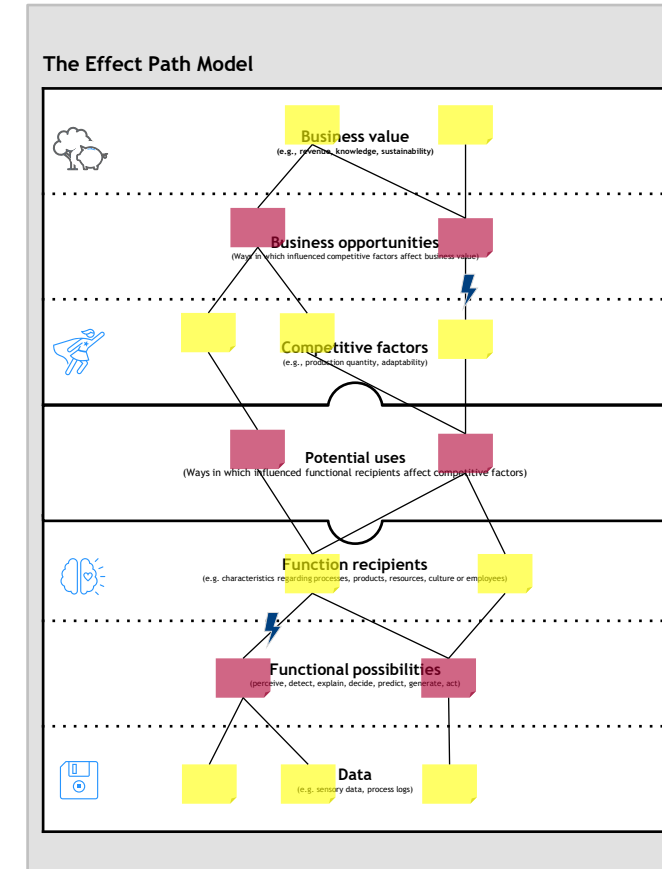
Application potential of the Effect Path Model

Describe, analyze and quantify the creation of business value and obstacles

Side effects:
- common language on all levels
- business-IT alignment
- uncovering new potentials
- …

The Effect Path Model

Business value
(e.g., revenue, knowledge, sustainability)

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The question whether to "Make or Buy?" can be evaluated according to techno-economic criteria
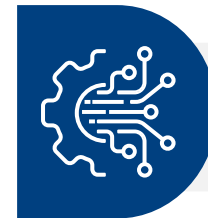
Techno-economic AI decisions

- Techno-economic decisions refer to decisions that take into account both technical and economical aspects.
- In the context of AI, techno-economic decisions refer to the trade-off between the technical possibilities and challenges of AI systems and the associated economic costs and benefits.

Decisions factors

Economic criteria

- Development and training costs
- Computational costs
- Maintenance and update costs

Technical criteria

- Model choice
- Architecture planning
- Integration into IT landscape
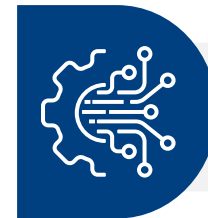
Silk et al. (2020), Chai Wang et al. (2022)

The question whether to "Make or Buy?" can be evaluated according to techno-economic criteria

Techno-economic AI decisions

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Decisions factors

Economic criteria

- Development and training costs
- Computational costs
- Maintenance and update costs

Technical criteria

- Model choice
- Architecture planning
- Integration into IT landscape

Silk et al. (2020), Chai Wang et al. (2022)

The process of developing a proprietary generative AI application exemplified by building an LLM

Make

Stage 1: Pretraining

1. Gather ~10TB of text
2. Get a cluster of ~6.000 GPUs
3. Compress the text into a neural network, pay ~$2M, wait ~12 days
4. Obtain base model

High quantity of data, low quality model

Stage 2: Finetuning

1. Write labeling instructions
2. Collect 100k high quality ideal Q&A responses
3. Finetune base model on this data, wait ~1 day
4. Obtain assistant model

Low quantity of data, high quality model

Stage 3: Add filters & controls

1. Develop and integrate filters that screen the model's outputs for undesirable content
2. Add mechanisms allowing to specify constraints in the model's outputs

Improved model behavior

Davis (2023), Karpathy (2023)

The process of developing a proprietary generative AI application exemplified by building an LLM

Buy   GPT-4

You can integrate commercial off-the-shelf AI services from AI service platforms.

Standard Chatbot for Personal Productivity

- AI Service: GPT-4 from OpenAI
- Input: $0.03 / 1K tokens | Output: $0.06 / 1K tokens
- Users: 100 employees
- Purpose:
  - 4 Ideations (Input: 100 tokens | Output: 500 tokens)
  - 2 Summarizations (Input: 2500 tokens | Output: 500 tokens)
  - 1 Proofreading (Input: 500 tokens | Output: 500 tokens)

Rule of thumb: 4 tokens = 3 words

Daily token consumption per user:
Input : 4 * 100 + 2 * 2500 + 1 * 500 = 5.900 tokens
Output: 4 * 500 + 2 * 500 + 1 * 500 = 3.500 tokens
Price/user: $0.03 * 5.9K token + $0.06 * 3.5K = $0,387

Total price per year:
100 employees * 250 d * $0,387 = **$9.675**

OpenAI (2024)

The process of developing a proprietary generative AI application exemplified by building an LLM

Buy | GPT-4o

You can integrate commercial off-the-shelf AI services from AI service platforms.

~~Stage 1: Pretraining~~
~~Stage 3: Add filters & controls~~

Standard Chatbot for Personal Productivity

- AI Service: GPT-4o from OpenAI
- Input: $0.005 / 1K tokens | Output: $0.015 / 1K tokens
- Users: 100 employees
- Purpose:
  - 4 Ideations (Input: 100 tokens | Output: 500 tokens)
  - 2 Summarizations (Input: 2500 tokens | Output: 500 tokens)
  - 1 Proofreading (Input: 500 tokens | Output: 500 tokens)

Rule of thumb: 4 tokens = 3 words

Daily token consumption per user:
Input : 4 * 100 + 2 * 2500 + 1 * 500 = 5.900 tokens
Output: 4 * 500 + 2 * 500 + 1 * 500 = 3.500 tokens
Price/user: $0.005 * 5.9K token + $0.015 * 3.5K = $0,082

Total price per year:
100 employees * 250 d * $ 0,082 = **$2.050**

OpenAI (2024)

The process of developing a proprietary generative AI application exemplified by building an LLM

Buy

GPT-4o with Batch API: Simultaneous processing of multiple requests, but can potentially result in longer response times as all requests in a batch must be processed before a response is returned

You can integrate commercial off-the-shelf AI services from AI service platforms.

Stage 1: Pretraining

1. Gather ~10TB of text
2. Get a cluster of ~6.000 GPUs
3. Compress the text into a neural network, pay ~$2M

Stage 3: Add filters & controls

1. Develop and integrate filters that screen the model's outputs for undesirable content
2. Add mechanisms allowing to

1. Write labeling instructions
2. Collect 100k high quality ideal Q&A responses

Standard Chatbot for Personal Productivity

- AI Service: GPT-4o from OpenAI
- Input: $0.0025 / 1K tokens | Output: $0.0075 / 1K tokens
- Users: 100 employees
- Purpose:
  - 4 Ideations (Input: 100 tokens | Output: 500 tokens)
  - 2 Summarizations (Input: 2500 tokens | Output: 500 tokens)
  - 1 Proofreading (Input: 500 tokens | Output: 500 tokens)

Rule of thumb: 4 tokens = 3 words

Daily token consumption per user:
Input : 4 * 100 + 2 * 2500 + 1 * 500 = 5.900 tokens
Output: 4 * 500 + 2 * 500 + 1 * 500 = 3.500 tokens
Price/user: $0.0025 * 5.9K token + $0.0075 * 3.5K = $0,041

Total price per year:
100 employees * 250 d * $ 0,041 = **$1.025**

OpenAI (2024)

The process of developing a proprietary generative AI application exemplified by building an LLM

Hybrid

You can also use foundational training and use a pretrained **open-source model.**

(e.g., LLaMA from Meta)

Stage 2: Finetuning

1. Write labeling instructions
2. Collect 100k high quality ideal Q&A responses
3. Finetune base model on this data, wait ~1 day
4. Obtain assistant model

Low quantity of data, high quality model

Stage 3: Add filters & controls

1. Develop and integrate filters that screen the model's outputs for undesirable content
2. Add mechanisms allowing to specify constraints in the model's outputs

Improved model behavior

OpenAI (2024)

The question whether to "Make or Buy?" can be evaluated according to techno-economic criteria
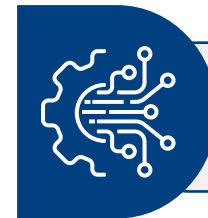
Techno-economic AI decisions

- Techno-economic decisions refer to decisions that take into account both technical and economical aspects.
- In the context of AI, techno-economic decisions refer to the trade-off between the technical possibilities and challenges of AI systems and the associated economic costs and benefits.
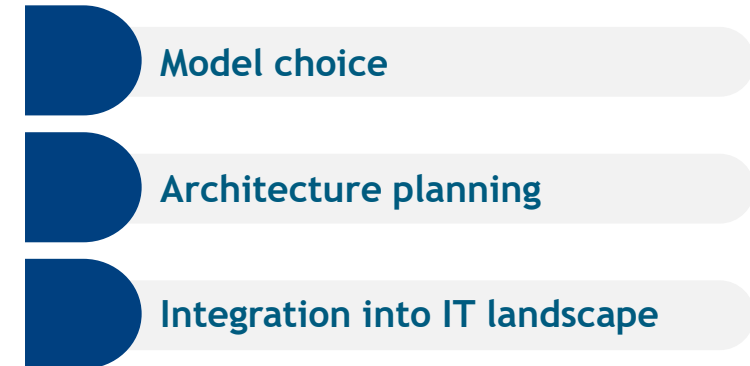
Decisions factors

Economic criteria

- Development and training costs
- Computational costs
- Maintenance and update costs

Technical criteria

- Model choice
- Architecture planning
- Integration into IT landscape

Silk et al. (2020), Chai Wang et al. (2022)

Technical evaluation criteria for LLMs

1/ **Model size**
The performance, accuracy, resource requirements and adaptability depend on the model size.

2/ **Training language**
Language-specific competence, contextual understanding, application relevance and error reduction can be influenced by the language of the training course.
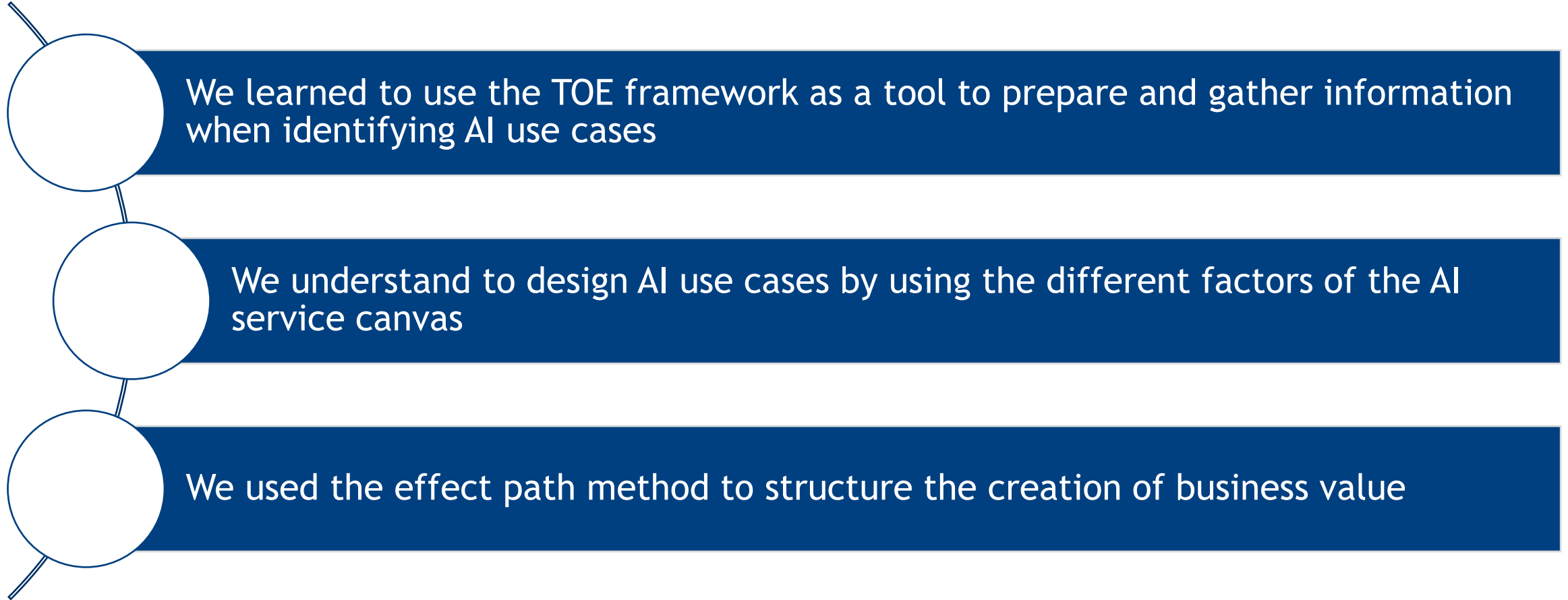
3/ **Data security**
Confidentiality, compliance, data protection and security protection are decisive aspects of the data security criterion.

4/ **Inference**
The inference of a model influences real-time processing, user experience, and scalability.

5/ **Context window**
Information retention, complex tasks, accuracy and application diversity are influenced by the size of the context window.

A detailed evaluation of the GenAI model is an important role for critical applications.

User rankings can also be used for less critical applications: https://chat.lmsys.org/?leaderboard

Industry interviews (2024)

Today's lecture at a glance

We learned to use the TOE framework as a tool to prepare and gather information when identifying AI use cases

We understand to design AI use cases by using the different factors of the AI service canvas

We used the effect path method to structure the creation of business value
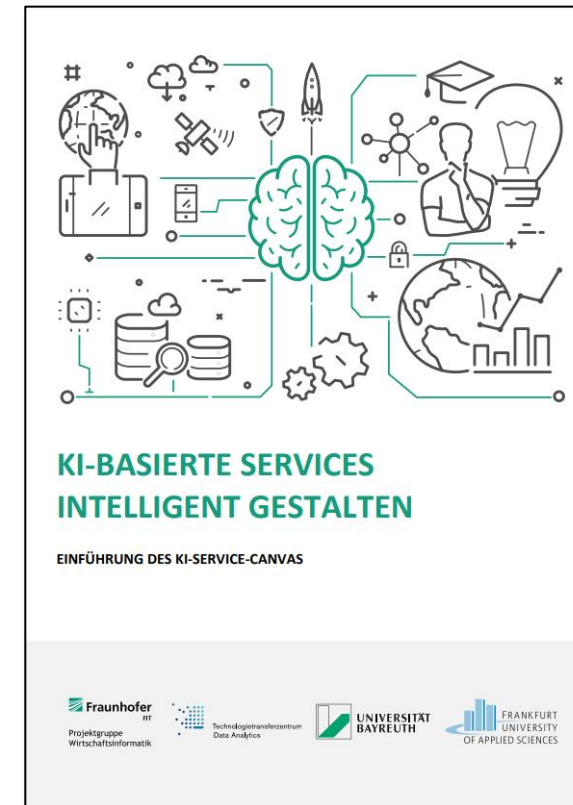
Recommended Readings

AI Use Case Identification

AI Service Canvas

Questions, comments, observations

Scientific references

- Hofmann, P., Jöhnk, J., Protschky, D., Stähle, P., Urbach, N., & Buck, C. (2020). KI-Anwendungsfälle zielgerichtet identifizieren. Wirtschaftsinformatik & Management, 12, 184-193.

- Urbach, N., Häckel, B., Hofmann, P., Fabri, L., Ifland, S., Karnebogen, P., Krause, S., Lämmermann, L., Protschky, D., Markgraf, M. und Willburger, L. (2021) KI-basierte Services intelligent gestalten – Einführung des KI-Service-Canvas. Projektgruppe Wirtschaftsinformatik des Fraunhofer-Instituts für Angewandte Informationstechnik FIT, Hochschule Augsburg, Universität Bayreuth, Frankfurt University of Applied Sciences, Bayreuth, Augsburg und Frankfurt