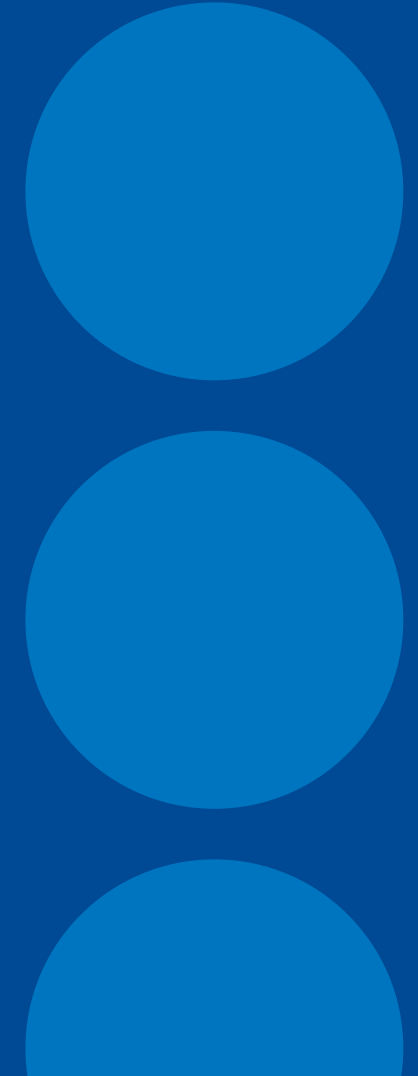# AI for supporting the examination of machines

ISSA Section Machine and System Safety

online seminar

Dr. Oliver Schmitt, April 29th, 2024

Your presenter today

- Research Assistant, Prevention Department BGN:

    - Section Machine and System Safety

    - Testing and certification body for food and packaging machinery (DGUV-Test)

    - Focal points: packaging machinery, EMF, opt. radiation, robots/cobots, AI, …

- Member of DGUV's specialist fields:

    - Packaging

    - Non-Ionising Radiation

Activities in the field of Prevention

- Testing and Certification of Machines

- EU-standardisation CEN/TC 146, CEN/TC 153

- Technical Advice for BGN inspectors

- Support for member companies

- Creation of DGUV publications

- Supervision of Seminars on Machine Safety

What terms come to your mind when you think of safe machines?

100 years Testing and Certification

Eckdaten DGUV Test

- 1921 foundation of Working Group for Accident Prevention.

- Today 13 DGUV Test testing and certification bodies all over Germany

- About 250 employees

- Proven competence through accreditation and notification

- About 3.000 - 4.000 certificates per year

- DGUV Test Food- and Packaging:

    ~25 employees
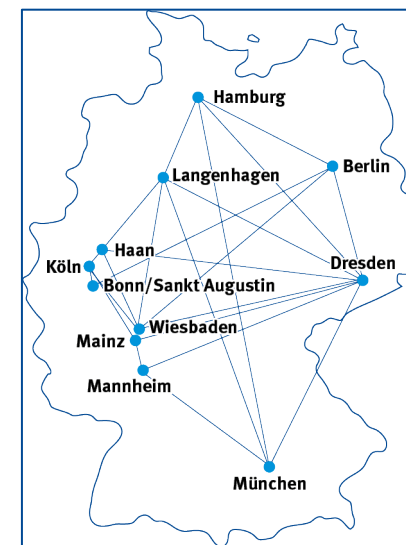
Fotos: Oliver Rüther/BGN, Gorodenkoff – stock.adobe.com, Production Perig - Perig Morisse, Kzenon – stock.adobe.com

Prevention Service Testing and Certification
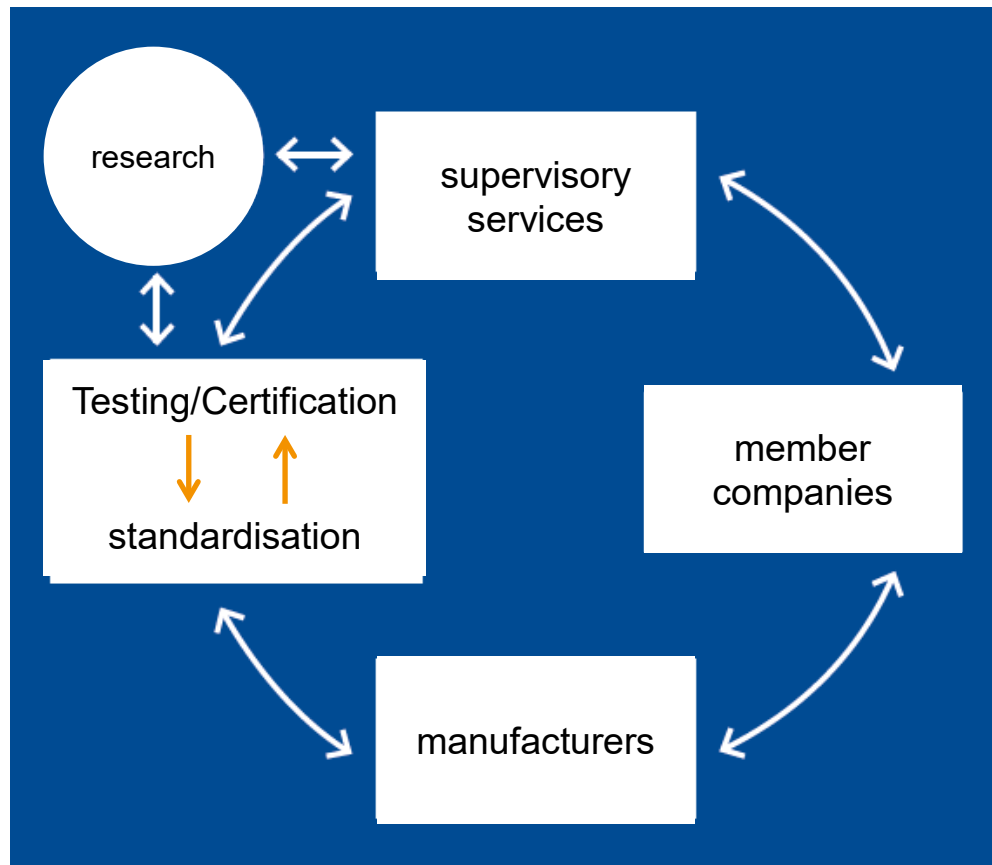
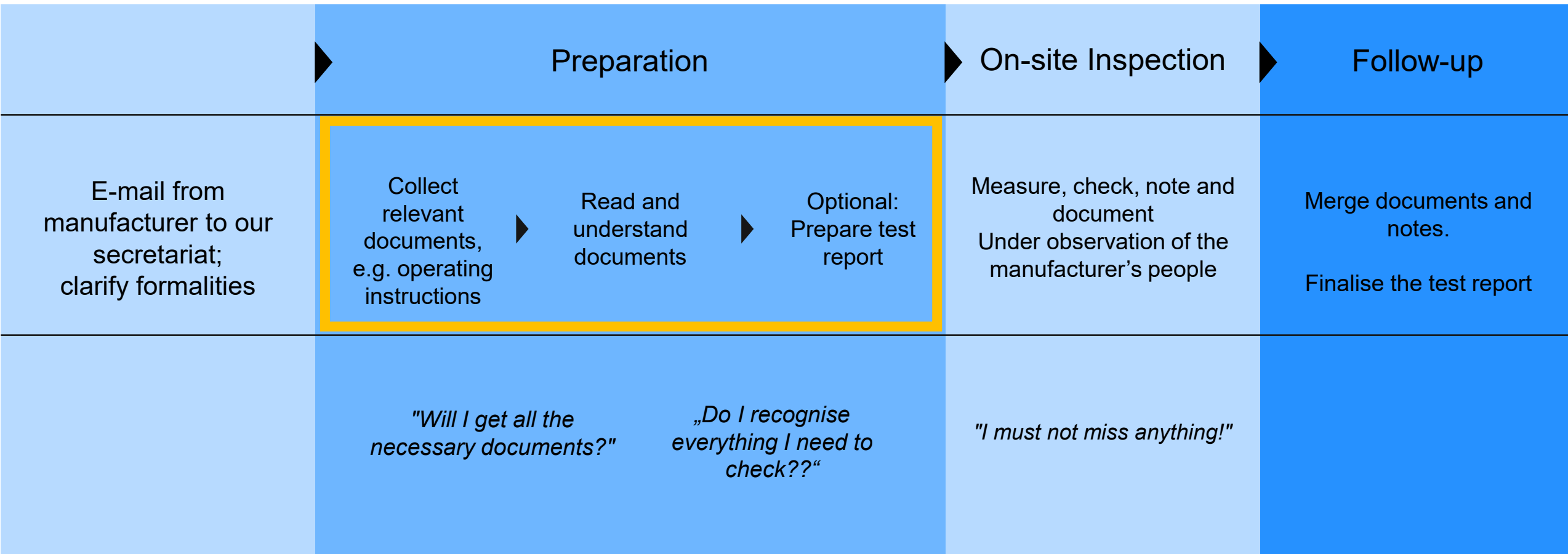**DGUV Test as a competence network for product safety**

- Expertise from testing activities

- Feedback to the manufacturer

- Exchange with standardization EN/ISO…

- Exchange with research

- Exchange with supervisory services

Focus: Safety of Food- and Packaging Machinery

Testing of Complex Machinery

BGN

Actual situation of a Test Procedure (Type Examination)

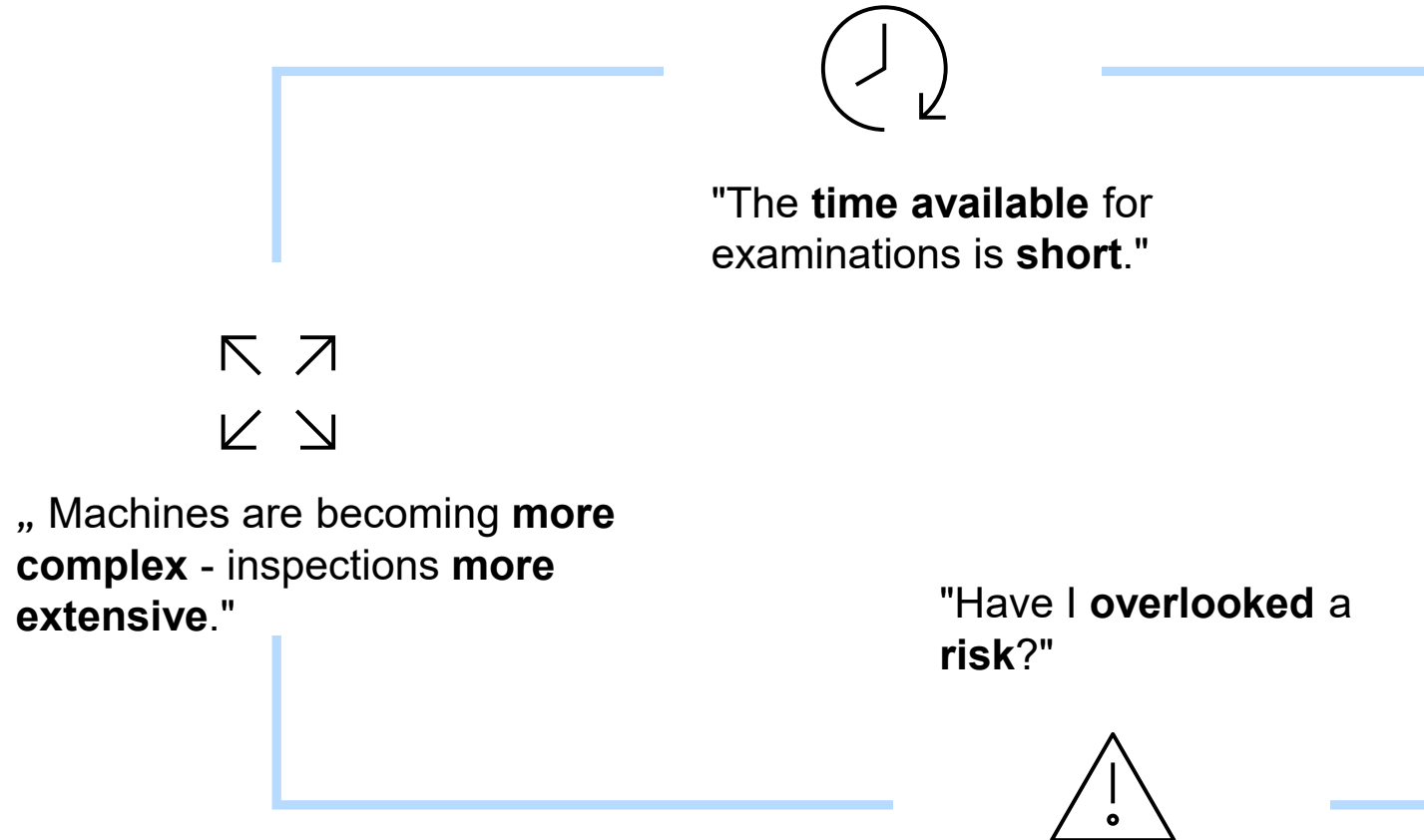|	Preparation			On-site Inspection	Follow-up
E-mail from manufacturer to our secretariat; clarify formalities	Collect relevant documents, e.g. operating instructions	Read and understand documents	Optional: Prepare test report	Measure, check, note and document Under observation of the manufacturer's people	Merge documents and notes. Finalise the test report
	"Will I get all the necessary documents?"	„Do I recognise everything I need to check??"		"I must not miss anything!"	

The Test Report as a central document in the Testing Process

Risks that (could) occur with the machine to be tested

Risk reduction measures that are/could be implemented for the machine under test

Risk / Requirement	Risk reduction measures	yes	No
Type plate	The machine has a type plate with the required information in German. The designation of the machine is indicated on the type plate: Filling machine The full address of the manufacturer is given.	X	
Sharp edges	Are not present.	X	
Stability	The machine is stable. It is mounted on height-adjustable feet.	X	

The header "Requirement fulfilled?" spans the "yes" and "No" columns.

Increasing Pressure on Inspectors

"The **time available** for examinations is **short**."

„ Machines are becoming **more complex** - inspections **more extensive**."

"Have I **overlooked** a **risk**?"

Vater Smart Hackathon 2022

... compete against each other with digitalisation projects

... **operating instructions** for risks specified by the

... on in the test report:

... lan (Red kite)

... Intelligent Risk Identification Service)

Project phase of IRIS

Discovery phase	Project phase Remote — 22.08. bis 27.09.2022			Vater Smart Hackathon Berlin — September 28 – 30 2022
Framing, Discovery, Solve				
Kickoff				
	Scoping			
	development phase with weekly iterations			
				Finalisierung und Präsentation
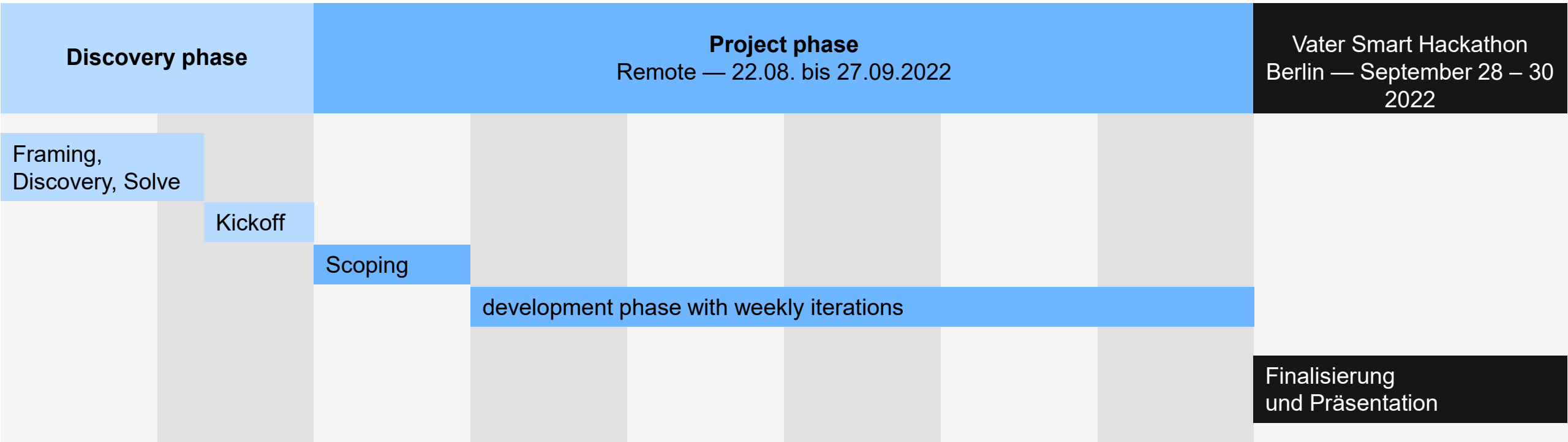
- Identification of the challenges
- Concretisation

- Definition of the scope
- Clarification of architecture
- Organisational setting

– **MVP** (Minimum Viable Product) Build
– Weekly iteration (planning, daily, retrospective)

– finalising MVP
– presentation

Cooperation of different specialist disciplines

DGUV Test
Prüf- und Zertifizierungssystem der
Deutschen Gesetzlichen Unfallversicherung

BGN

BGN

Klaus-Dieter Pohl

BGN

Oliver Schmitt

IBM

Data Scientist Consultant

Technology Engineer

Senior Managing Consultant

Source: Pixabay

Technical Specialist – Data & AI

Manager IBM Client Engineering Public

Designer

Data Scientist

Business Technology Leader

Components of the MVP: Structure recognition, risk extraction and classifications

The MVP consists of:

- Frontend/Backend

- Databases

- Watson AI Services-

  - Smart Document Understanding

  - Named Entity Recognition

  - Classification algorithm

IRIS: Willkommen Oliver

○ Quellen auswählen   ○ Vorlage überprüfen   ○ Vorlage exportieren

Um eine automatisch vorausgefüllte Prüfberichtsvorlage generieren zu lassen, wähle zunächst den gewünschten Hersteller,nachfolgend die gewünschte Auftragsnummer sowie die zu durchsuchenden Dokumente aus. Oder wähle ein eigenes Dokument aus und lade es hoch.
Dokument hochladen

Hersteller   Auftragsnummer
Hersteller XYZ   ∨   Auftragsnummer 123   ∨

Art der Prüfung
◉ Wiederholungsprüfung   ○ Prüfung einer neuen Maschine

Quelldokumente für Analyse
☑ Prüfberichtsvorlage   ☐ Ähnliche Prüfberichte (5)
                               ☐ Alle Prüfberichte

Zurück   Vorlage generieren

Components of the MVP:
Structure recognition,
risk extraction and classifications
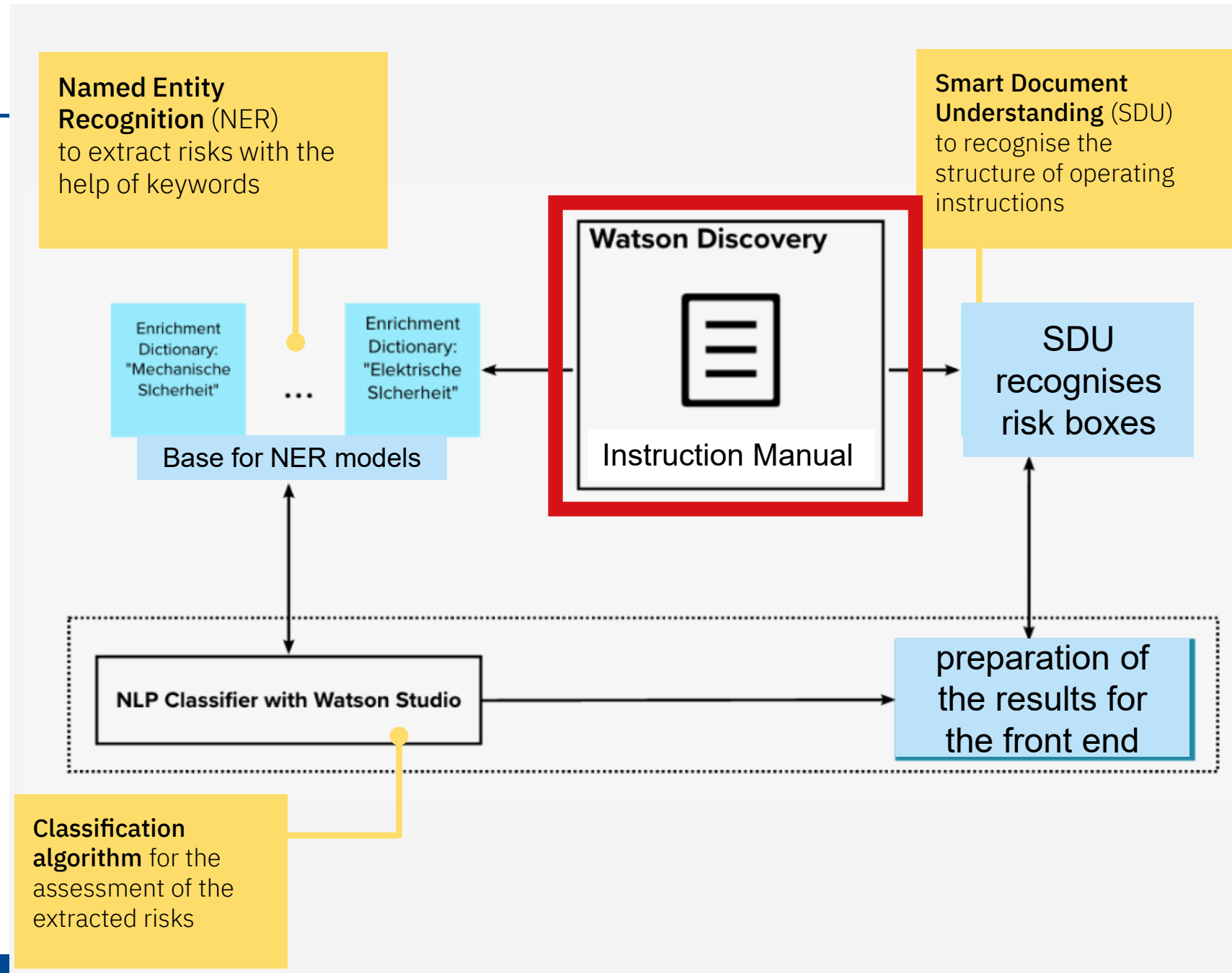
The MVP consists of:

Watson AI Services

- **Smart Document Understanding (SDU):** Recognising the structure of operating instructions

- **Named Entity Recognition (NER):** Extraction of risks with the help of keywords

- **Classification Algorithm:** Evaluation of the extracted risks

AI Services

Technologies of NLP

Named Entity Recognition (NER) to extract risks with the help of keywords

Smart Document Understanding (SDU) to recognise the structure of operating instructions

Enrichment Dictionary: "Mechanische SIcherheit"

...

Enrichment Dictionary: "Elektrische SIcherheit"

Base for NER models

Watson Discovery

Instruction Manual

SDU recognises risk boxes

NLP Classifier with Watson Studio

preparation of the results for the front end

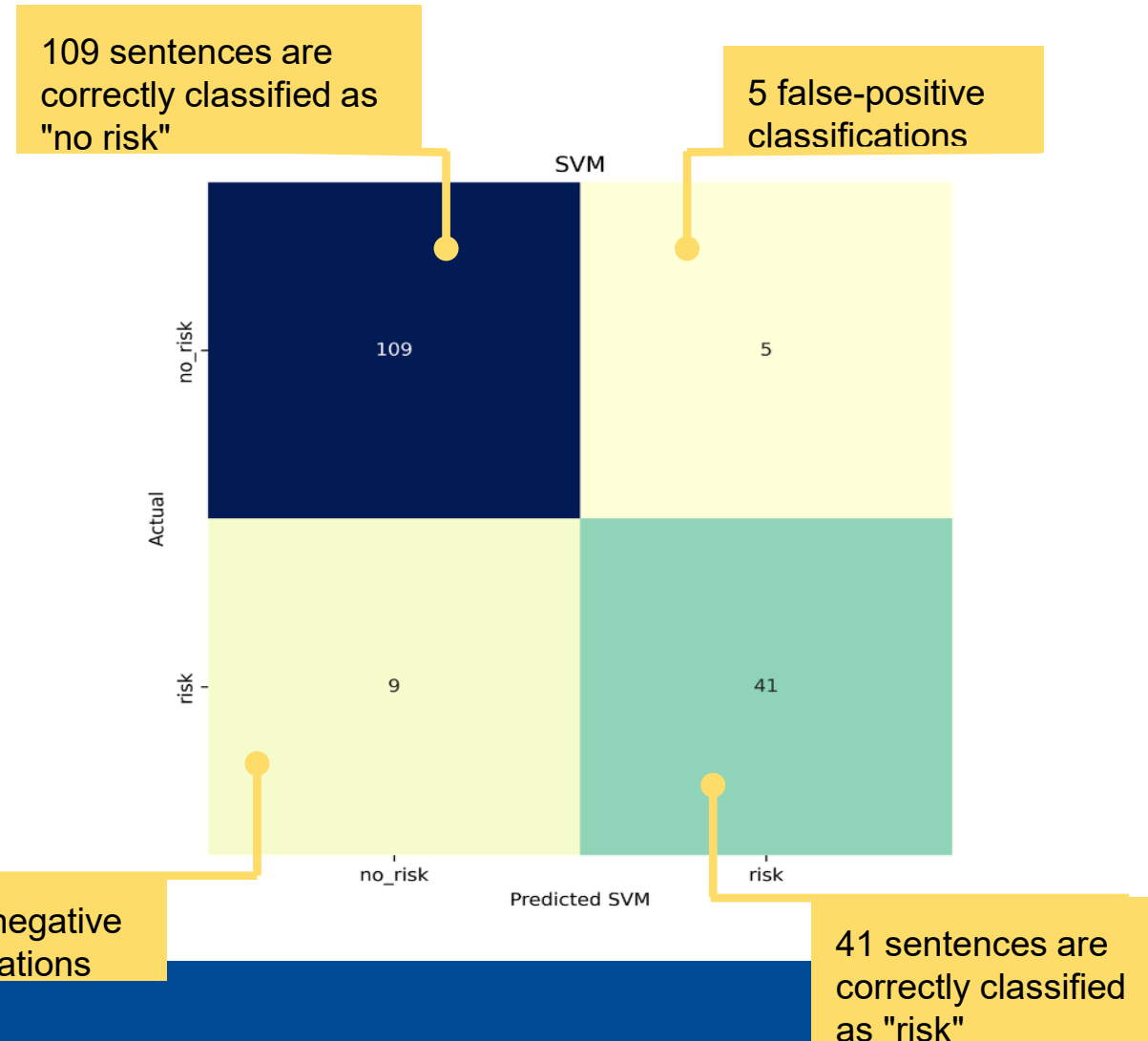**Classification algorithm** for the assessment of the extracted risks

Classification algorithm

results

Utilisation of *support vector machines (SVM)*

- Training data was **extracted** from the **operating instructions** on the basis of **keywords** found (e.g. danger, laser, knife, ...) **and labelled manually** ("risk" or "no risk").

- The sentences obtained in this way are transformed into a **high-dimensional vector space** for mathematical processing (so-called *embeddings*). This is done using a **pre-trained model**.

- The semantic similarity of two sentences correlates with the relative position of the corresponding *embeddings* in the vector space. This enables **classification using *supervised learning***.

- The SVM algorithm was trained with the *embeddings* and the respective labels.

- In this way, locations of the NER can be evaluated and prioritized.

=> Text Classification Trained by Humans

109 sentences are correctly classified as "no risk"

5 false-positive classifications

9 false-negative classifications

41 sentences are correctly classified as "risk"

SVM

	no_risk	risk
no_risk	109	5
risk	9	41

Actual

Predicted SVM

Named Entity Recognition (NER) + classification

Mechanical risks

Electrical risks

- Video

Outlook 1 2023: Prepopulation of risk reduction measures

Risk / requirement	Risk reduction measures	Requirement fulfilled?	
		yes	no
Type plate	The machine has a type plate with the required information in German. The designation of the machine is indicated on the type plate: Filling machine The full address of the manufacturer is given.	X	
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❖ Identify measures in operating instructions by
- Technical keywords (from synonym list, e.g. knife) **and**
- Formulation (learnt) for measure

❖ Allocate list "**Risk reduction measures**" to list "**Risk / Requirement**"

Necessary :

Training to recognise the formulation of measures

Outlook 2 2023: Expanding the information base

IRIS: Welcome Oliver

◐ Quellen auswählen   ○ Vorlage überprüfen   ○ Vorlage exportieren

Um eine automatisch vorausgefüllte Prüfberichtsvorlage generieren zu lassen, wähle zunächst den gewünschten Hersteller,nachfolgend die gewünschte Auftragsnummer sowie die zu durchsuchenden Dokumente aus. Oder wähle ein eigenes Dokument aus und lade es hoch.
Dokument hochladen

manufacturer
Hersteller XYZ ▾

order number
Auftragsnummer 123 ▾

Source documents
☑ Prüfberichtsvorlage
☑ **previous reports**

Weitere Dokumente
☑ operating instructions   ☑ ISO /EN
                                    ☑ **Accident statistics**

Zurück   Vorlage generieren

Include risk assessments from test reports of similar machines

Include accident statistics in the risk extraction

2023? Current Status

- IRIS has not yet found its way into our day-to-day business
- Questions to be answered:
  - "Do these services offer us added value? -Are the (high) costs worth it?"
  - "How will the employees deal with it?"
  - "How do we know if the tool provides good answers?"
  - "How do we evaluate how it's doing?"
  - "Is AI the right answer?"

Outlook 2024

- Searching for partners

- Fast progress in ready-to-use AI tools

- Use free open-source software?

- Adapt LLM-models for automatic text creation

- Consider high data protection requirements

Conclusion

- Safe machines, inspected by an external body, are an important pillar of primary prevention

- Inspections include documentation and are becoming increasingly complex

- IRIS uses modern artificial intelligence methods to support the analysis of operating instructions

- Training by experts is essential

- Advantages: Automation, Time savings, Error prevention, Expandability

- IRIS has not yet found its way into our day-to-day business