

# AI in manufacturing: trends and maturity model

→ 23 September 2024

# AI in manufacturing: trends and maturity model

→ Agenda

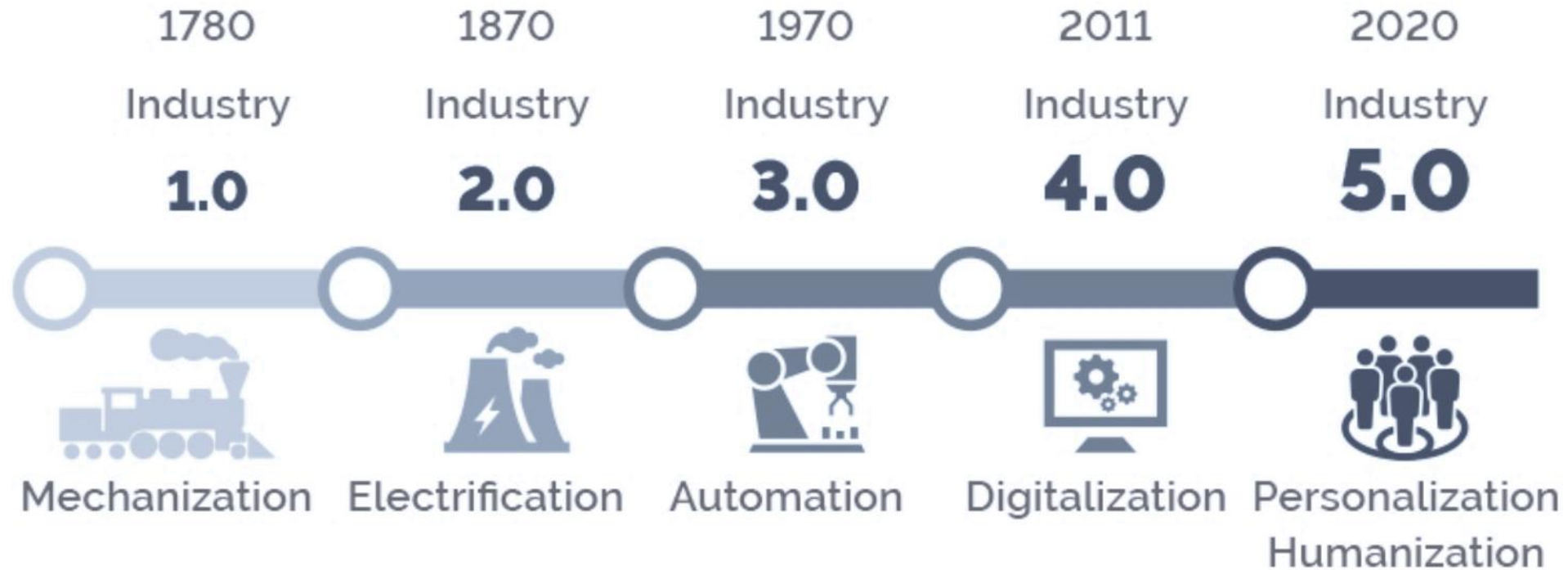
1 AI in manufacturing: an overview

2 An AI maturity model

3 Q&A

# The industrial revolution

→ Towards Industry 5.0



# AI in manufacturing

→ At the core of the transformation

## Main logic:

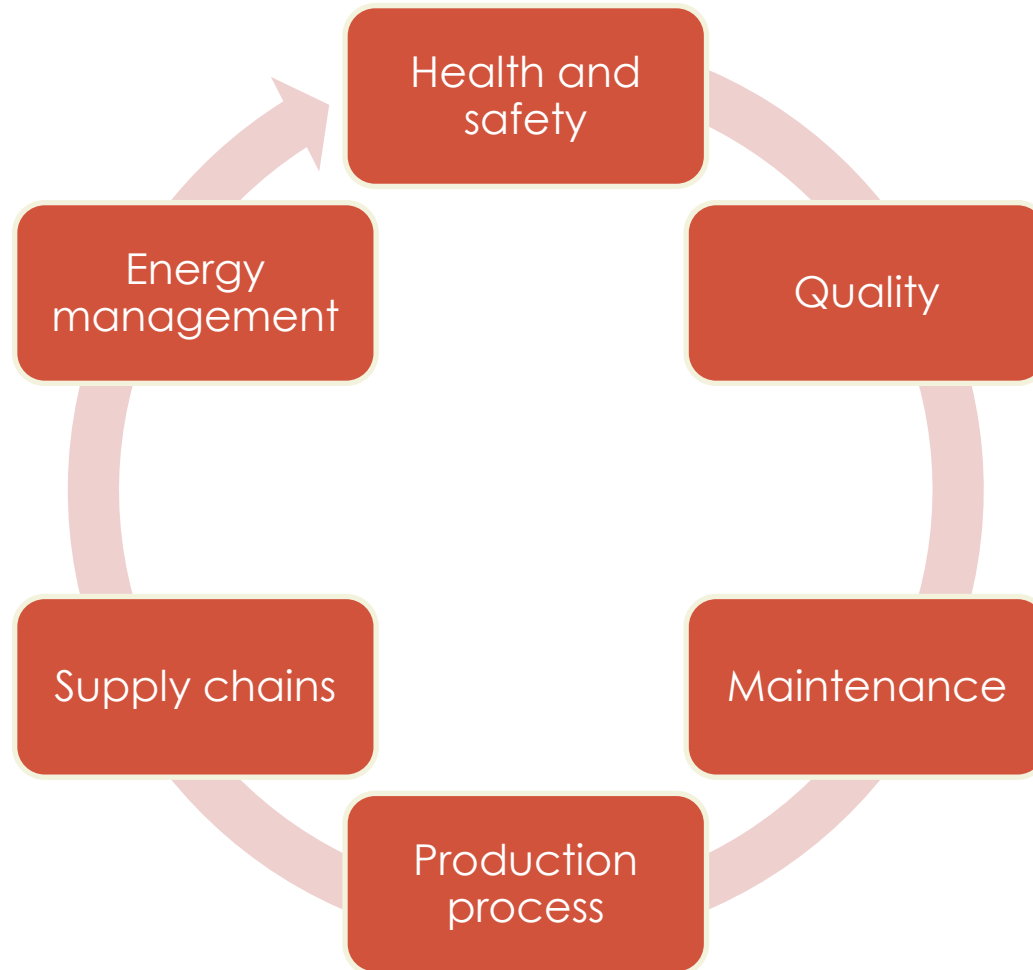
AI allows the conversion of large amounts of data into **actionable insights** and **predictions** that can provide impetus to **data-driven process**

## AI augments tasks such as

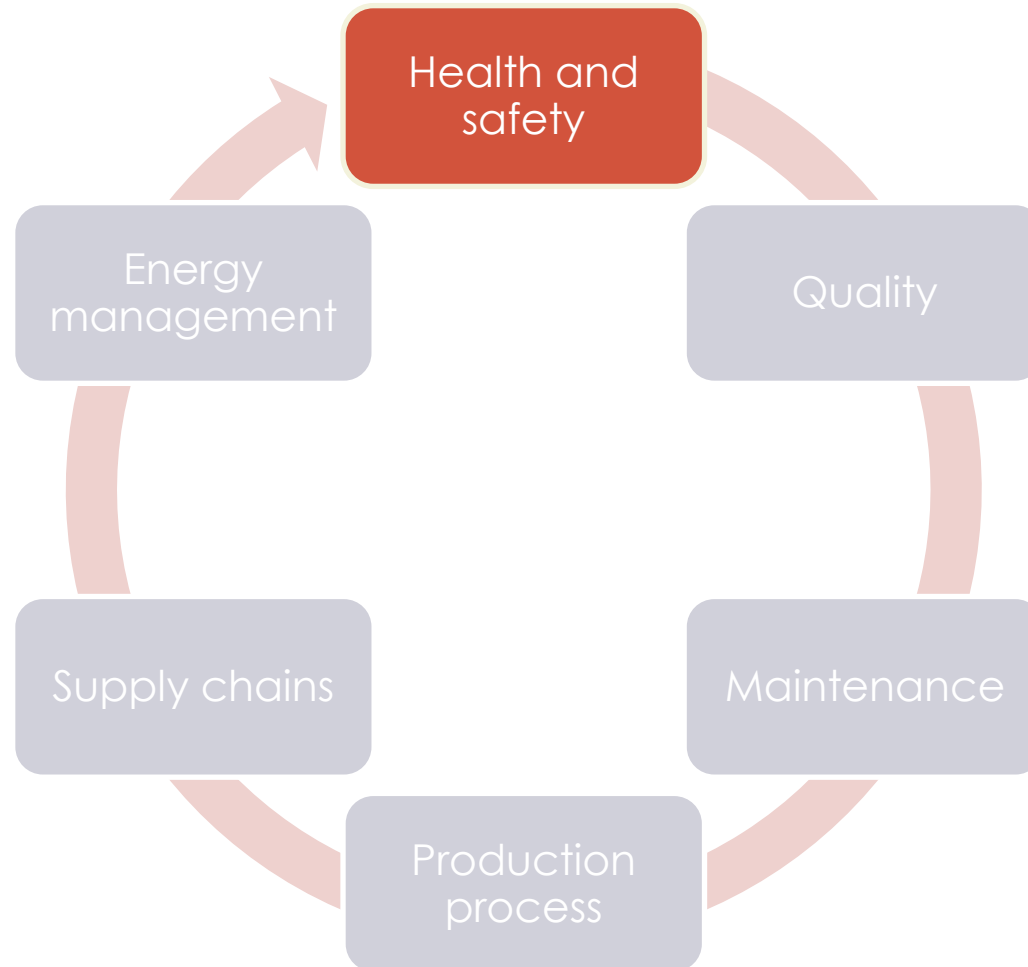
- Classification
- Continuous estimation
- Clustering
- Optimization
- Anomaly detection
- Rankings
- Recommendations and data generation



# Main use cases in manufacturing

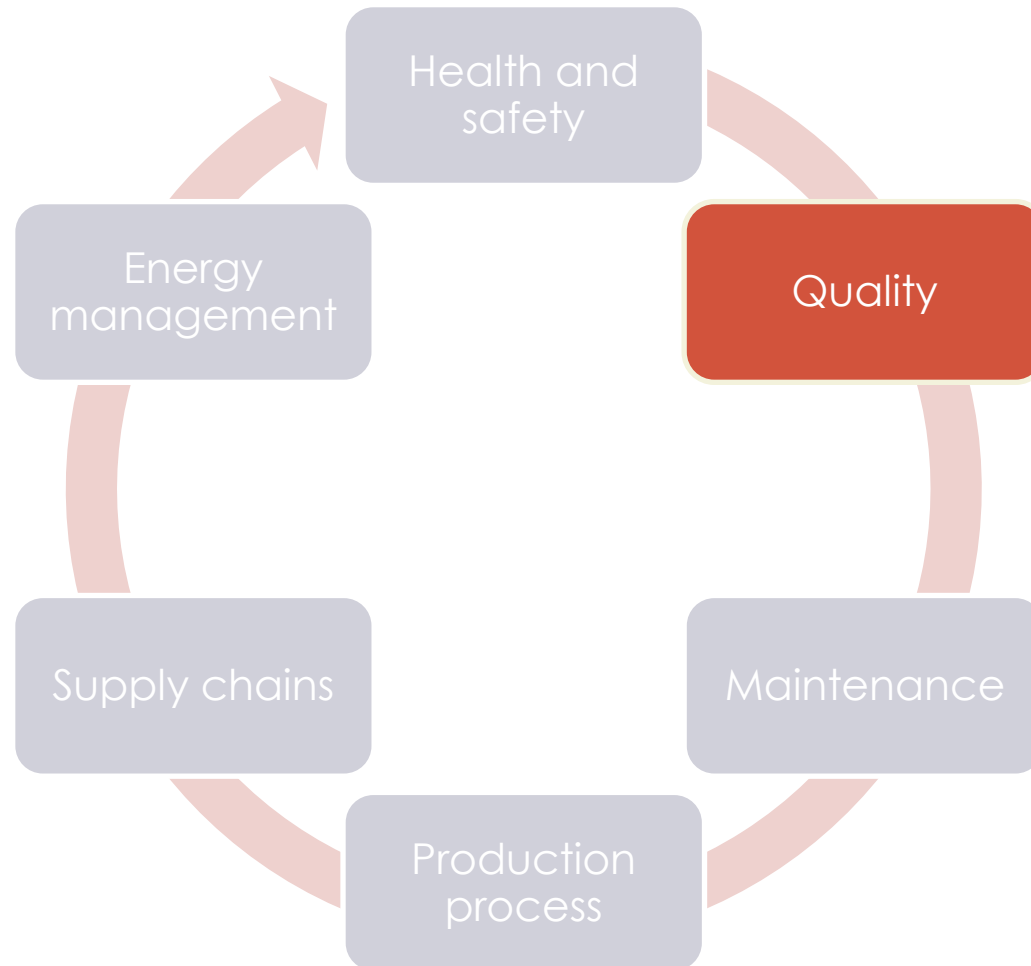


# Main use cases in manufacturing



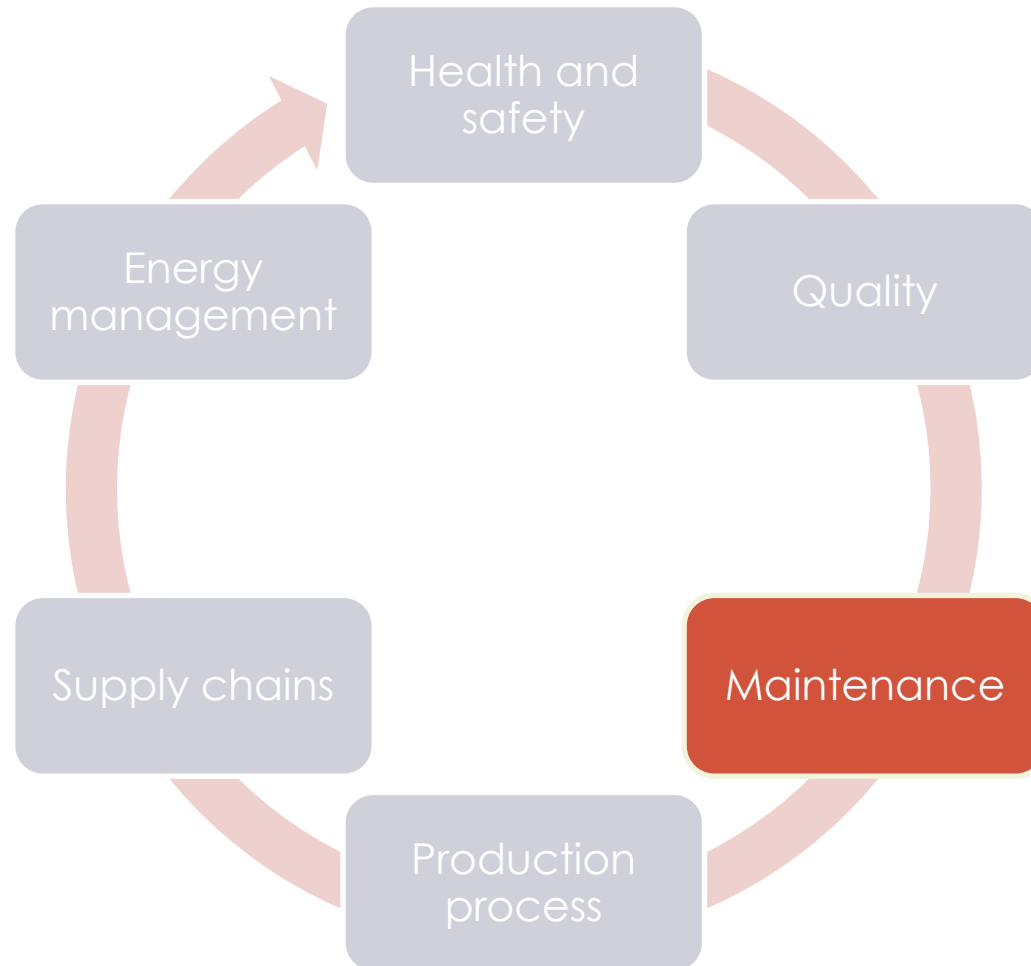
- Employees health
- Incident prevention
- Employees satisfaction
- Process safety

# Main use cases in manufacturing



- Advanced alarm analytics
- Quality assurance /defect inspection
- Quality testing
- Quality prediction

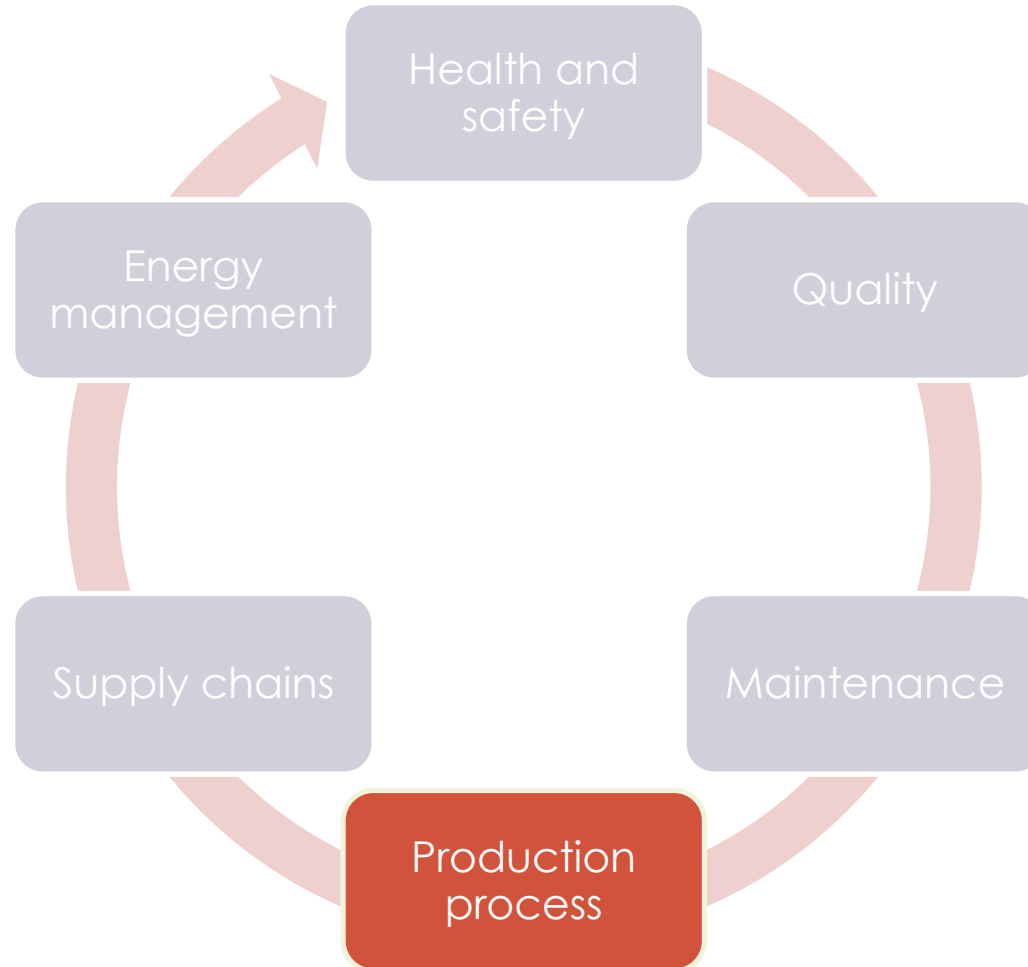
# Main use cases in manufacturing



- Machine health monitoring
- Predictive maintenance
- Maintenance planning



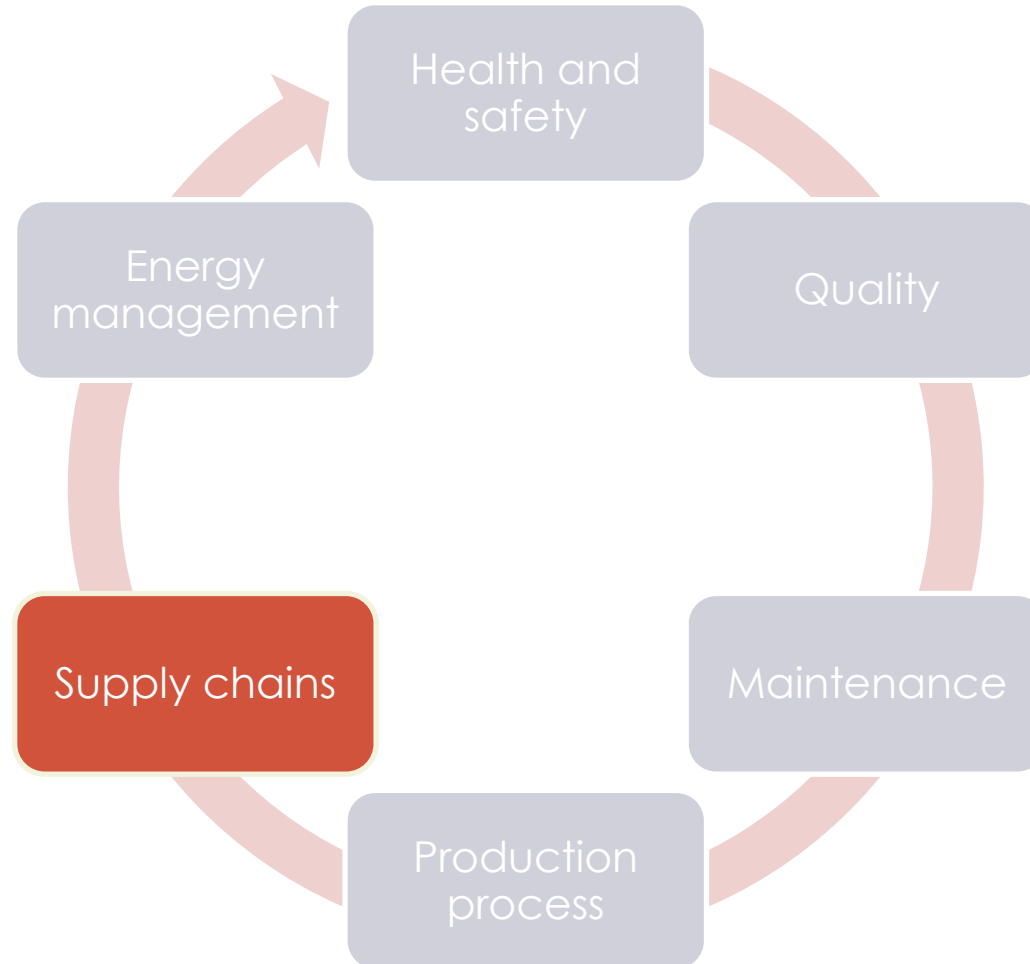
# Main use cases in manufacturing



- Process parameter optimization
- Production planning/ decision support

- Process optimization
- Line balancing
- Product design and development

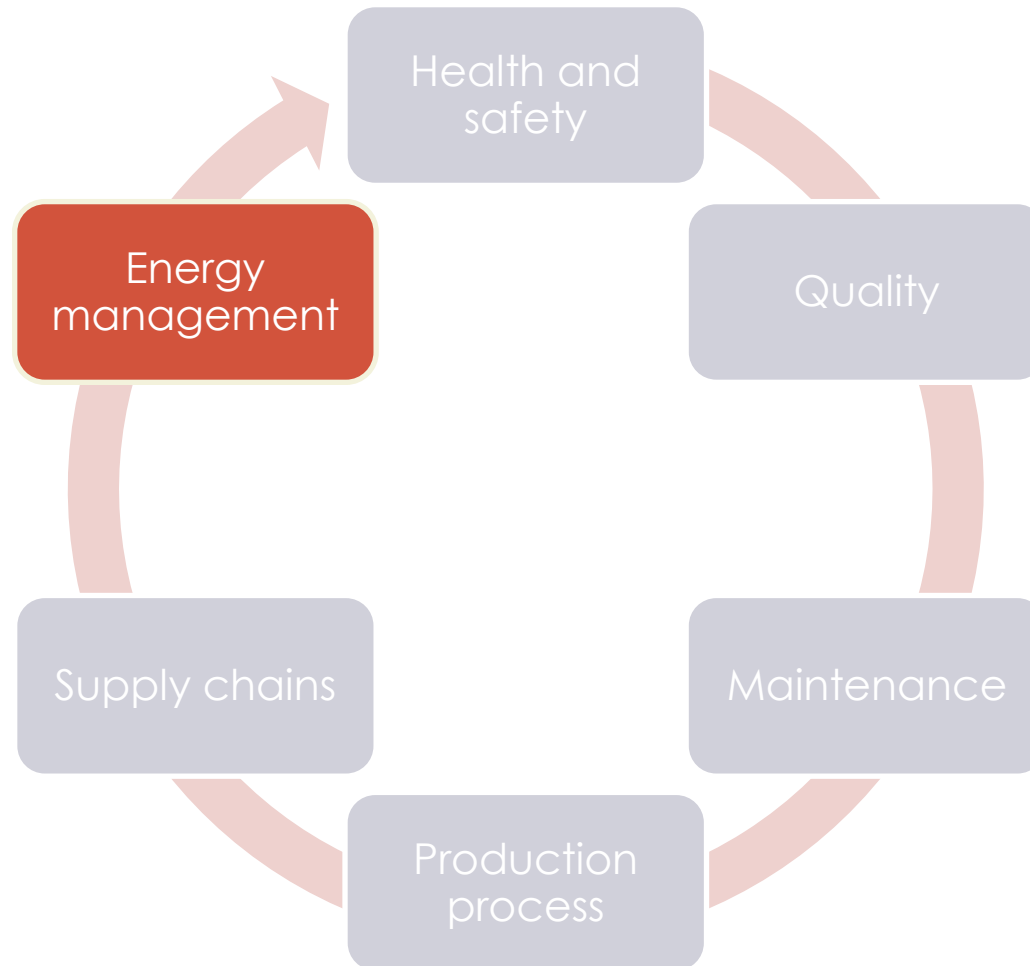
# Main use cases in manufacturing



- Warehouse management
- Future demand and price forecasting
- Supply chain control tower
- Warranty and service management

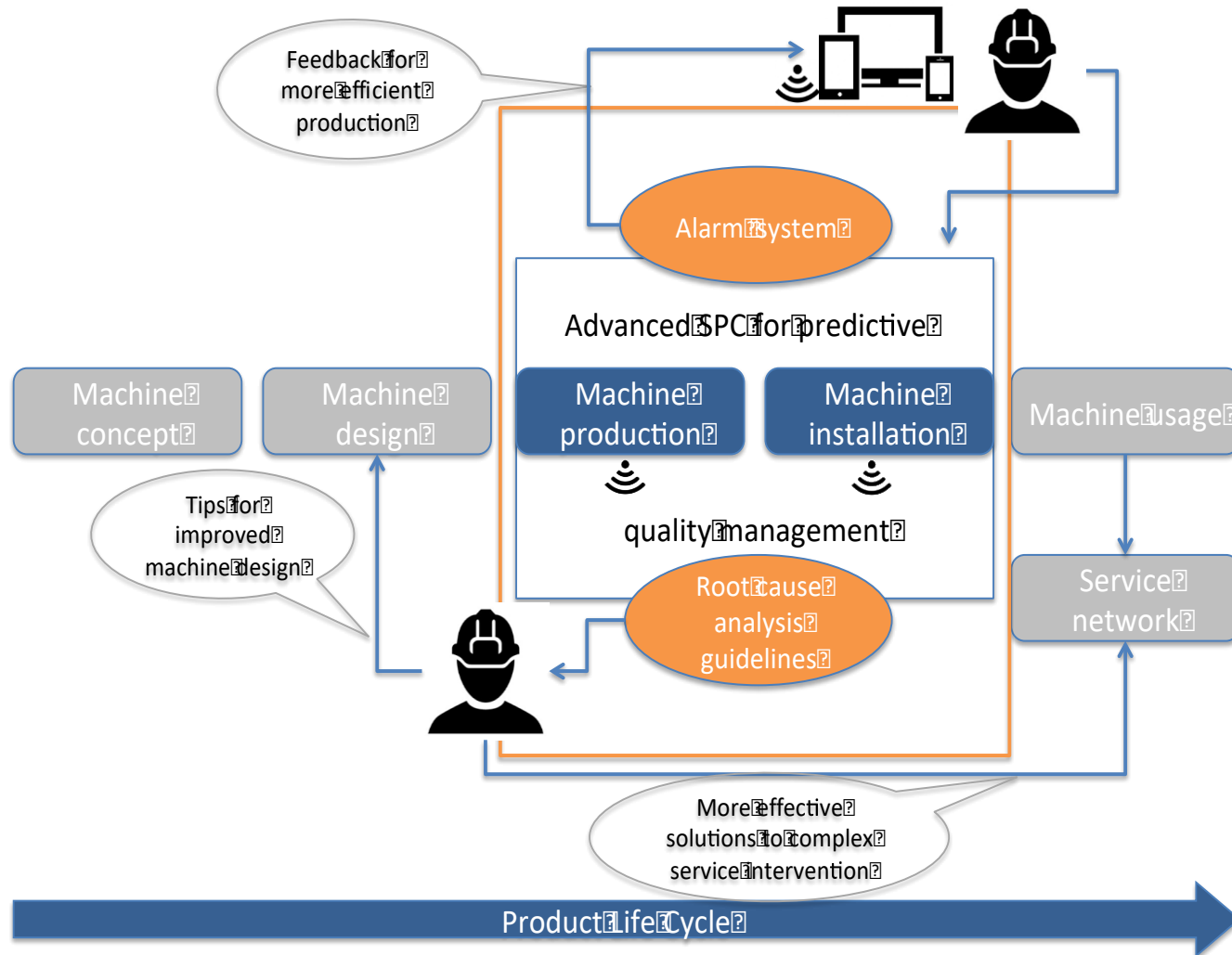
# Main use cases in manufacturing

- Energy optimization
- Electricity demand forecasting
- Heating and cooling optimization



# TALOS – Predictive quality

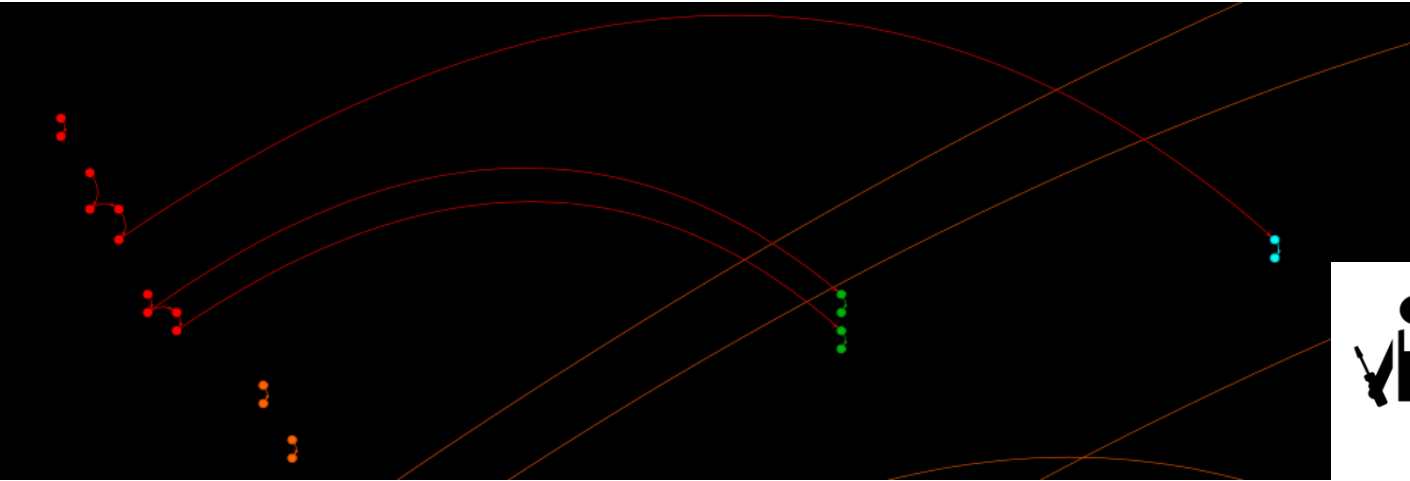
→ An application example in the quality field



A predictive system for quality control of the EDM assembly process has been integrated through the development of an alarm system that identifies the probability of occurrence of non-conformities

# TALOS – Predictive quality

→ An application example in the quality field



The system is based on the use of **Bayesian networks** that identify statistical correlations from historical data



Technician takes a measurement



Talos engine calculates probabilities of errors



An alarm arises! One (or more) variables have probability of error > 15%



A notification is sent to backoffice

Approximately **200 variables** measured during the assembly process relevant to determining the quality level of the machine

An alarm is sent when there is a 15% greater probability that one of the following steps will lead to a non-conformity

# Creating value in manufacturing through AI

→ Main categories of benefits

## Operational performance

- ↑ Production performance (e.g. yield optimization)
- ↑ Throughput (e.g. fewer unwanted breakdowns, decreased lead time)
- ↑ Quality (e.g. fewer process defects and failure rates)
- ↑ Business uptime (e.g. productive time and capacity)

## Workforce augmentation

- ↑ Decision-making and planning support
- ↑ Collaboration
- ↑ Prediction and forecasting accuracy
- ↑ Task automation
- ↓ Risk (e.g. feedback mechanism to avoid incidents and alarms)

## Sustainability

- ↑ Material efficiency
- ↑ Energy efficiency
- ↑ Machine lifetime
- ↓ Scrap rate and used material

# Adoption trends

→ Results from the BCG survey

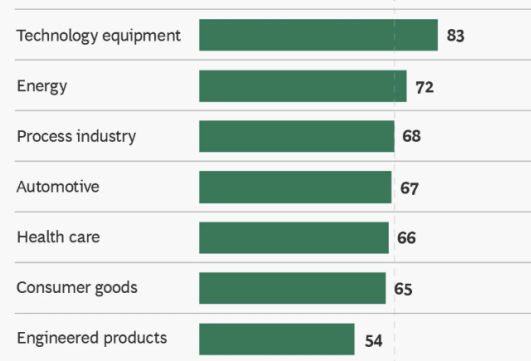
## AI-Powered Industrial Operations (2023)



The sample:

- 1'800 manufacturing executives
- 7 industries
- 15 nations worldwide

Share of companies having fully implemented at least one AI use case in their production networks, by industry (%)



Average  
68%

Source: BCG global AI survey, 2023.

Share of companies planning to implement (or further implement) AI in the next three years, by industry (%)



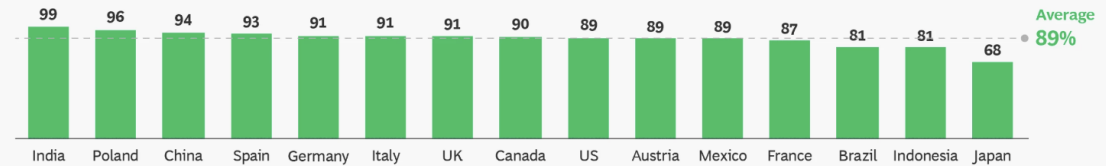
Average  
89%

Share of companies having fully implemented at least one AI use case in their production networks, by country (%)



Average  
68%

Share of companies planning to implement (or further implement) AI in the next three years, by country (%)



Average  
89%

Source: BCG global AI survey, 2023.

- Adoption is increasing
- AI is highly relevant to industrial operations
- Manufactureres in any nation want to increase their AI usage

# Adoption trends

→ Results from the BCG survey



## AI-Powered Industrial Operations (2023)

RANK	AI APPLICATION AREA	SHARE OF COMPANIES HAVING THE APPLICATION FULLY ROLLED OUT (%)
01	Quality control	25
02	Robotics and production automation	22
03	Production alert system	21
04	Inventory optimization	21
05	Self-optimization of machine/process parameters	20
06	Predictive maintenance	19
07	Enhanced production visibility	19
08	Operator support	18
09	Resource and utility optimization	18
10	Production planning and scheduling (1–8 weeks)	18
11	Autonomous handling and transport	17
12	Root-cause analysis and recommendation system	17

→ Manufacturers use AI applications in many areas

→ Maturity levels remain fairly low

Source: <https://www.bcg.com/about/partner-ecosystem/world-economic-forum/ai-project-survey>



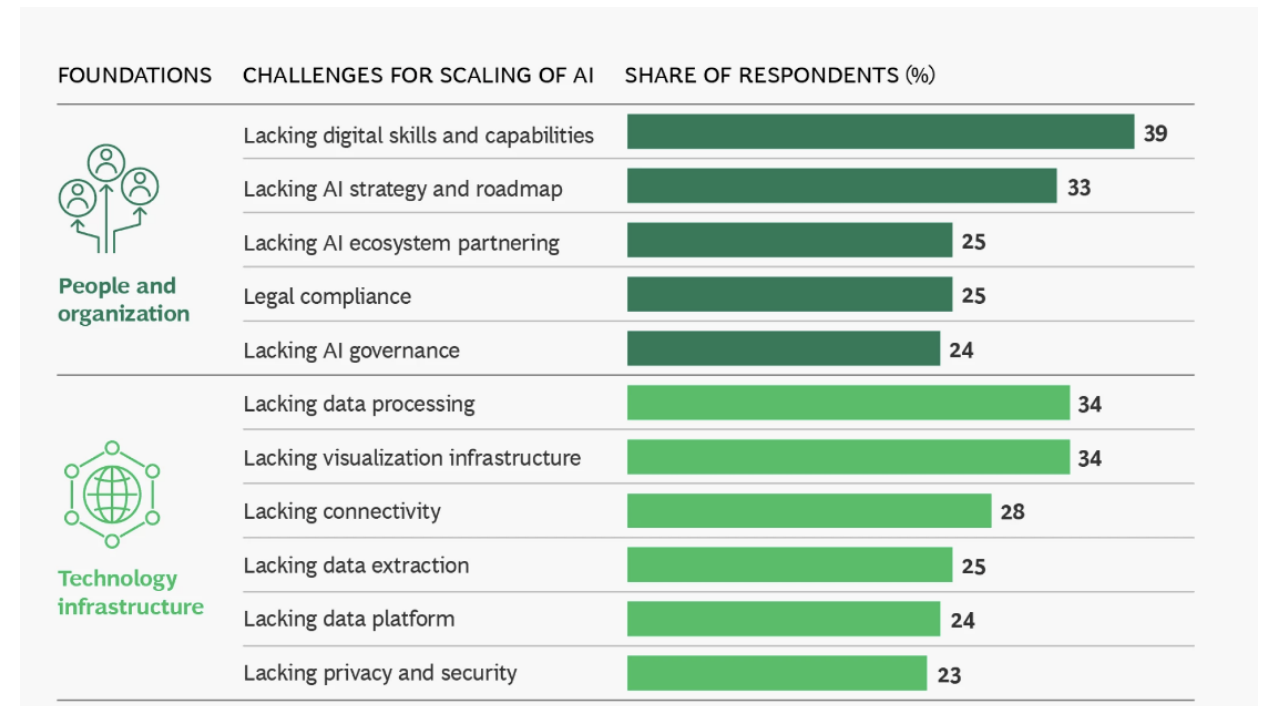
# Adoption trends

→ Results from the BCG survey



## AI-Powered Industrial Operations (2023)

- 98% of companies face challenges scaling AI throughout their production network
- Only 16% of companies have achieved their AI-related targets



Source: <https://www.bcg.com/about/partner-ecosystem/world-economic-forum/ai-project-survey>

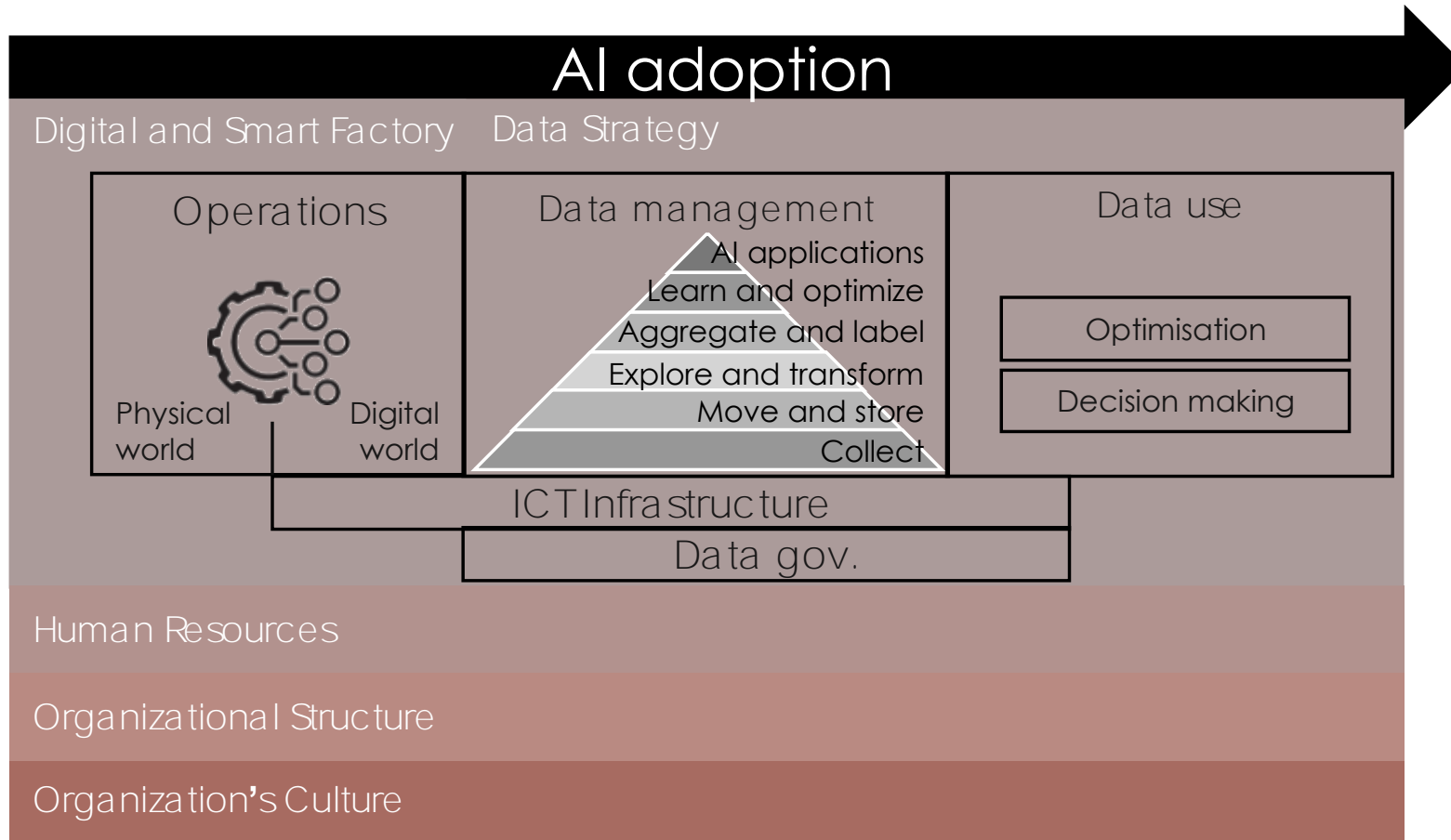
# Barriers to AI adoption in manufacturing

→ Beyond the technological aspects

- Mismatch between **AI capabilities** and operational needs
- Absence of a **strategic approach** and leadership communication
- Insufficient **skills** at the intersection of AI and operations
- Data availability and absence of a **data governance structure**
- Lack of **explainable AI** models in manufacturing
- Significant **customization** efforts across manufacturing use cases

# An AI maturity model

→ Developed by ISTEPS - SUPSI



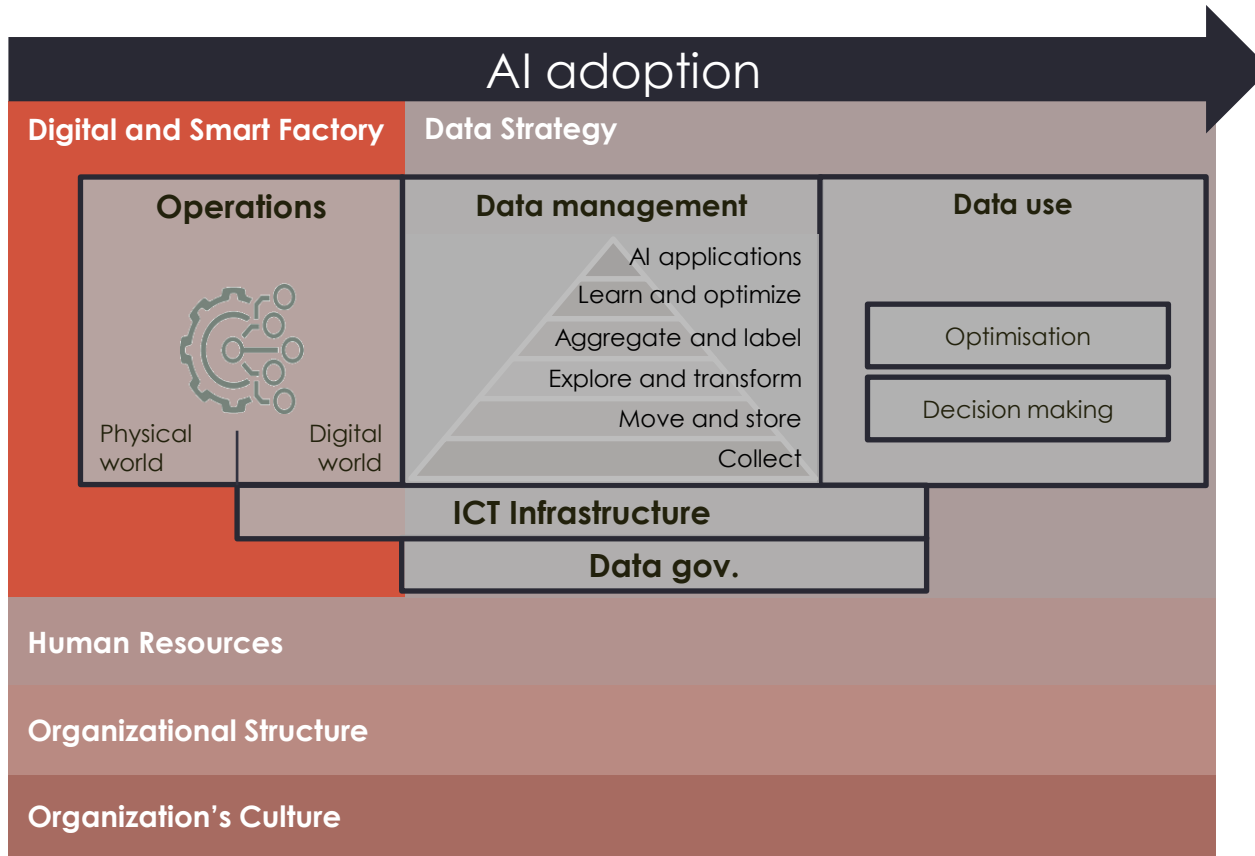
→ 5 Pillars

→ SME-oriented

→ Focused on supporting the adoption with personalized recommendation

# An AI maturity model

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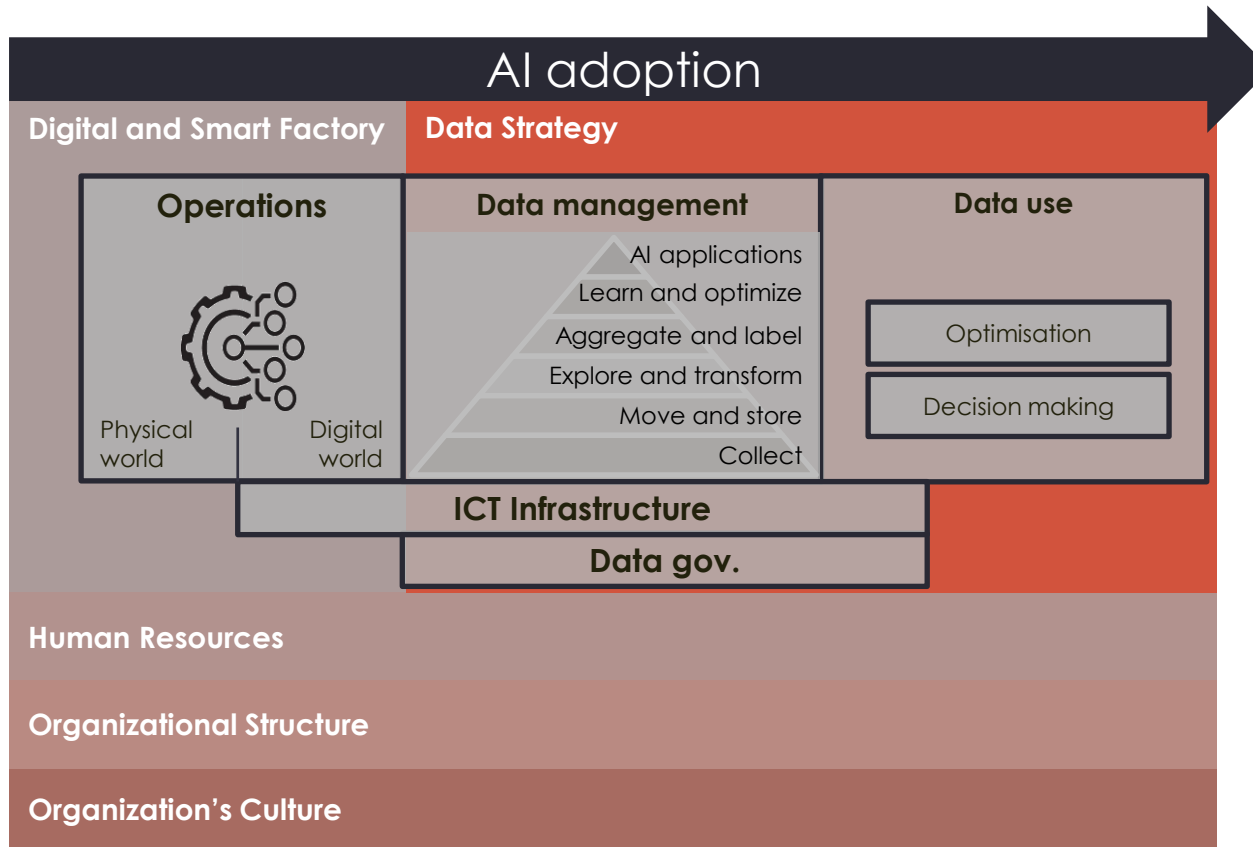


Thanks to **digitisation of the real world**, information can be displayed, analysed, stored and used to make better decisions

- *Do the machines and equipment in your company integrate sensors to monitor processes and/or machines status?*
- *What is the actual and desired level of automation inside the company?*

# An AI maturity model

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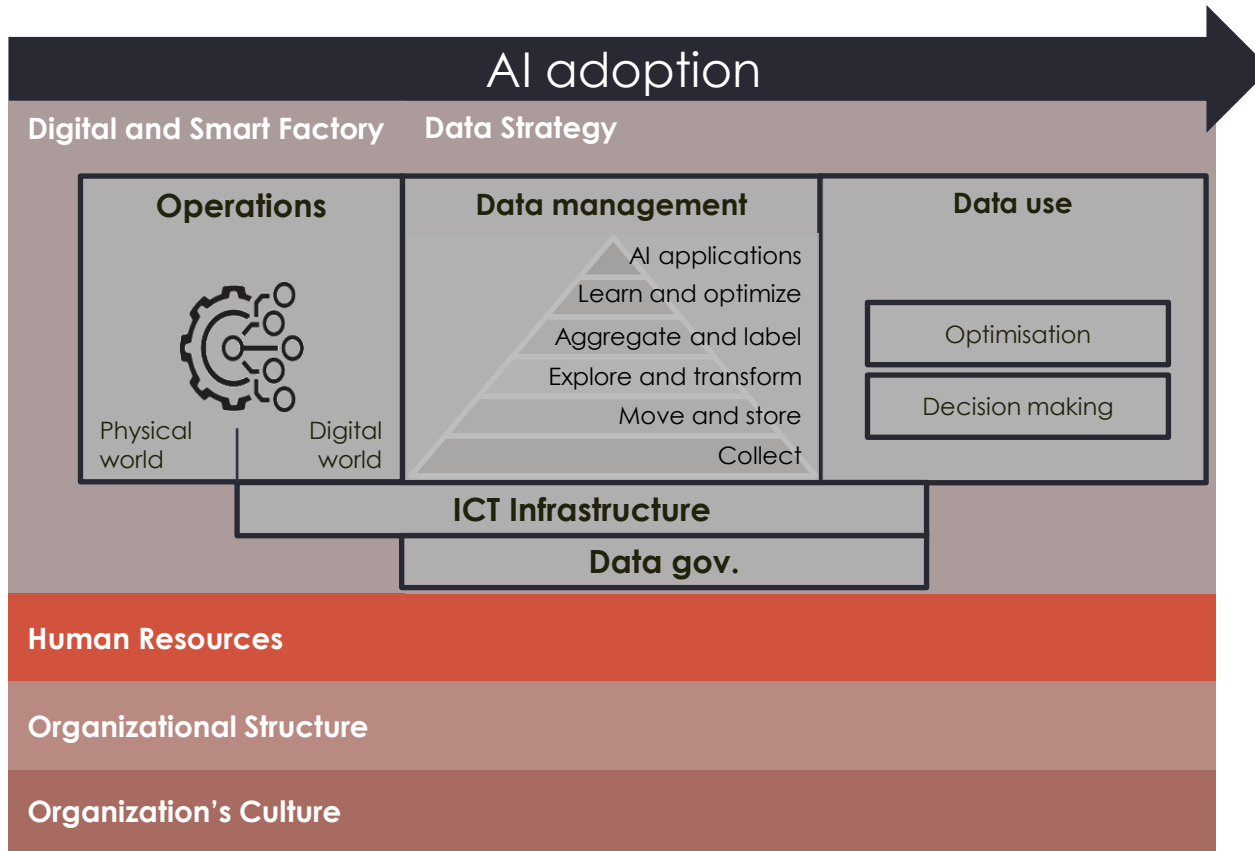


AI solutions take data from the factory environment as input and can **extract useful information**, optimise operations and suggest or even make decisions

- *Is the company able to collect data from the processes and machines inside the company?*
- *Does the company share its data along the supply chain?*

# An AI maturity model

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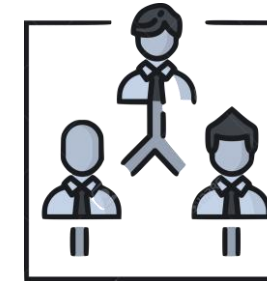
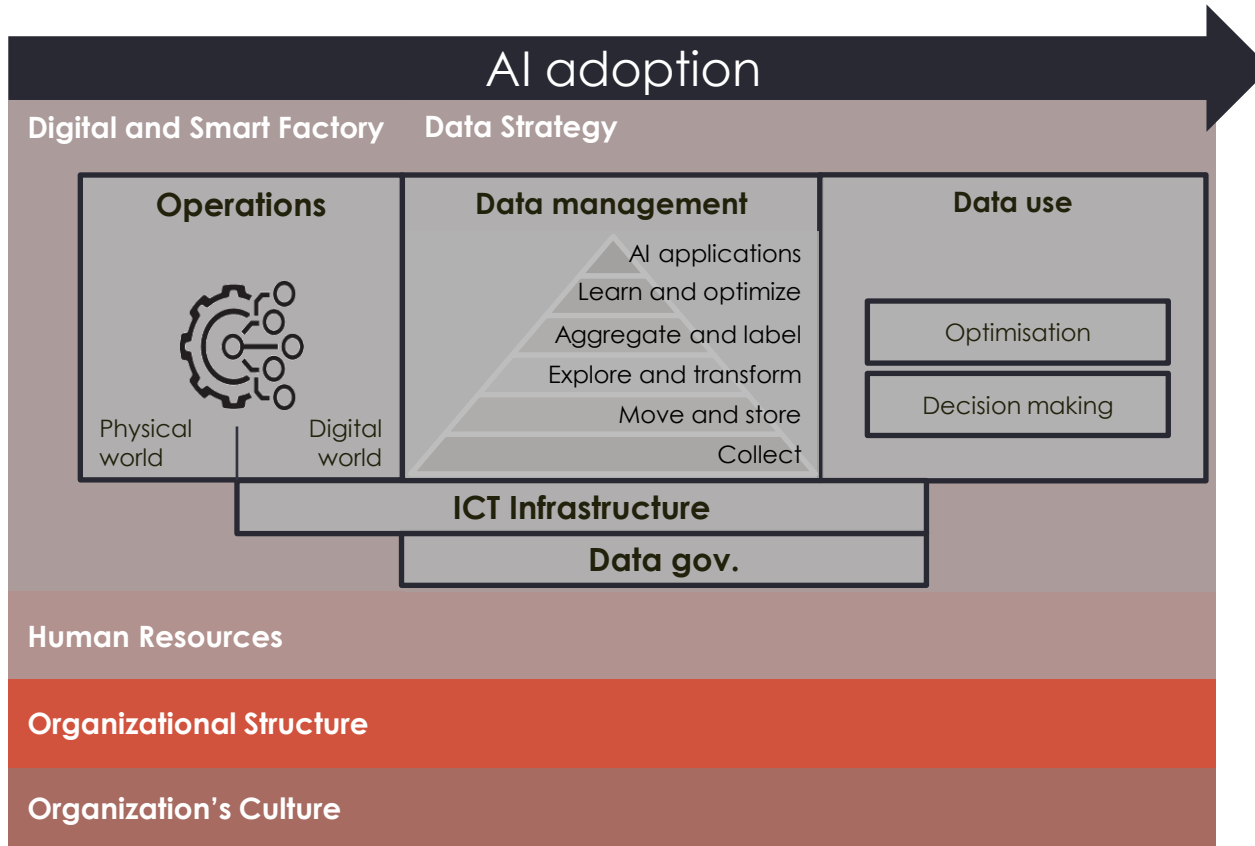


As AI solutions spread through company processes, the workforce must master **new competencies** to make the most out of it

- *What will be the company's actions to train the personnel in case of adoption of Industry 4.0/AI solutions?*
- *How does the company identify the skills of the worker?*

# An AI maturity model

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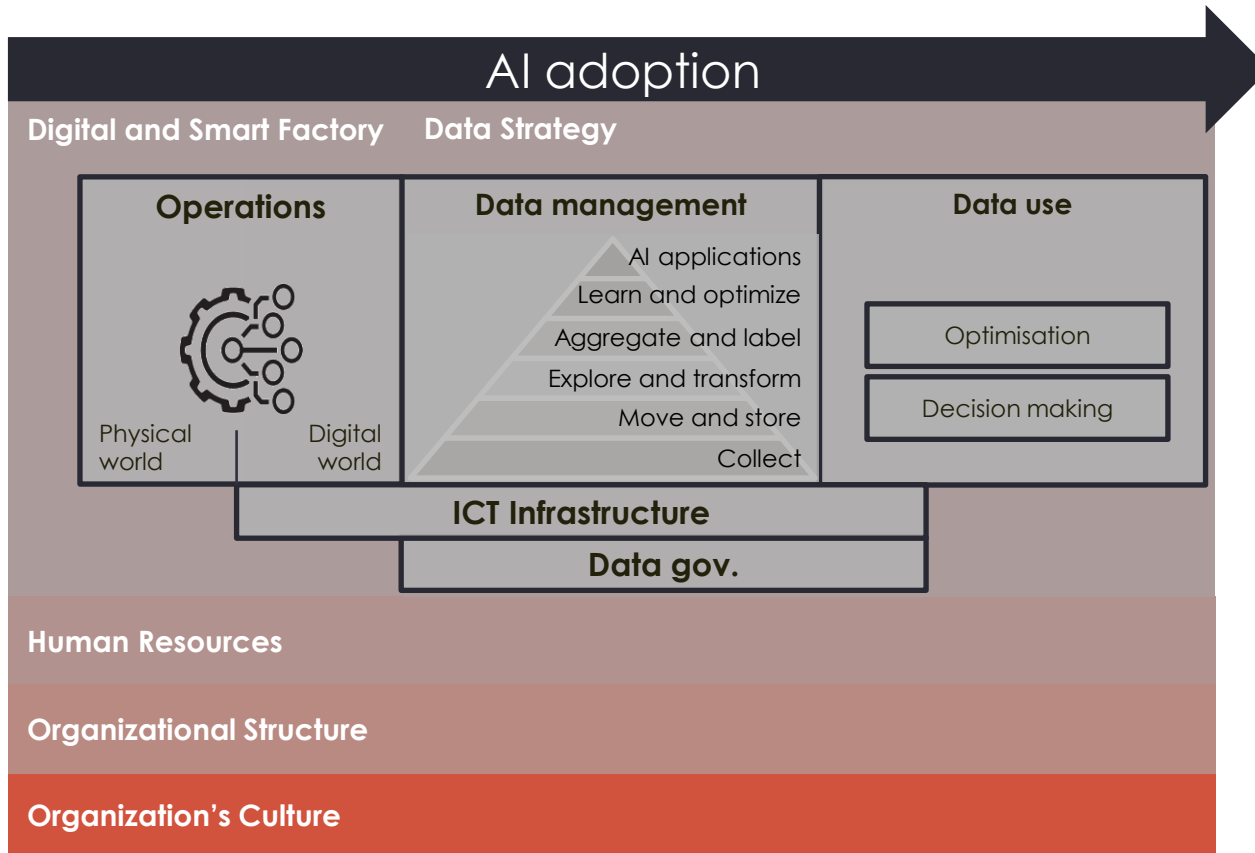
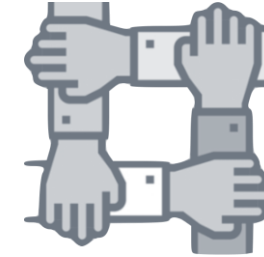


The transition to AI-based organisations involves a **left- to-right rethinking** of how organisations run their operations, empower their employees, and even define their products

- *Is a motivational goal system used to encourage employees to contribute all the skills at their disposal to the organization?*
- *Have you got roles or positions that specifically target industry 4.0 or AI adoption in your company?*

# An AI maturity model

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AI demands a culture shift because it **alters the relationship between machines and humans**, changing machines from passive receivers of commands into informed, sentient collaborators

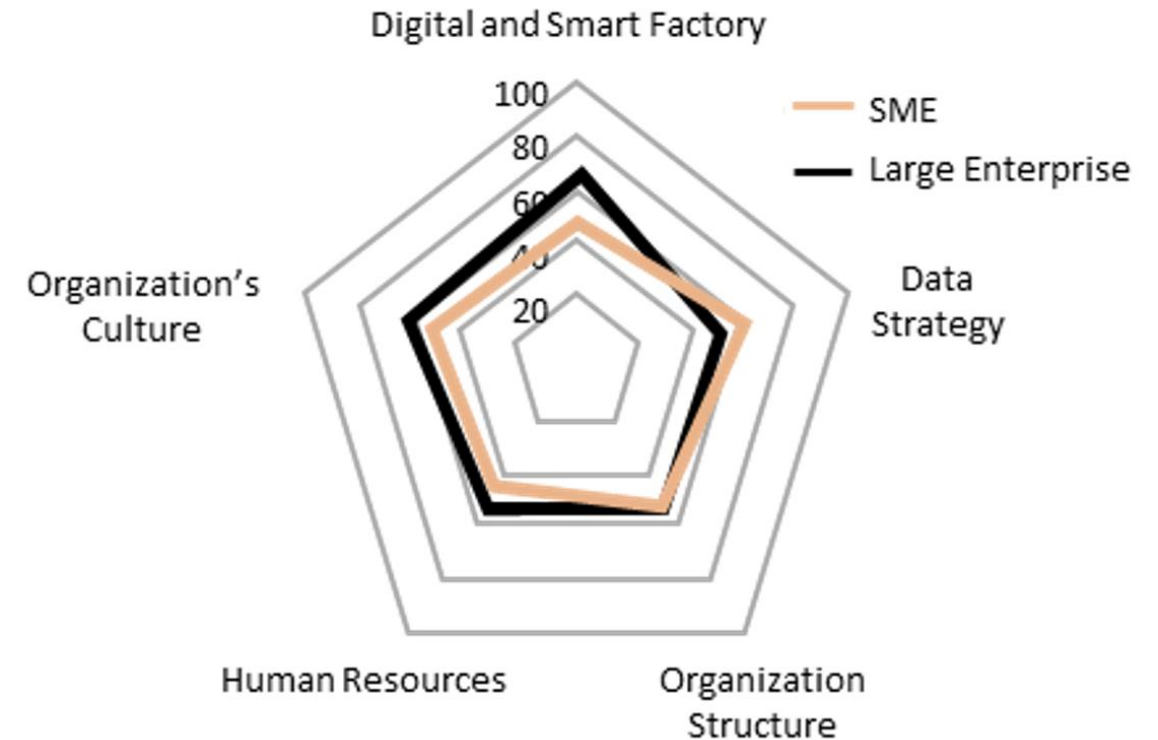
- *How do you think that AI adoption will be perceived by workers?*
- *To what extent are workers encouraged to continue with internal projects aimed at promoting innovation?*



# An AI maturity model

→ The use of the model

- For each pillar a set of questions is included in an online questionnaire
- An assessment method has been developed to quantify the positioning for each pillar
- The model can be used to carry assessment and benchmark analysis



# An AI maturity model

→ The personalized feedback

Four organization archetypes:

- **Rookies:** organisations that have not expressed any interest in AI and have not yet moved in any direction
- **Experimenters:** organisations that have touched the practical aspects of digitisation and AI. However, they lack a high-level overview, including strategy and culture
- **Young talents:** organisations that have expressed interest in AI and are already implementing an effective data strategy
- **Forerunners:** Organisations that look well prepared and have already adopted AI. They have already a clear and defined strategy, aiming at getting the most from digital and AI solutions

Recommendations grouped in 3 macrocategories:

- actions to start walking in the AI and digitalisation world
- actions to ride inside the group of AI adopters
- actions to boost and join the AI leaders to get the most from this technology

Recommendations per pillar:

- 8 for Digital and smart factory
- 9 for Data Strategy
- 8 for Human Resources
- 3 for Organizational Structure
- 5 for Organization's Culture

# An AI maturity model

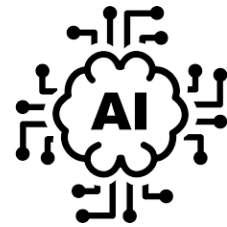
→ The validation

39

Respondents

3

Countries (Switzerland,  
Poland, Italy)



Nearly 1/2

of companies do not  
have any AI solutions or  
applications in place



33%

of respondents are defining  
a strategy to promote AI  
adoption within the  
company



Only 1/10

of companies are training their employees on digital skills

## Several industries

Aerospace

Automotive

Cotton

Defence

Energy

Food and Beverage

Metalworking

Paper

Pharma

Plastic

Steel production  
and  
transformation

Textile

...



69%

of companies believe that the collection  
of data is fundamental for their business

# A serious game

→ Learning objective

Acting as an **innovation manager**, to be able to guide a manufacturing company in the AI journey by:

- applying a maturity model to assess the as-is situation
- identifying a proper set of recommendations with budget constraints

# A serious game

→ Game implementation

1. Analyze the description of the assigned case study
2. Fill in the evaluation questionnaire for the assigned case study
3. Pick up from a predetermined list of recommendations the ones that have the highest priority according to the output of the previous analysis considering the budget constraints

**TECHTWEEZ**

TECHTWEEZ is a large German-based company operating in the production of tweezers for biomedical applications. Founded in the 1930s, TECHTWEEZ has gone through a significant digital transformation over the past decade, positioning itself as a market leader with sales of over 500 million euros by the end of 2023 and a workforce of 500 employees, 300 of whom work in the production plant. The company's main product is tweezers, which are used in various industries. The production process requires high precision and quality control. The company's main market is Europe, but it also exports to other regions. The company's main competitors are other large tweezers manufacturers.

**WOODOR**

WOODOR, a manufacturing company located in a small town in France, produces high-quality wooden doors and doorframes. Since its establishment in the '70s, its business focus has been always in two areas, namely large residential properties, such as apartment and condominium blocks, and in commercial properties such as hotels, resorts and office buildings. For the most important customers, customer care also of the continuous nature of the construction industry.

**METBEN**

METBEN is a small company based in Switzerland operating in the metallic furniture field. The company was established in the '80s and has undergone an important reorganization in the 2020s. Thanks to the new management, the turnover has reached 5 million at the end of 2023 and 40 people are now employed, out of which 25 work in the production plant and 15 in the administrative department. The growth has been driven by the launch of a new service meant to rent lockers for public events (e.g. concerts and festivals) or for public institutions (e.g. schools) supported by some initiatives to improve the production performance.

A new informative system has been introduced in 2022 to make easier the management of the service and it has improved also the information flow within the company. What is missing is a direct link with the data coming from the shop floor. Production performances are assessed only every three months and no change in the approach has been introduced in the last few years even if the amount of data has considerably increased.

Since his arrival in the company in 2021, the production manager has tried to push some technological innovations in the company and has attended several seminars and workshops organized by the local industrial association. The main result has been the redefinition of the quality control process. The number of reworks was, indeed, quite high and often caused delivery delays. A new vision system has been introduced to carry out a quality check of welding that is a critical step in the production flow. At the same time, it has been decided to exploit data that can be easily gathered from the new machines introduced in the last years. Unfortunately, most of the machines are 20 or 30 years old and they are not equipped with sensors and data from their functioning cannot be collected in real-time. Some attempts have been done to reduce also the downtime of machines by introducing some form of preventive maintenance. A simplified plan has been developed by the two operators who are used to carry out simple maintenance tasks, but it could be improved adopting some advanced algorithms.

The first obtained improvements are promising and there is a huge potential to be exploited, yet a clear strategy has not been developed and the production manager is still experimenting. Some time inspiration is taken from the initiatives brought forward by competitors and other companies operating in similar industries. From this point of view, the company is very active and the participation to the industrial association allows to easily find benchmark information.

Relying on an external consultant has been essential in this phase since the company completely miss the right set of skills to implement new technologies. Employees have been always chosen for their expertise in carrying out mechanical tasks and, due to the small size, it is not affordable to hire new personnel familiar with new technologies. Nonetheless, the management has understood the importance of AI and innovative technologies for the future of the business. A training plan has been recently approved to upskill the youngest operators in the next couple of years.

The company's goal is to integrate advanced robotics. The main information within the company's processes, enabling operations. During infrastructure, equipment performance and optimization algorithms to optimize the company's production process. The company has received enables the automation of specific tasks in the sector it is very competitive due to many quality causes.

TECHTWEEZ gives now established the project that can bring best results wins a project.

TECHTWEEZ active technological edge in which the aim. Furthermore, each taught by international research and development efficiency and quality.

However, the annual company. Main introduction of new creation process of years ago, they will.

After the retirement of recent graduate to bring competences and knowledge company considering that breakdowns occur. They sensorized machines considering approach, but they do not.

As the next step, the CI results risk to vanish if it on an external consultant assembly, packaging and

Even if the journey towards cutting department when and thickness and the level of automation not thanks to the integration real time data for a dynamic.

The line supervisors of technologies and are aware for all the line operator. information coming from understanding the root causes.

In July 2018, the company considered the actions manager had experience for a company in the fertile ground than in the reorganization of the profits started to raise a from 180 to 203.

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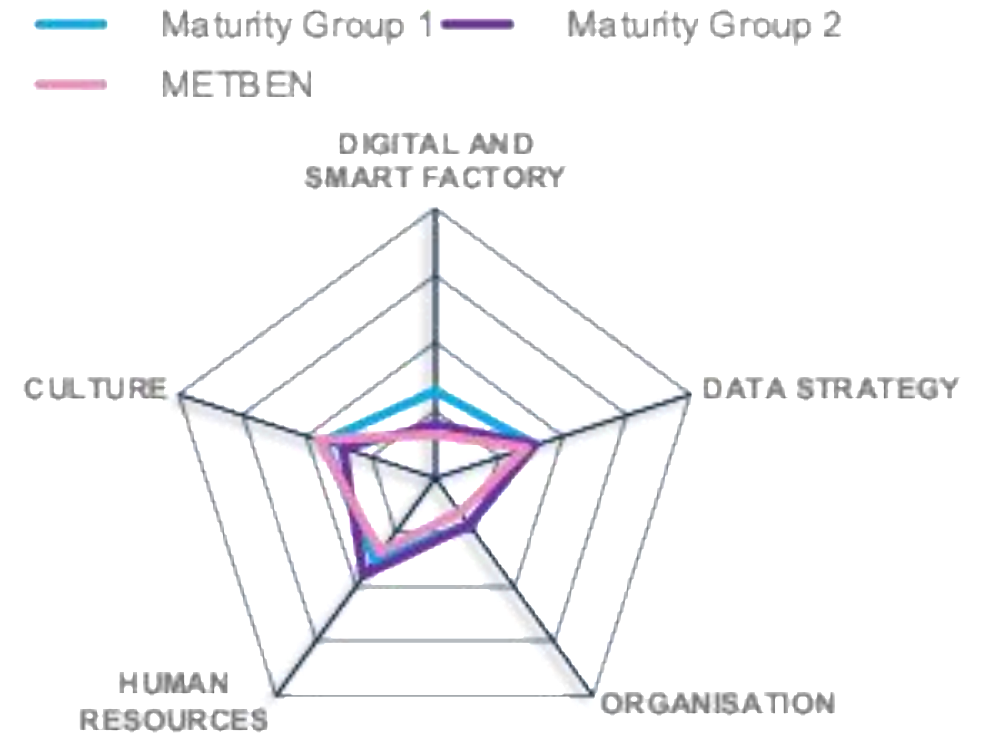
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# A serious game

→ Provided feedback

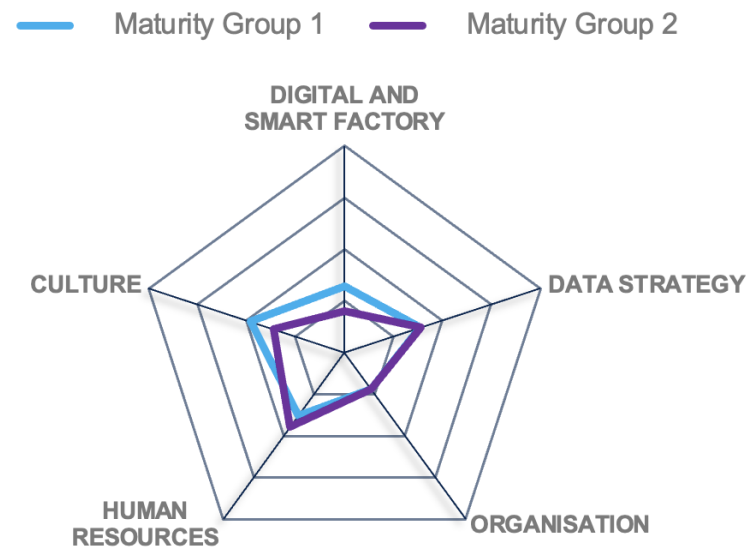
1. Radar chart comparing the positioning of the working group against the pre-determined assessment



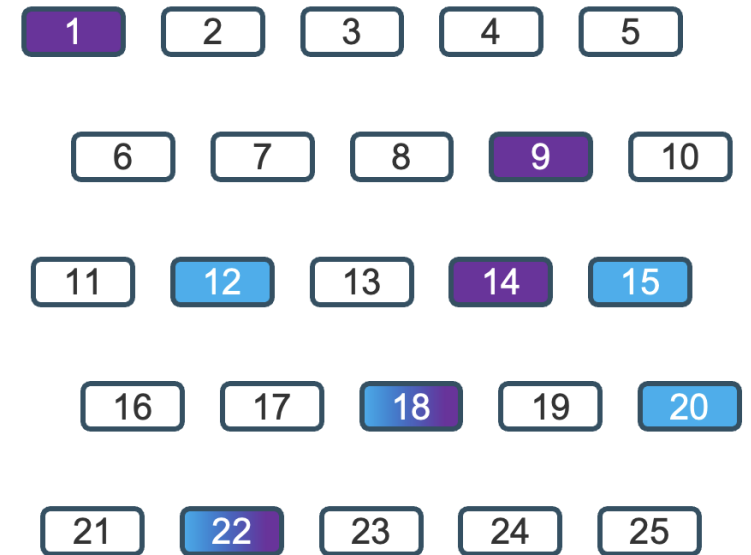
# A serious game

→ Provided feedback

1. Radar chart comparing the positioning proposed by the groups working on the same case study against the pre-determined assessment
2. Comparison of the set of recommendations proposed by the groups working on the same case study



## Recommendations Selected



# A serious game

→ Provided feedback

1. Radar chart comparing the positioning proposed by the groups working on the same case study against the pre-determined assessment
2. Comparison of the set of recommendations proposed by the groups working on the same case study
3. Feedback on the set of selected recommendations

## Group 2

YOUR SCORES:

- |    |  |   |
|----|--|---|
| 1  | You decide to organise a workshop involving all the internal stakeholders in order to identify the most significant challenges, existent problems and current level of automation  | ✓ |
| 9  | You identify the most relevant data that can provide useful information on processes related to the AI use case identified ( <i>probably it has been already done</i> )  | ⊖ |
| 14 | You set up a validated AI use case pipeline (from pilot ideation to solution rollout) ( <i>this is too early considering the maturity of the company</i> )   | ✗ |
| 18 | You develop a budget plan for the next three years considering all the costs that introduction of AI means (training, recruitment, solution purchase,...) and discuss it with the upper management   | ✓ |
| 22 | You inform the workers the willingness to adopt AI and plan an adequate training and information days to prepare them for the digital transformation, by showing them how AI can be useful for them ( <i>probably it has been already done</i> ) | ⊖ |



**Thank you for your attention!**

For any further information please contact:  
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