AI CUBE

Workshop for AI & BD Technologies Experts in the process industry

Gaps analysis, opportunities and barriers

- February 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958402

THE AI-CUBE PROJECT IN BRIEF

Funded under the Horizon 2020 Research and Innovation Programme.

Aimed at harnessing and optimizing the potential of AI and BD in the European process industry.

Will result in a roadmap for each of the 10 SPIRE industrial sectors, with specific recommendations on the application of AI and BD in process industries, to guide researchers, managers, and operators in the implementation of these technologies.

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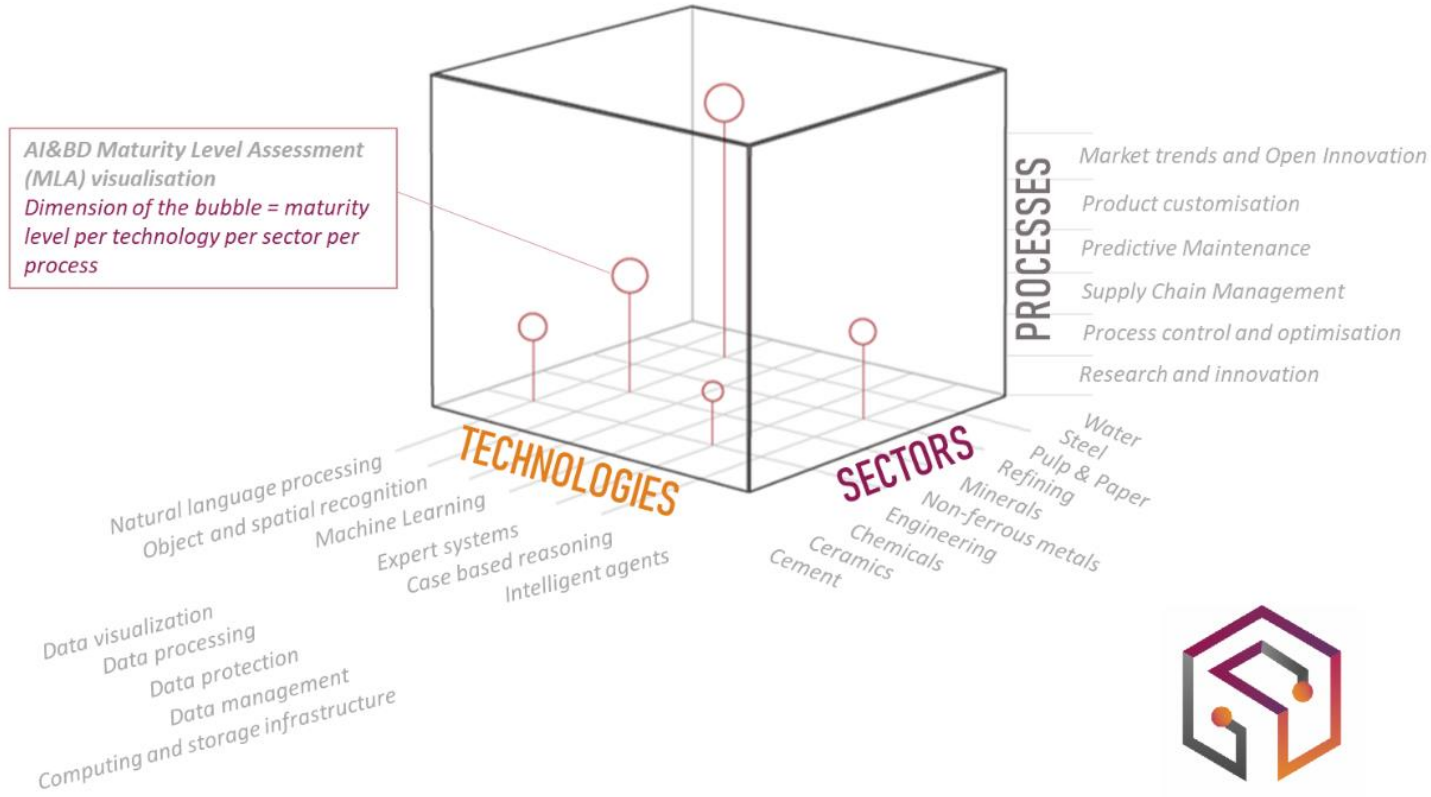
AI-CUBE concept

The AI-CUBE concept is based on a tri-axial mapping of AI and BD technologies. It allows to map and visualize the status of AI & BD use and penetration per SPIRE sector and macro-application process areas.



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AI CUBE

Partners

PNO

ZLC | MIT GLOBAL SCALE NETWORK
TALENT HUB FOR SUPPLY CHAIN

IRIS TECHNOLOGY GROUP

Consiglio Nazionale delle Ricerche

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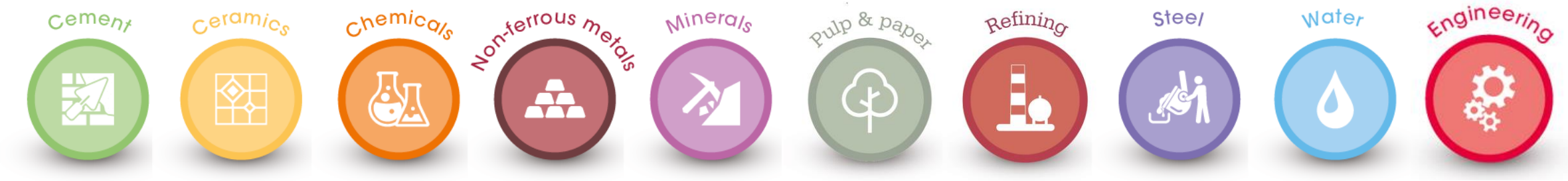
WORKSHOP OBJECTIVES

- Identify the main gaps and opportunities for Artificial Intelligence & Big Data technologies in the process industry
- Latest results of AI-CUBE on the AI and BD technologies applied in the 10 SPIRE sectors
- Preliminary set of concerns, opportunities and barriers per sector to be validated by experts in AI & BD technologies with experience in the process industry
- Expand the findings with new opportunities and transferability of AI & BD solutions



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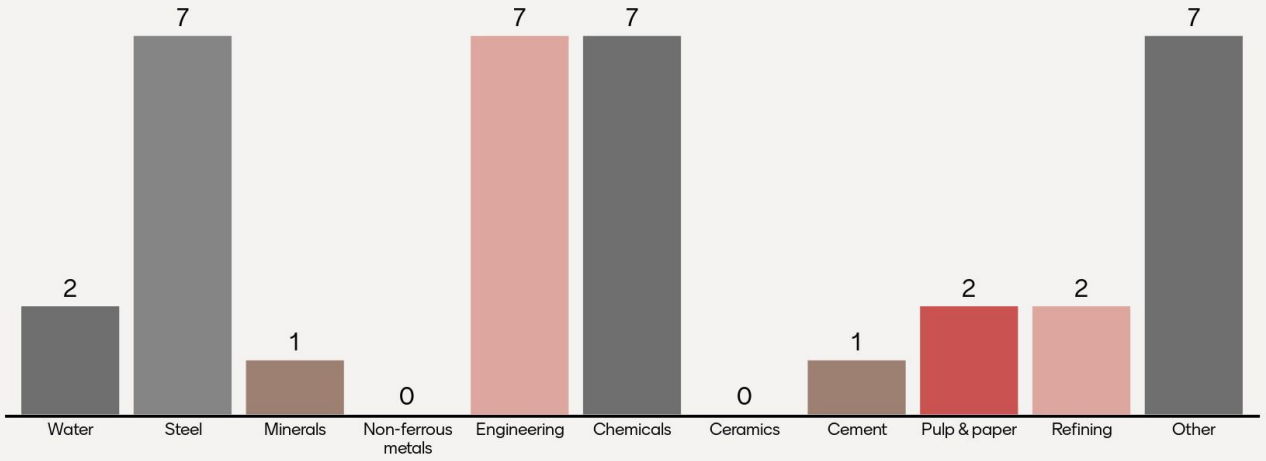
POLLING

Which sector do you belong to or work with?



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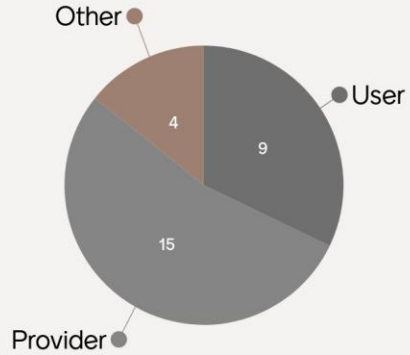
Are you user or provider of AI & BD technologies?



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Business Concerns

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BUSINESS CONCERNS

From an exhaustive analysis review of 160 reference, AI-CUBE has identified the main business concerns per sector

Starting point to start addressing the specific needs of each sector with AI & BD technology solutions

Water	Waste water processing, clean water processing
	Complex processing chain, large processing volumes, yield
Steel	Security and human safety
	Quality control
	Logistics, Value Chain
Minerals	High energy consumption
	Security and human safety
	Scheduling/planning
	Automation, remote monitoring
Non-ferrous metals	High energy consumption
	Security and human safety
	Scrap quality control
	Logistics
Engineering	Fault detection, quality assurance
	Predictive maintenance, data quality, sensor data capture
Chemicals	Conversion of materials
	Waste avoidance
	Process complexity, reliability, production planning
	Continuous sensor-based monitoring
	Process control logistics, goods shipments tracking
Ceramics	Raw material processing, firing, finishing
	High energy consumption
	Reduce defects (cracking/foaming)
Cement	High energy consumption
	Predictive maintenance, remote operation
	Predict process behavior
	Better understanding of value chain
Pulp & paper	
Refining	

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BUSINESS CONCERNS

WORKSHOP RESULTS

Water	Waste water processing, clean water processing
	Complex processing chain, large processing volumes, yield
	Water management and quality
Steel	Security and human safety
	Quality control
	Logistics, Value Chain
	Process optimization and stable operation
	Fossil free energy soruce (fuel switch – Hydrogen)
Minerals	High energy consumption
	Security and human safety
	Scheduling/planning
	Automation, remote monitoring
	Real time monitoring (control of raw materials)
	Temperature control during the full process (since aggregated to the use)
Non-ferrous metals	High energy consumption
	Security and human safety
	Scrap quality control
	Logistics
Engineering	Fault detection, quality assurance, **rapid quality diagnosis**
	Predictive maintenance, data quality, sensor data capture
	Proccess optimization
	Degradation prediction and infrastructure monitoring (i.e. boiler fouling)
Chemicals	Conversion of materials
	Waste avoidance
	Energy concumption
	Security and human safety
	Process complexity, reliability, production planning **(complex reaction mechanism identification, PAT data processing / identification)**
	Continuous sensor-based monitoring
	Process control logistics, goods shipments tracking
Ceramics	Raw material processing, firing, finishing
	High energy consumption
	Reduce defects (cracking/foaming)
Cement	High energy consumption
	Predictive maintenance, remote operation
	Predict process behavior
	Better understanding of value chain
Pulp & paper	High energy consumption
	Water consumption
	Product quality
	Process efficiency and waste avoidance
Refining	**Emissions minimizarion in the destilation process**
	Proccess control and product quality assurance
	Performance optimization
	Corrosion, abrasión and fouling by exterme temperatures

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AI & BD technology solutions

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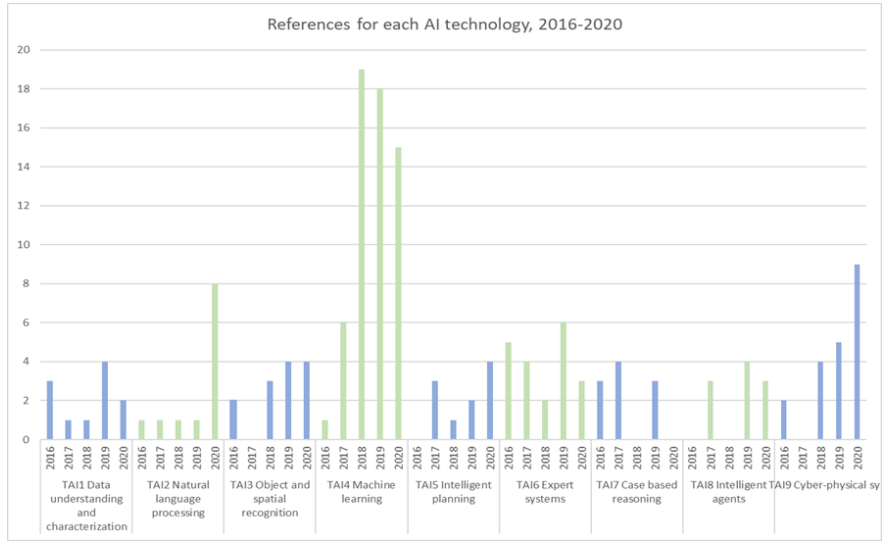
AI & BD SOLUTIONS



"heat map" → number of references found in the literature search for technologies with respect to processes.

Machine learning, data processing, expert systems and object and spatial recognition

	Data understanding and characterization	Natural language processing	Object and spatial recognition	Machine learning	Intelligent planning	Expert systems	Case based reasoning	Intelligent agents	Cyber-physical systems	Data visualization	Data processing	Data protection	Data manage-ment	Computing and storage infrastructure
Cement				4		3	1		1	2	2		1	
Ceramics			2	4	4	2	1	1	2	1	4		2	
Chemicals	8		1	10			1		1		2		3	3
Engineering	1	8		5	1	4	4	4	8	1		1	5	3
Minerals	2	1	4	14	4	1	1	2	1	1	1	1	3	2
Non ferrous metals				7		2	1		1	1	3		1	
Steel		2	5	8		7	1	2	5		2		2	
Water		1	1	7	1			1	1	2	2		3	

HEAT MAP	
>9	high
4-9	medium
0-3	low

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POLLING

- Which AI & BD technologies have you applied in your organization?
- Which process have you addressed with AI & BD technology?
- Which results have you achieved with AI & BD technology?

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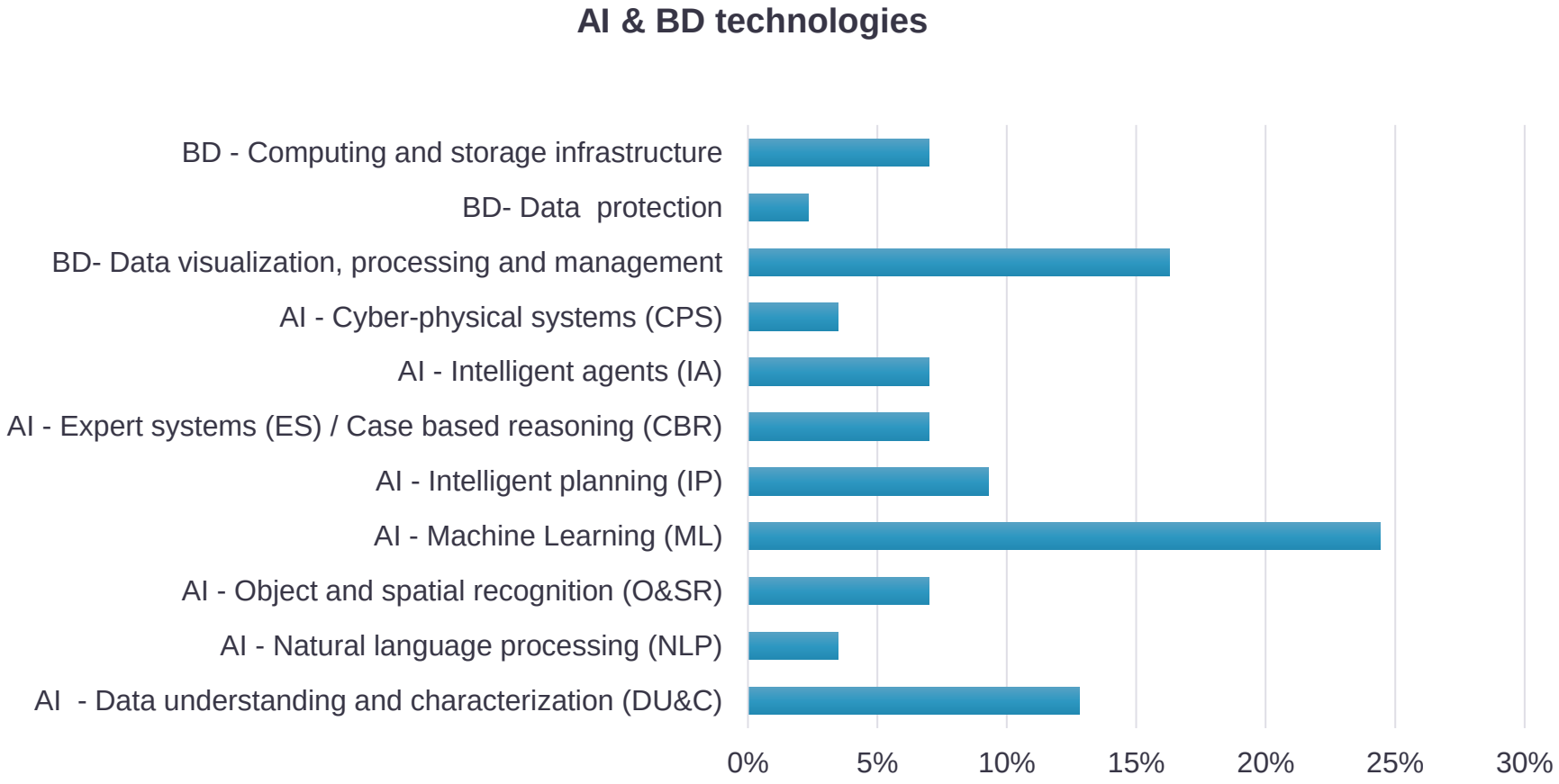
AI & BD SOLUTIONS

WORKSHOP RESULTS



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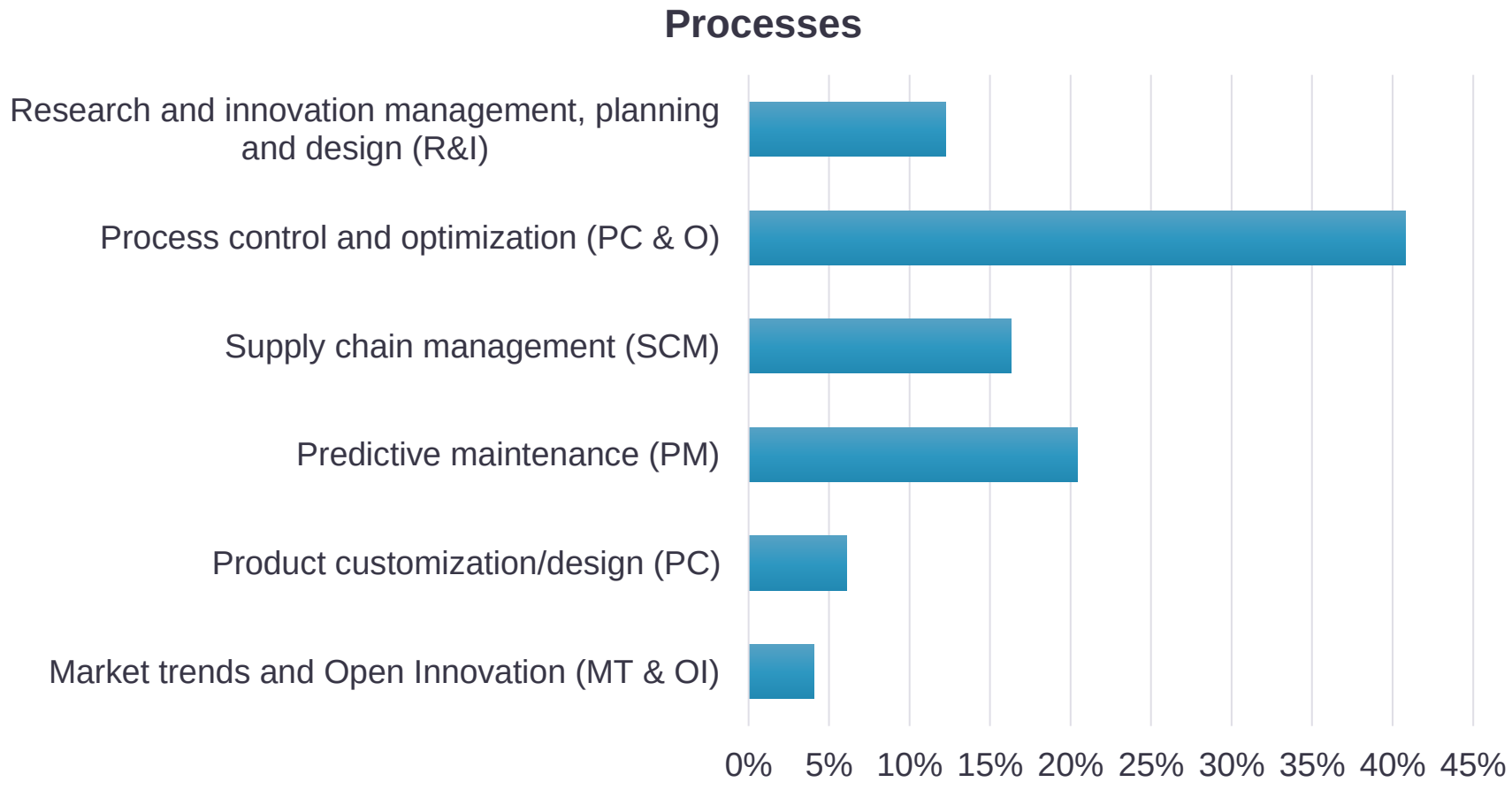
AI & BD SOLUTIONS

WORKSHOP RESULTS



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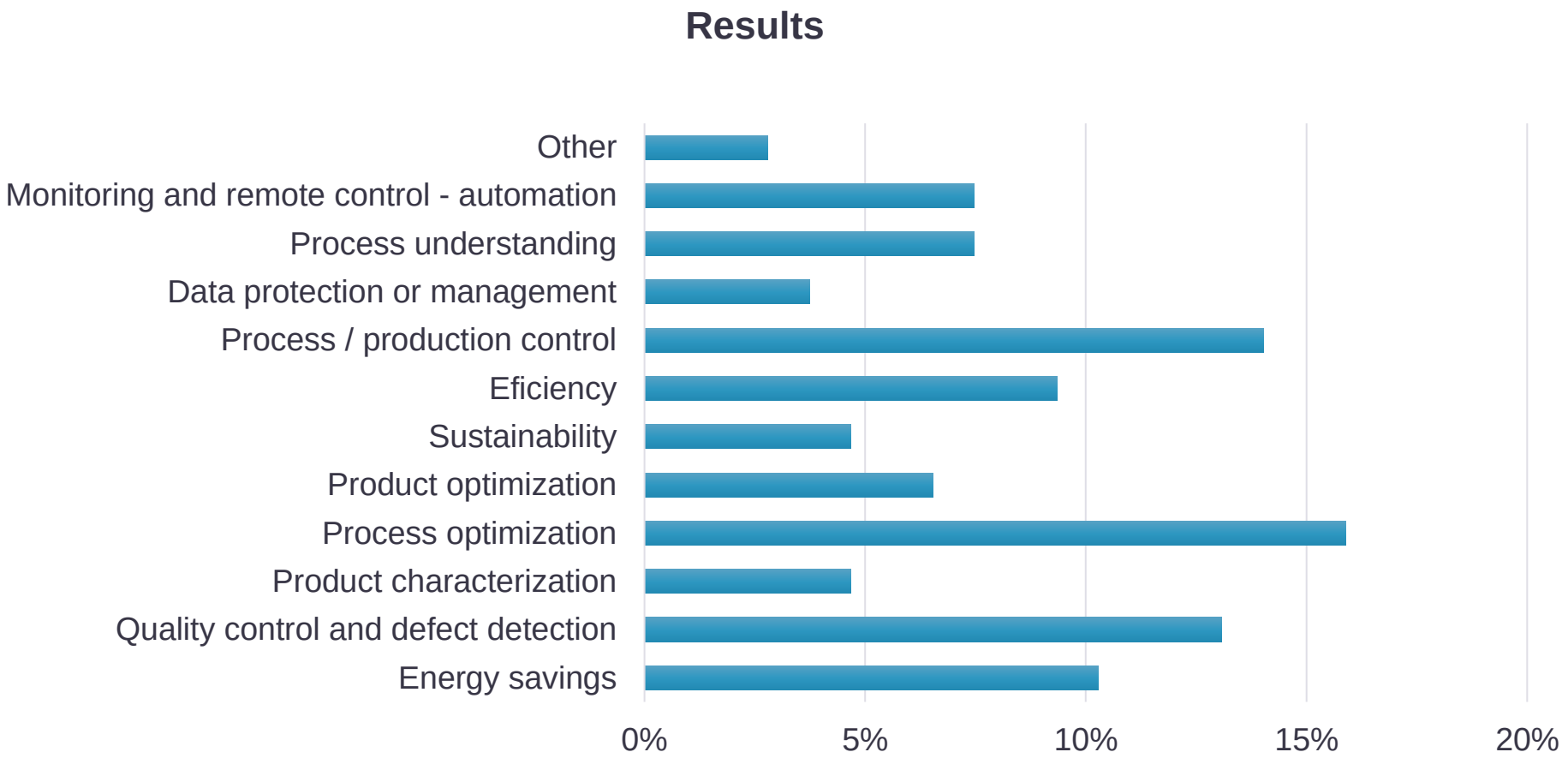
AI & BD SOLUTIONS

WORKSHOP RESULTS



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Transferability of the proposed solutions

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TRANSFERABILITY OF THE PROPOSED SOLUTIONS (between sectors or processes)

From the solutions identified during the workshop boards we then found opportunities for transferability of the soltuions from one sector to another or from one process to another to address the concerns of the specific sectors

Here below is an example of solution transfer from one sector to another, based on AI-CUBE literature search and desk work analysis of the findings

CURRENT SITUATION		TRANSFER		
GAP	**SECTOR**	**RESULT**	**SECTOR**	**APPLICATION**
Better understanding of value chain	Water Steel NF metals Cement	Optimized process (redesign, energy and time savings, i.e.)	Engineering	supply chain mapping of structures to increase their visibility
High energy consumption	NF metals	Optimized process (redesign, energy and time savings, i.e.)	Steel	optimization of heat losses - Energy saving
	Ceramics	Energy savings	Water	ML and other techniques applied to improve energy and resource efficiency in the water distribution systems
	Minerals Cement	Energy savings	Chemicals	ANN and related solutions (e.g. neuro-fuzzy) within different control loops such as network predictive control regarding energy savings

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SOLUTIONS AND TRANSFERABILITY

AI & BD TECHNOLOGIES AND PROCESSES

ARTIFICIAL INTELLIGENCE TECHNOLOGIES

Data understanding and characterization (DU&C)
Natural language processing (NLP)
Object and spatial recognition (O&SR)
Machine Learning (ML)
Intelligent planning (IP)
Expert systems (ES)
Case based reasoning (CBR)
Intelligent agents (IA)
Cyber-physical systems (CPS)

BIG DATA TECHNOLOGIES

Data visualization (DV)
Data processing (DPc)
Data protection (DPt)
Data management (dDM)
Computing and storage infrastructure (C&SI)

Market trends and Open Innovation (MT & OI)
Product customization/design (PC)
Predictive maintenance (PM)
Supply chain management (SCM)
Process control and optimization (PC & O)
Research and innovation management, planning and design (R&I)

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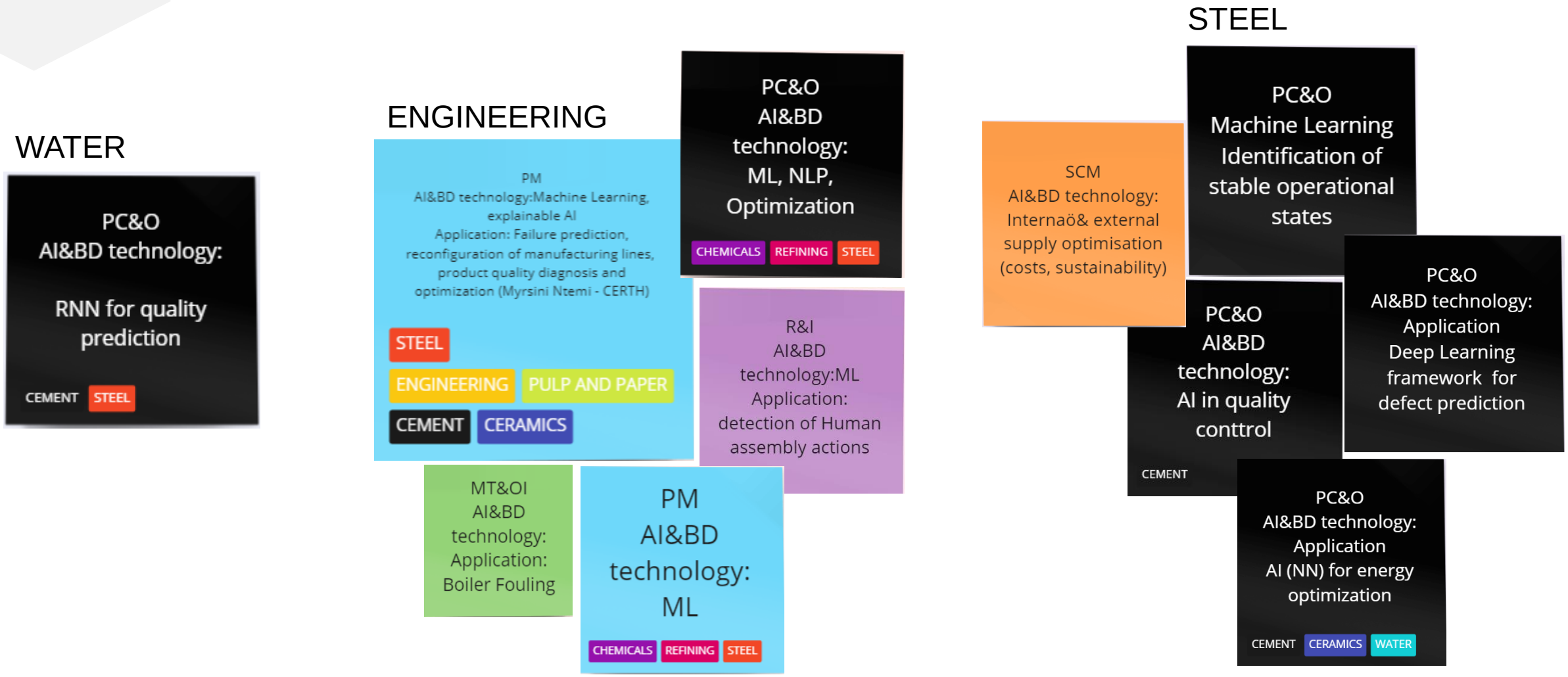
SOLUTIONS AND TRANSFERABILITY

WORKSHOP RESULTS



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SOLUTIONS AND TRANSFERABILITY

WORKSHOP RESULTS

CEMENT

PC&O
AI&BD technology: Application
Cooling system optimization using RNN

STEEL

CHEMICALS

PC&O
AI&BD technology: Application
Hybrid modelling/ Data preprocessing
Spectral data encoding

REFINING

PC&O
AI&BD technology: ML

STEEL
CHEMICALS ENGINEERING

MINERALS

R&I
AI&BD technology: Application: PLANNING

ENGINEERING MINERALS
CEMENT CERAMICS

PM
AI&BD technology: Application. BAGHOUSE

MINERALS PULP AND PAPER
CHEMICALS ENGINEERING
CEMENT CERAMICS

PC&O
AI&BD technology: Application. CONTROL DRYER DRUM

MINERALS
CHEMICALS ENGINEERING
CEMENT CERAMICS

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SOLUTIONS AND TRANSFERABILITY

WORKSHOP RESULTS

SECTOR	PROCESS	TECHNOLGY	APPLICATION	TRANSFERABILITY
WATER	PC&O	RNN	Quality prediction	CEMENT STEEL
WATER	PC&O	ML	To try to achieve zero defects	
ENGINEERING	PM	ML	Failure prediction, reconfiguration of manufacturing lines, product quality diagnosis and optimization	STEEL CEMENT CERAMICS PULP & PAPER
ENGINEERING	PC&O	ML NLP	Optimization	CHEMICALS REFINING STEEL
ENGINEERING	R&I	ML	detection of Human assembly actions	
STEEL	PC&O	ML	Identification od stable opertational states	
STEEL	PC&O	Deep learning	Framework for defect prediction	
STEEL	PC&O	NN	Energy optimization	CEMENT CERAMICS WATER
CEMENT	PC&O	RNN	Cooling system optimization	STEEL

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Barriers

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BARRIERS

AI-CUBE has identified the main common barriers for AI & BD technology solution implementation in the process industry

Participants were asked if they have encountered any of these barriers or any others when implementing AI & BD in their organizations.

Organizational	Unclear business case or strategy
	Missing Consumer Trust and Regulatory Acceptance
	Security Concerns regarding AI adoption
	Lack of Top Management support
	Budget constraints / lack of funding
	Time Constraints
Data	Complexity of data
	Insufficient data quality
	Data privacy
	Insufficient data access / Data sharing between companies
Technology	Limited technology capabilities or IT infrastructure readiness
	Lack of available tools
Human	Lack of Skills or needed talent
	Cultural Resistance

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Identified barriers per sector

WORKSHOP RESULTS

	Water	Engineering	Refining	Steel	Cement	Chemicals	Ceramic	Nonn-ferrous metals	Minerals	Pulp & Paper	
Unclear business case or strategy		■							■		2
Lack of Top Management Support		■		■							2
Misisng Consumer Trust / Regulary Acceptance											
Budget Constraints	■										1
Security Concerns				■							1
Time Constraints	■			■	■						**3**
Complexity of data		■	■			■			■		**4**
Data privacy									■		1
Insufficient data quality	■			■		■			■		**4**
Insufficient data access	■	■	■	■		■			■		**6**
Lack of available tools	■				■				■		**3**
Limited IT infrastructure readiness	■	■			■						**3**
Lack of Skill / talent				■	■						2
Cultural resistance		■		■							2

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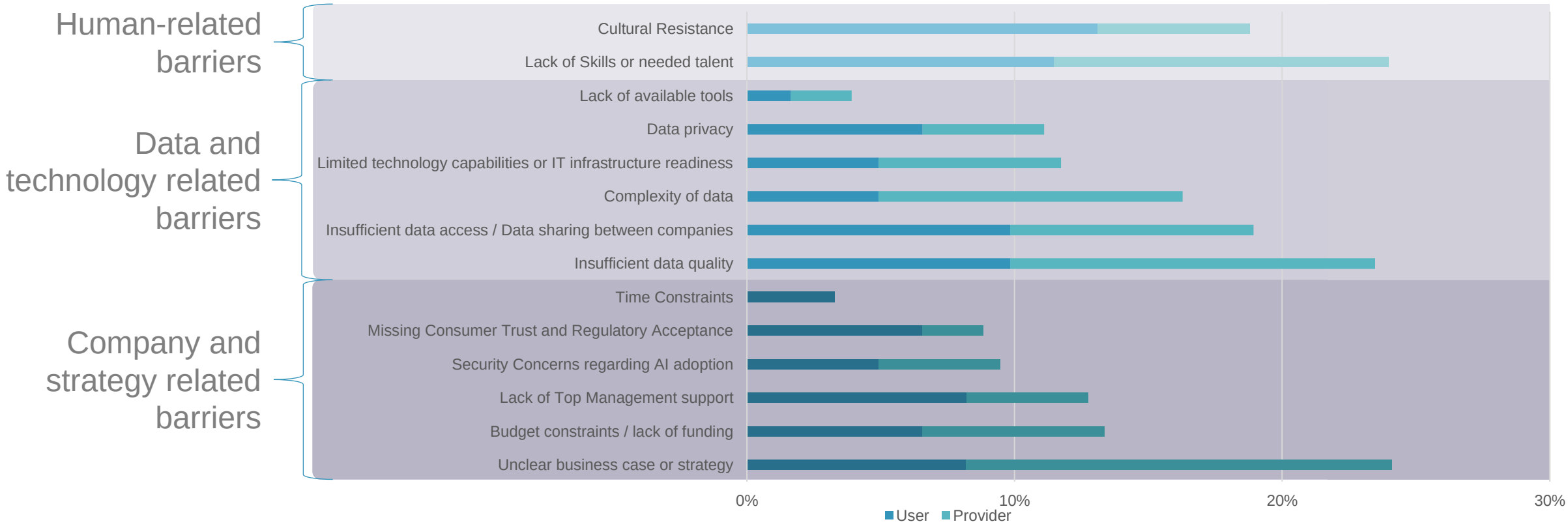
Barriers for AI or BD implementation

Interim analysis of our Online Survey



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Solutions to address the barriers in implementation

Cultural Resistance	Change Management | Transparent communication | Participation | development of overall vision | Top Management support | Explainable AI
Lack of Skills or needed talent	Separation in Primary and Secondary skills | Internal upskilling | collaboration with educational institutions
Lack of available tools	Open Source Frameworks | Implementation of existing tools | Use Case simplification
Complexity of data	Dimension reduction | Data transformation | Complexity reduction methods | Complexity management through tools
Limited IT infrastructure readiness	Focus on most important aspects | Cloud computing | Requirement identification through POC
Data privacy	Secure Data Interfaces | External assessments and certifications | Focus on necessary data | Reduction of personal data
Insufficient data access / Data sharing	Internal Communication | Contractual agreements | safe interfaces | Unified information models | Open source data sets
Insufficient data quality	Data Cleaning Methods | Consistent standardised approaches | Data Augmentation
Time Constraints	Use Case Reduction for POC | Focus on Value Creation | Expansion Roadmap
Missing Consumer Trust / Regulatory Acceptance	Clarity of Responsibilities | Transparency | Certification | Open Communication
Budget constraints / lack of funding	Focussing on Core issues (Scope Reduction, POC) | Transfer of existing solution | Collaborative projects | Public Funding
Security Concerns regarding AI adoption	Predictive Risk Management | Fall back scenarios | Security rules | Security Infrastructure | External certification
Lack of Top Management support	Creation of Awareness | Anchoring the AI strategy in the corporate philosophy | proactive Analysis of potentials
Unclear business case or strategy	Definition of Success | Stakeholder Integration (internal and external) | Use of Roadmaps | Proactive Planning

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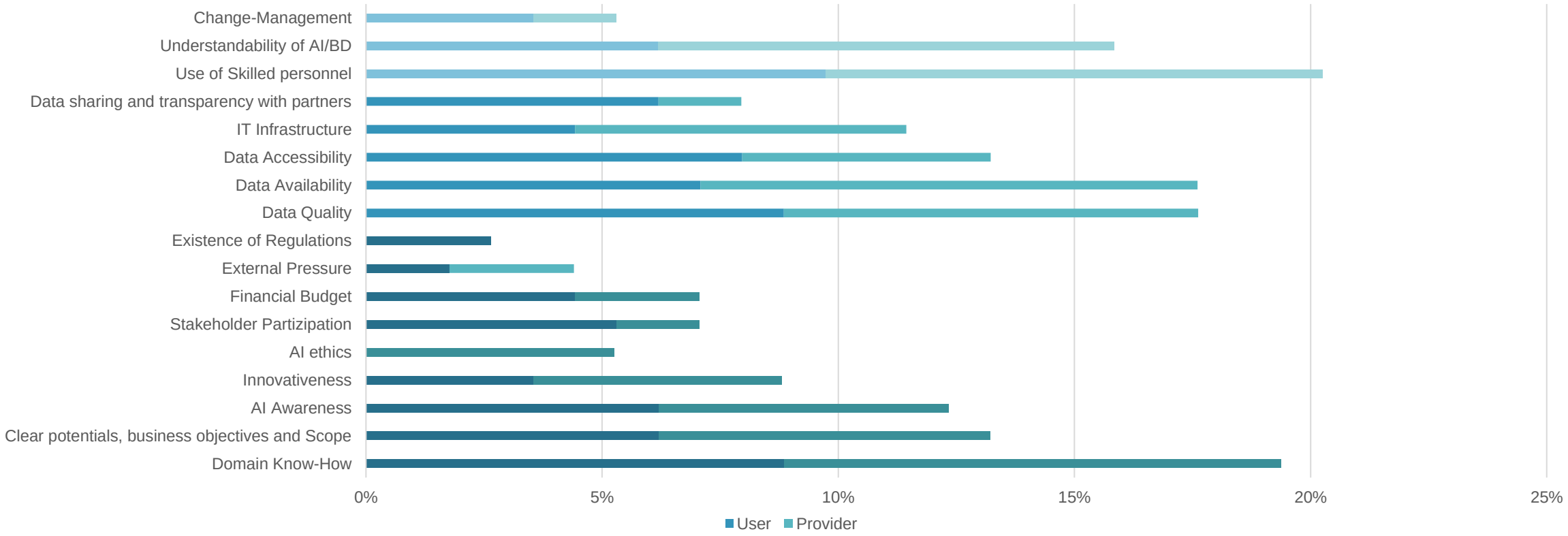
Identified Enabling factors

Interim analysis of our Online Survey



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Implementation process that considers the barriers

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MATURITY LEVEL ANALYSIS

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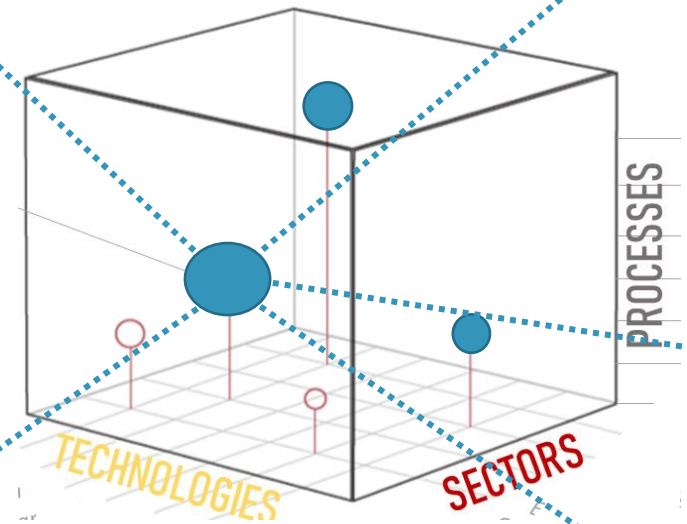
Maturity level model

Strategy → the strategic alignment of a company towards the AI/BD application. A clear AI/BD strategy should be integrated with the corporate level, and committed by the top management. AI/BD are considered as a competitive advantage for successful companies, and are aligned with the ethical, legal, and social issues.

Data → Features of the data in terms of richness, transparency, frequency, quality, formatting, capabilities to process unstructured data.



Organisation → the role of AI/BD experts and AI/BD governance capabilities within the company and its organisational structure. These aspects can affect the financial status and companies' capabilities to handle their AI/BD applications internally.

Technology → availability of AI/BD technologies within the different processes of a company, level of usage, human-interaction.

People → role and approach of employees towards AI/BD, training level, skill development, training aligned to the AI/BD objectives of the company.

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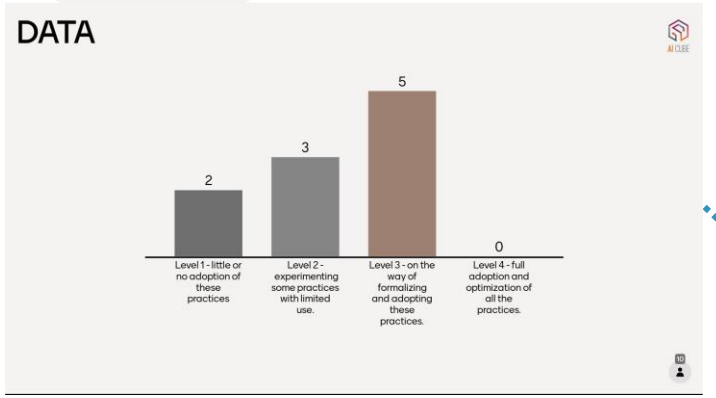
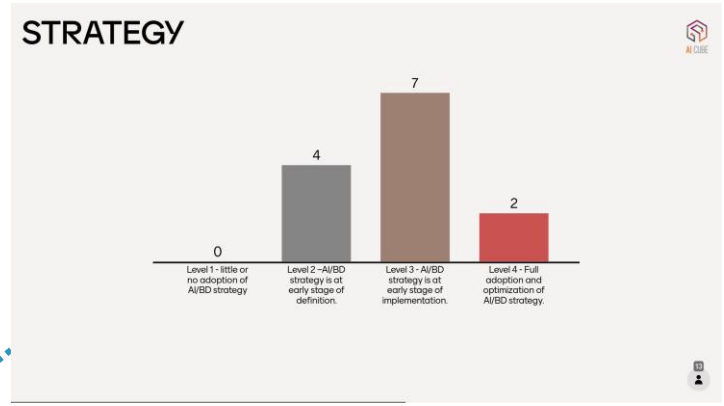
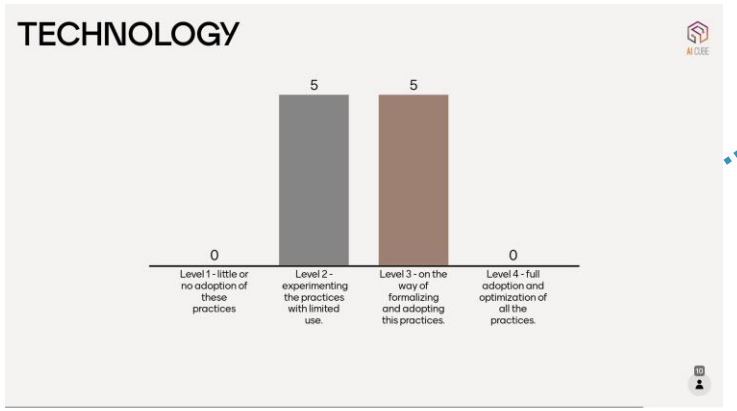
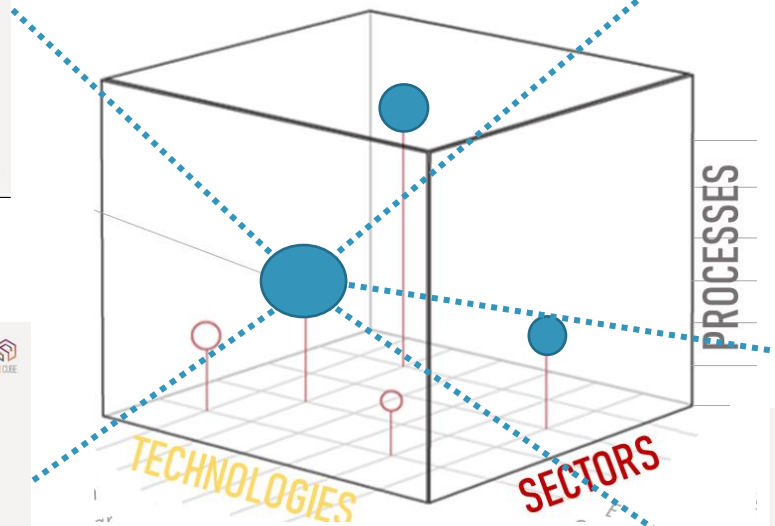
Maturity level model

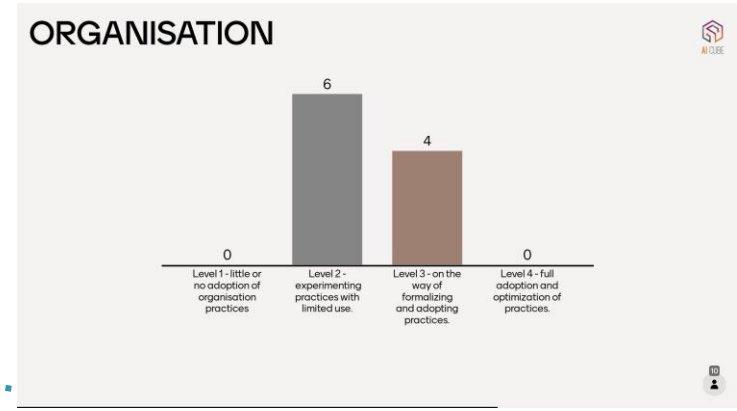
WORKSHOP POLLING RESULTS

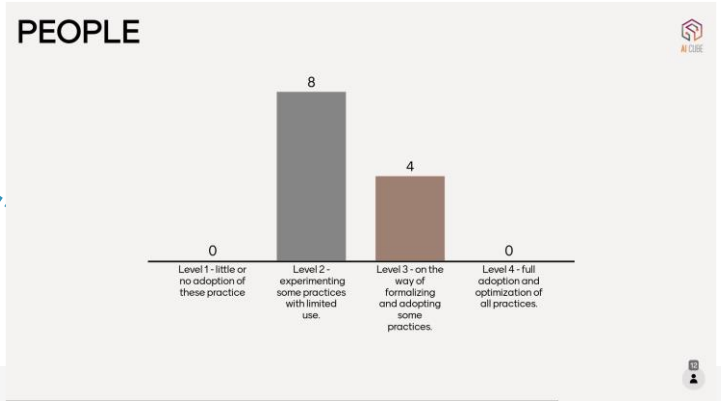












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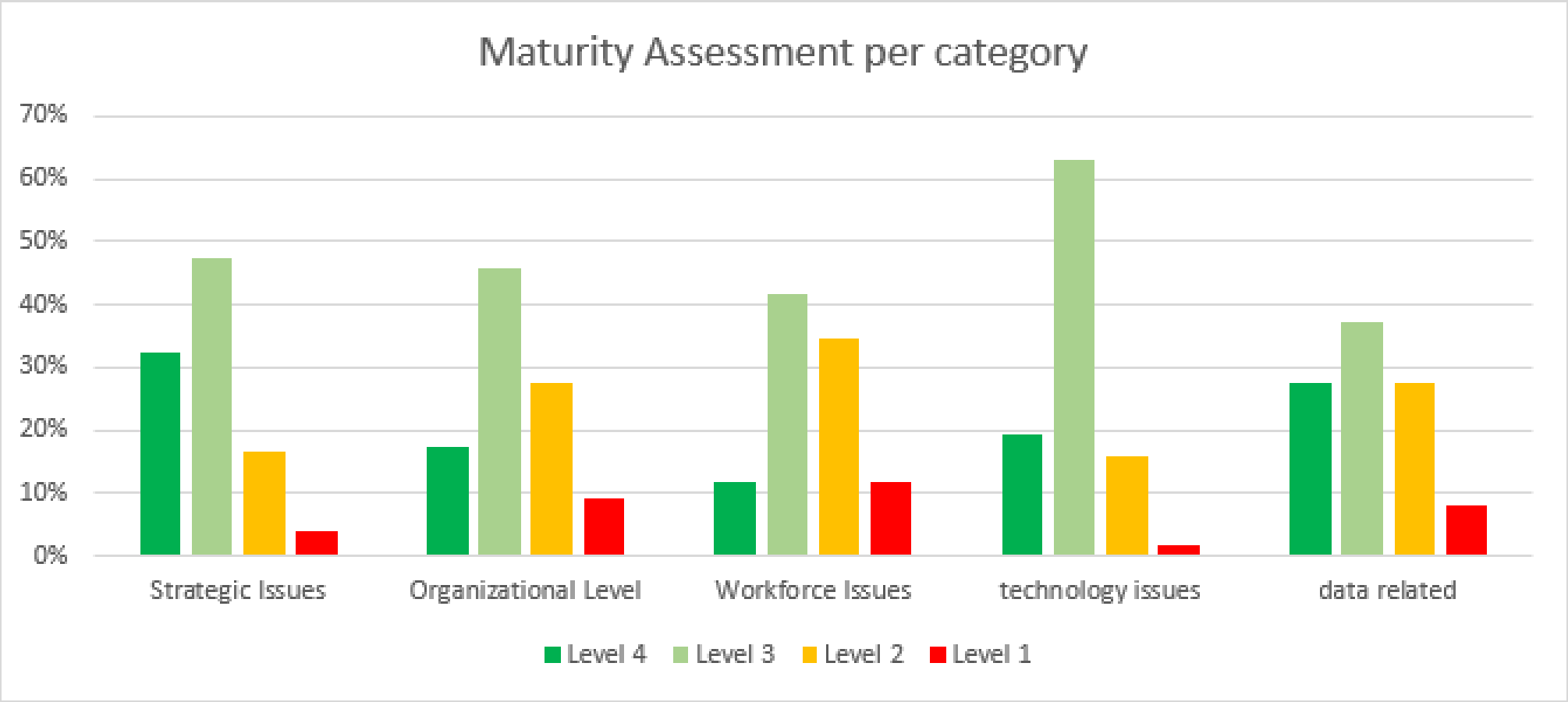
Maturity level model

ONLINE SURVEY RESULTS



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Call for Implementation Cases and Business Models

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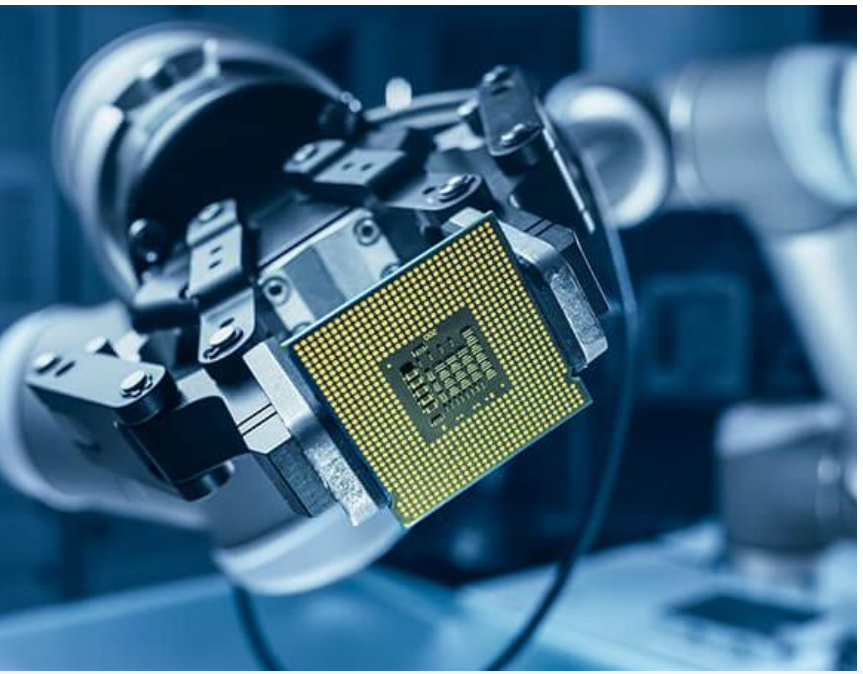
Implementation cases and business models call



We are looking for implementation cases of sucessful AI & BD technology solutions implementation in the process industry.

- Application understanding
- Requirements and barriers
- Achievements and benefits

Did the solution improve, change or create a new business model?

Fill in the form **here** with your example!

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AI CUBE

Thank you very much for your contribution

Contact: amartinez@zlc.edu.es

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