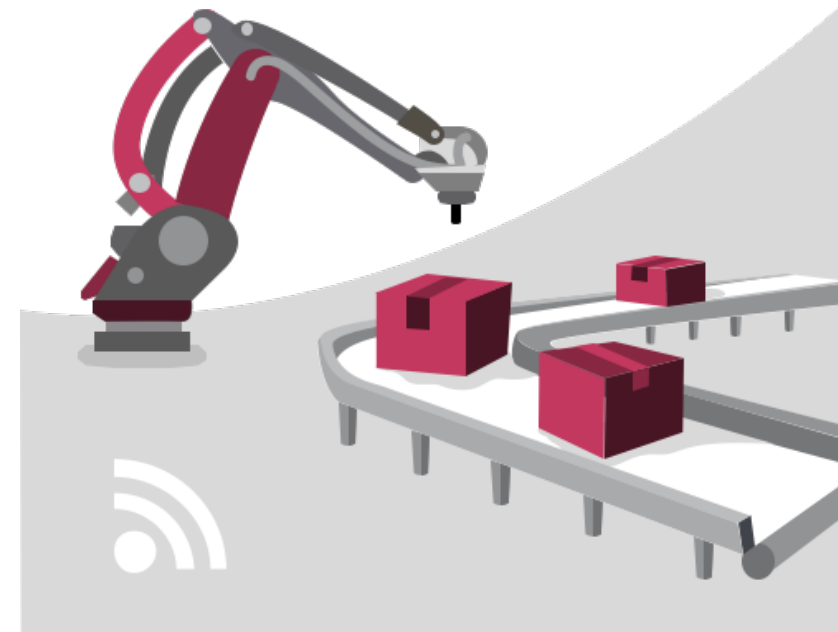


How to Start with Industry 4.0 in SMEs

Practical Roadmap for Industry 4.0 Introduction in SME

24th of November, 2017
Chambre de Commerce, Luxembourg



Portfolio

IPL - Institute for Production and Logistics Systems



Global orientation

- Worldwide projects
- Located in the Greater Region of FR, LU, DE



Production & logistics

- Greenfield-/Brownfield-concepts
- Development and transformation of production systems



Strategy consulting

- **Industry 4.0 Roadmapping**
- Supply chain organisation
- Design of material flow



Qualification, coaching and training

- Lean Six Sigma
- Company and supplier development



European Research and Development

- Academic research methodology
- Development of innovative methods for practical application



Management and organisation

- Project management
- Interims-management & service

Agenda

Content of Presentation

- Introduction
 - Strategic need for Industry 4.0 in the SME sector
 - Introductory examples
- Methodology for creating an individual Roadmap Industry 4.0
 - Phase 1: Company analysis
 - Phase 2: Identify opportunities
 - Phase 3: Select and evaluate opportunities
 - Phase 4: Create and realize Roadmap
- Summary

Strategic Need for Industry 4.0

Enablers, Opportunities and Risks

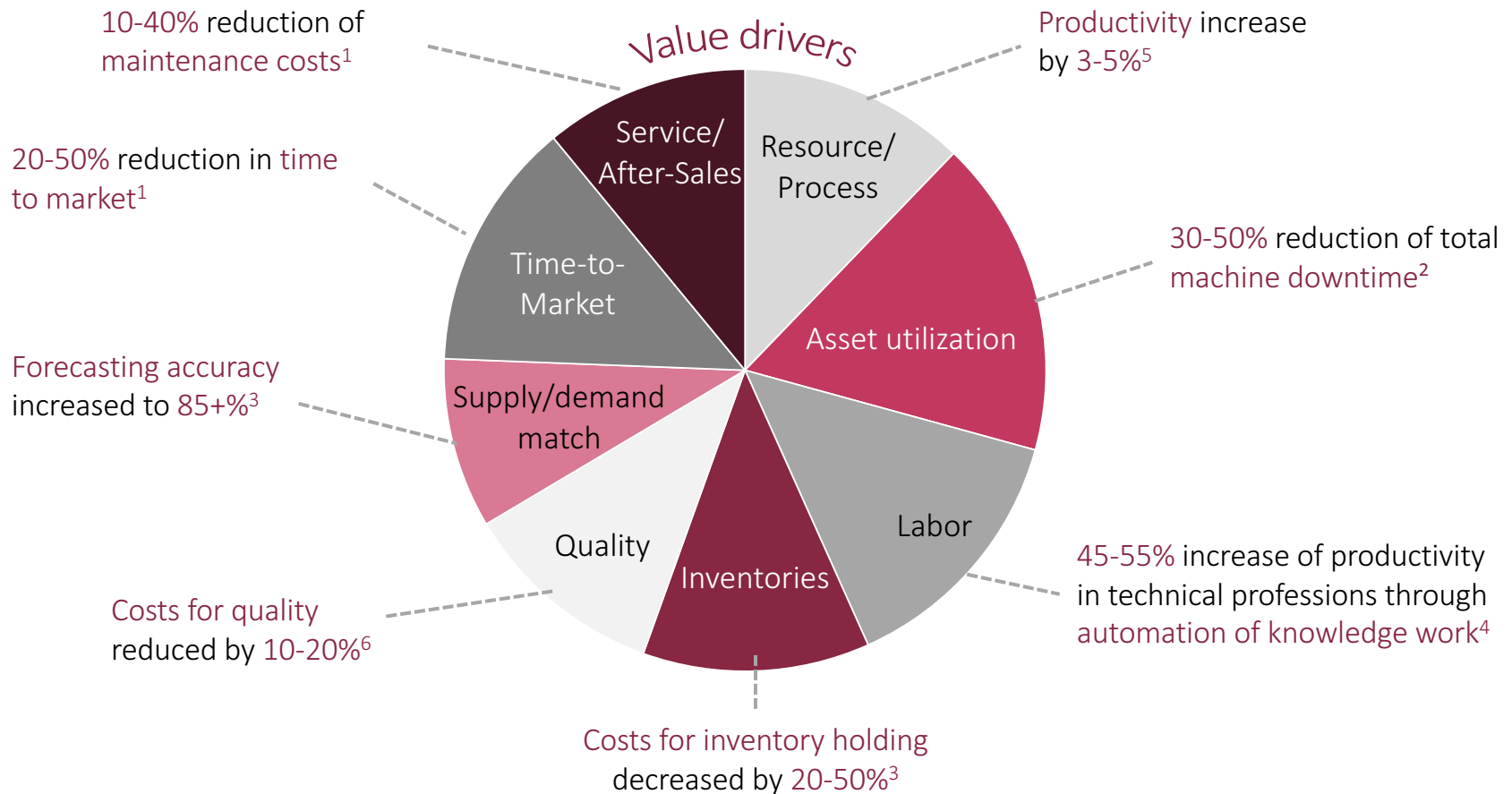
Enablers	
1	<p>Digitalization („Big Data“)</p> <ul style="list-style-type: none"> Increasing availability of data about customer, product and production
2	<p>Connectivity and communication (ICT)</p> <ul style="list-style-type: none"> Internet of Things (IoT) Real-time communication Permanent availability of broadband connections for large data
3	<p>Disruptive technologies/software</p> <ul style="list-style-type: none"> Cyber Physical Systems: lightweight robots, Automated guided vehicles, drones, 3D printing, VR / AR, mobile devices, pick-by-tech, etc. Business Analytics, AI, Blockchain

Opportunities	
Efficient production	<ul style="list-style-type: none"> Vertical/horiz. integration Supply Chain transparency Process automation Flexibility and agility
New business / products	<ul style="list-style-type: none"> New services Mass customization New types of cooperation
Barriers / Risks	
<ul style="list-style-type: none"> Delay due to unclear cost-benefit ratio Deficits prevent implementation: lack of technology and knowledge, rigid organizational structures, poor master data, etc. Culture of preservation and lack of courage grants competition time-critical advantages 	

A clever combination of enablers in own company leads to new opportunities

Indicative Opportunities of Industry 4.0

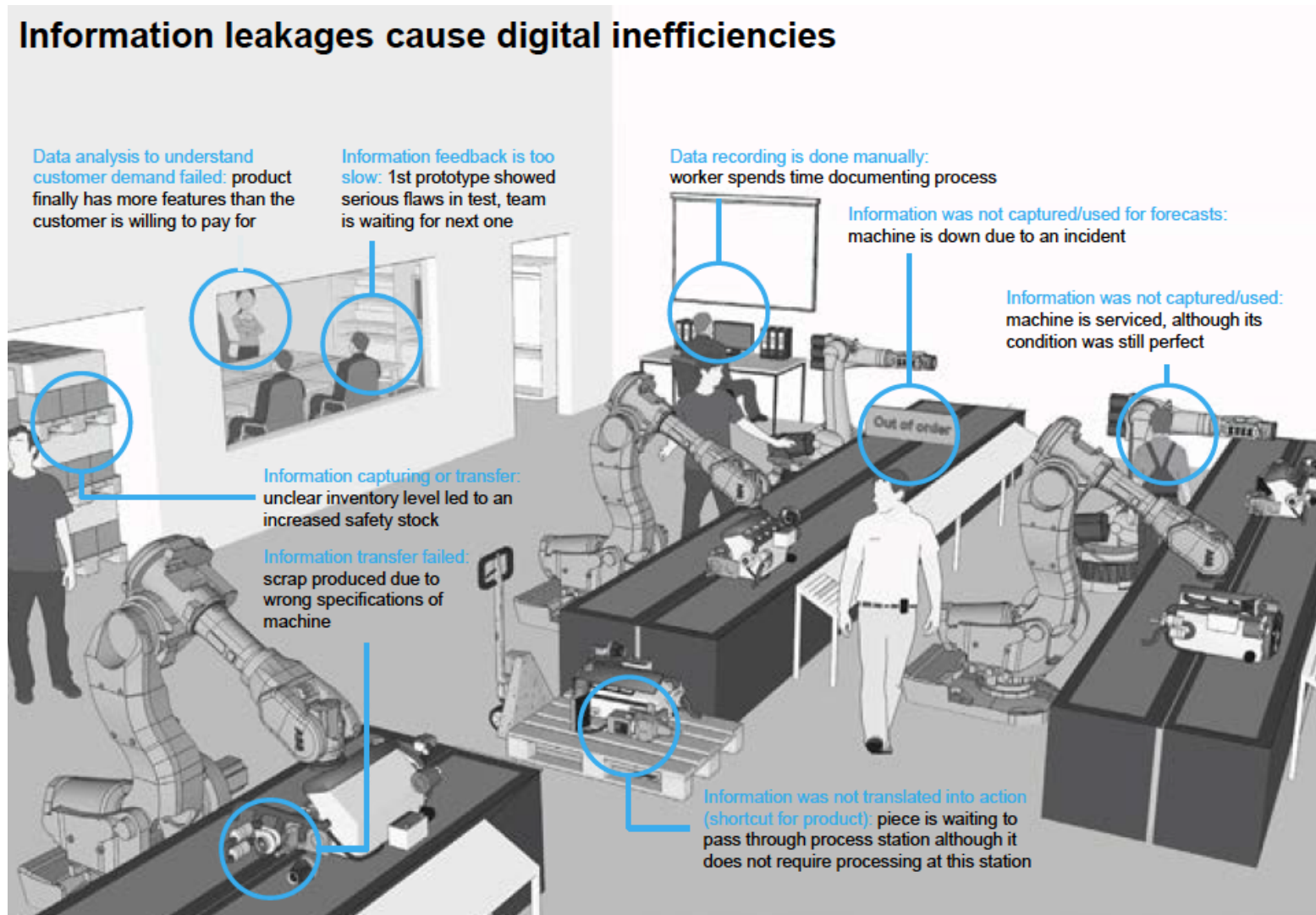
Value Drivers for Potentials according to McKinsey



1 Cf. McKinsey Global Institute: Big data: The next frontier for innovation, competition, and productivity 2 McKinsey analysis
3 McKinsey analysis 4 Cf. McKinsey Global Institute: Disruptive Technologies 5 See, for example, ABB case study
6 Cf. T.Bauernhansl, M. ten Hompel, B. Vogel-Heuser (Hrsg.): Industrie 4.0 in Produktion/ Automatisierung/Logistik (2014)

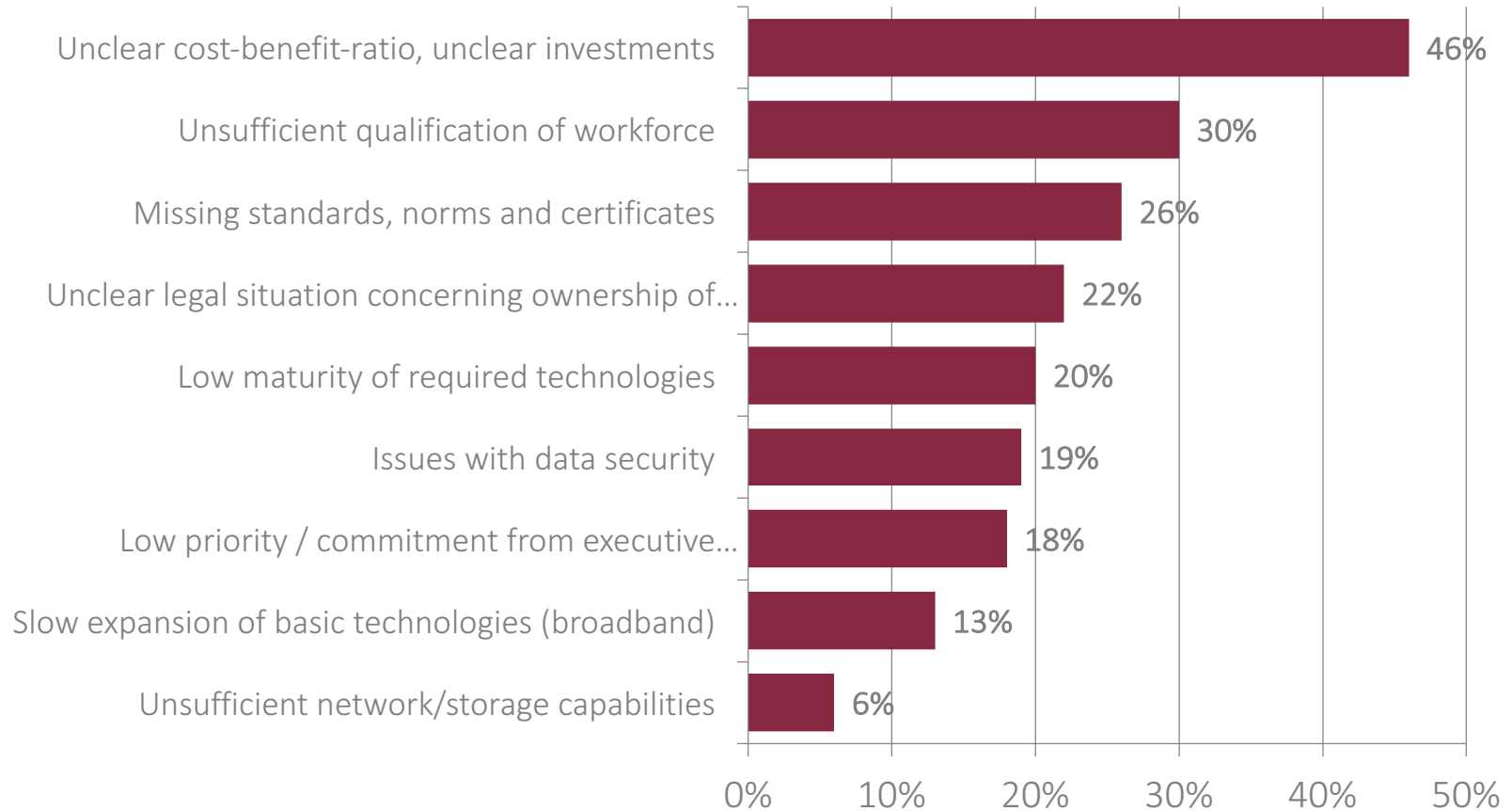
A New View on Waste

„Digital Waste“ by Unused Information according to McKinsey



Indicative Barriers for Industry 4.0 Introduction

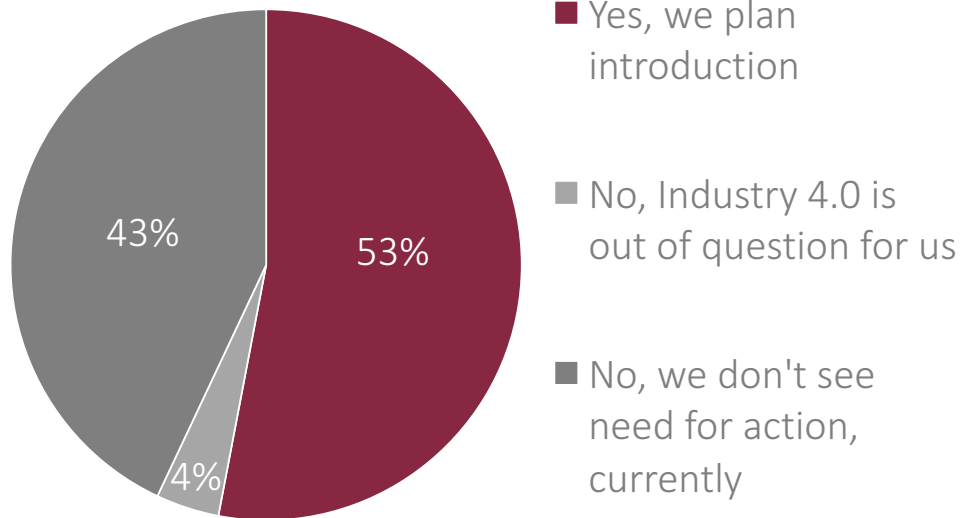
Challenges for a Successful Implementation of Industry 4.0



Facts about Industry 4.0 in SMEs

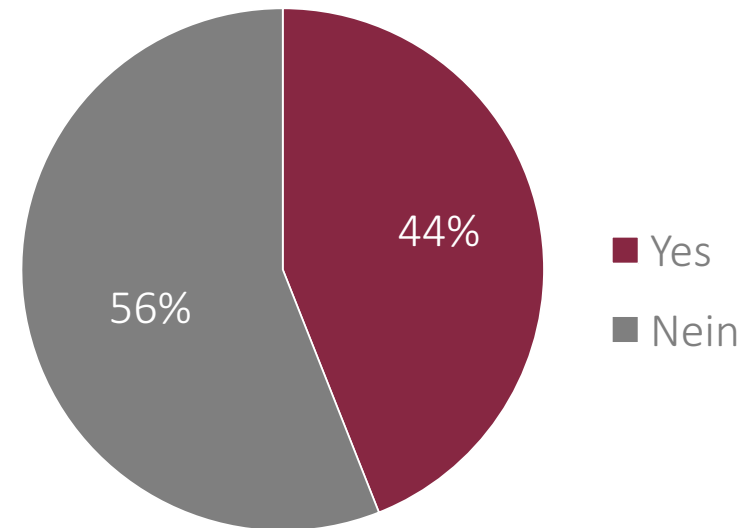
Status introduction and implementation of Industry 4.0 in Germany

Do you plan specific investments in Industry 4.0 applications?



Planned use of Industry 4.0-applications.
Result of questionnaire – Industry 4.0 in SME, n=202.

Is your company using Industry 4.0 applications?

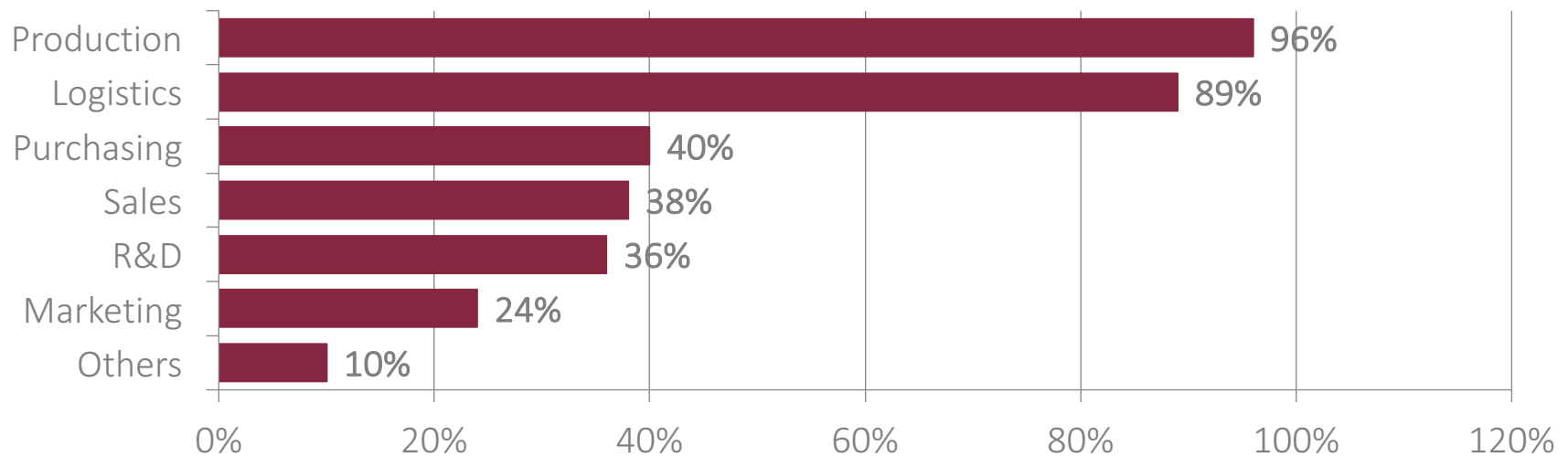


Current use of Industry 4.0-applications.
Result of questionnaire – Industry 4.0 in SME, n=297

Facts about Industry 4.0 in SMEs

Application

In which areas of the company could you imagine using Industry 4.0 applications?

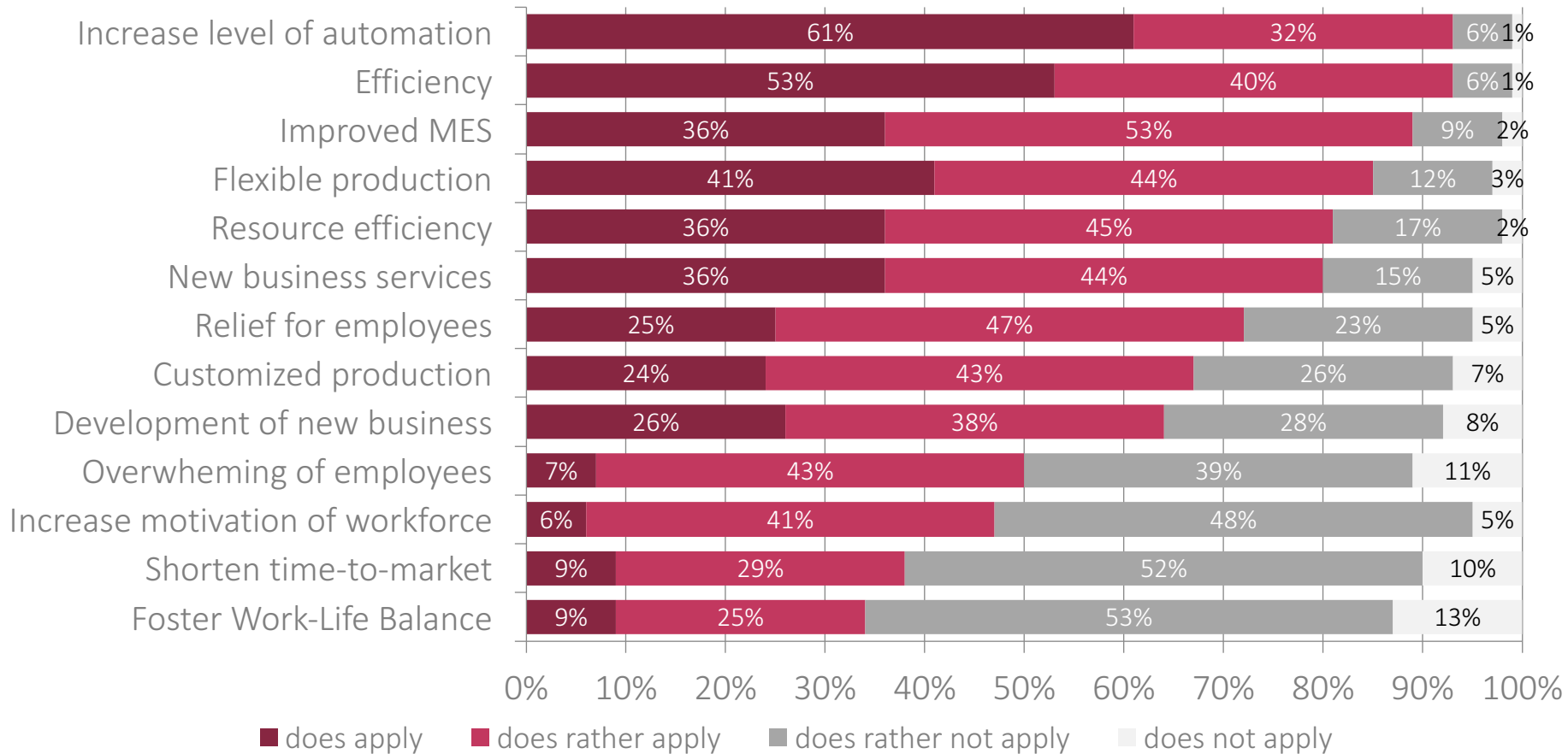


Application of Industry 4.0
Result of questionnaire – Industry 4.0 in SME, n=293, multiple answers possible.

Facts about Industry 4.0 in SMEs

Potential Benefits

Which of the following opportunities by Industry 4.0 do you consider realistic?



Opportunities for Industry 4.0
Result of questionnaire – Industry 4.0 in SME, n= 295, multiple answers possible

Industry 4.0 in Marketing & Sales

Introductory Example for Marketing 4.0 in the Apparel Industry

„BigData Monitor“

- Comprehensive analysis of sales data for high variety fashion products
- Increase expertise of responsible employees
- Development of a data model for early warnings in customer demand
- Model provides probability of success of a new product before market entry
- Eases decision making in product development
- Reduction in number of variants



Industry 4.0 in Production

Introductory Example for Craftsmanship 4.0

Observational studies and situational analysis for construction sites

Sensoren



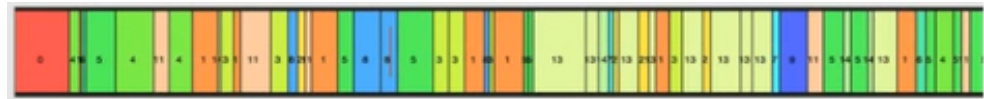
- **Google glass**
Accelerometer
Gyroscope
Magnetometer
Linear acceleration
Rotation vector



- **Smart Watch**
Accelerometer
Gyroscope
Magnetometer
Air pressure
Linear acceleration
Rotation vector



0	Null
1	Walking
2	Wander
3	Carry
4	Carry Heavy
5	Use Hands
6	Use Knife
7	Use Hammer
8	Use Drill Machine
9	Use Saw Machine
10	Use Glue Pistol
11	Talk
12	Talk on Phone
13	Measure
14	Look Around
15	Collect Trash
16	Use Broom
17	Climb



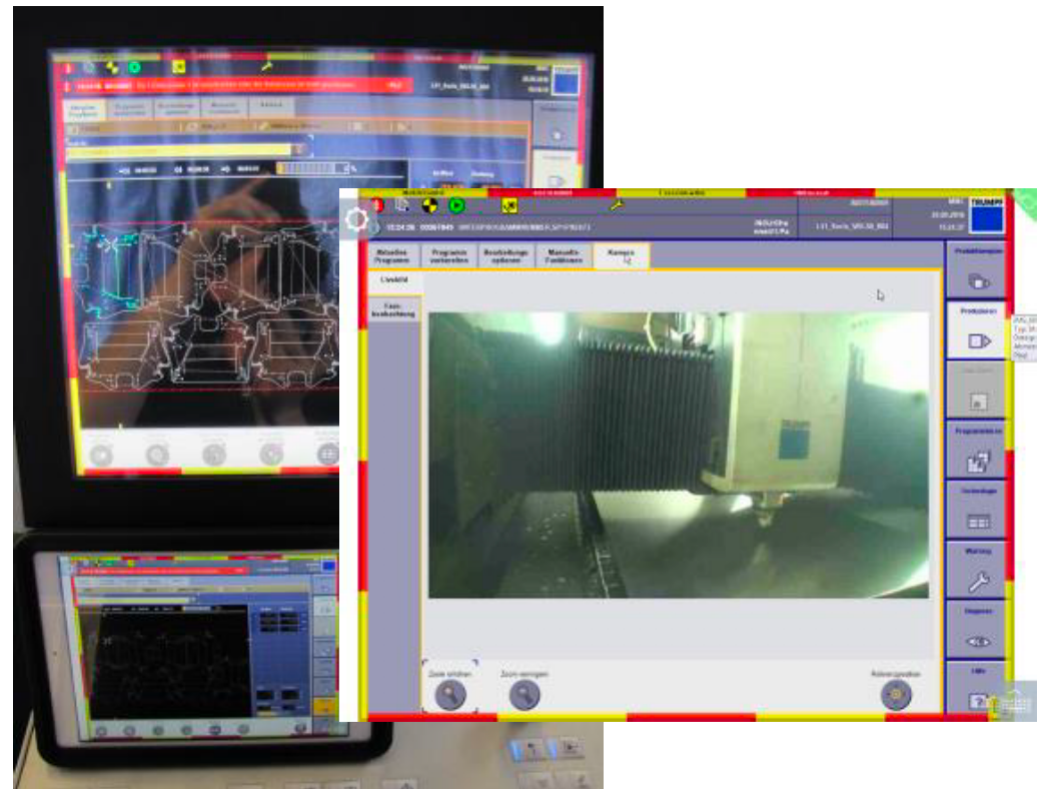
Industry 4.0 in Production

Introductory Example for Maintenance 4.0

Machine condition monitoring at
AGFA Peißenberg and maintenance
via Internet 24/7

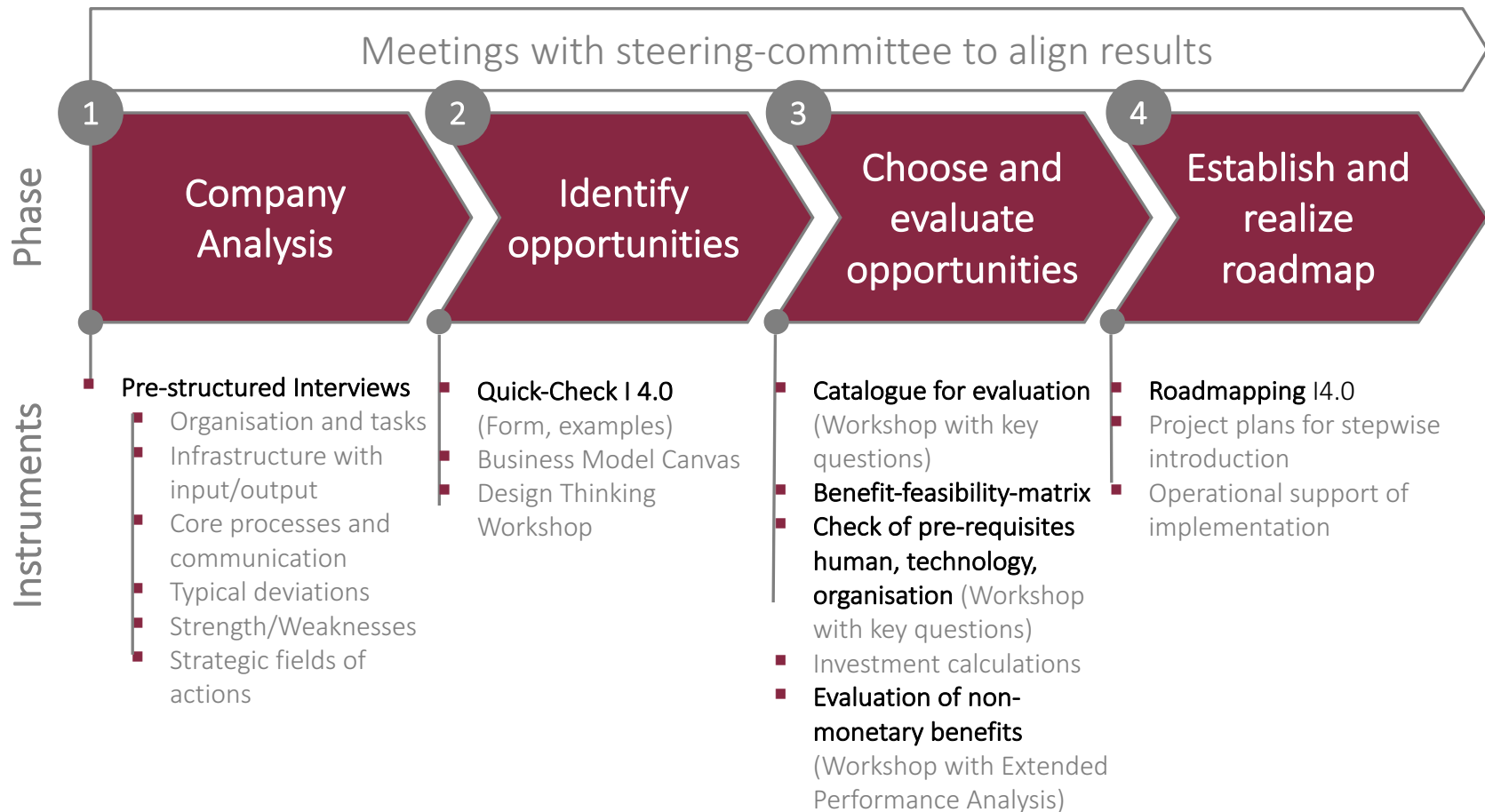
„Mobile ControlApp“

- Get machine information
- Make program changes
- Integrated camera transmits video from production process live to iPad
- Online monitoring from "outside"



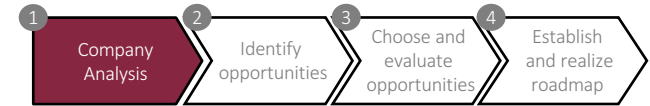
Individual Company Roadmap for Industry 4.0

Approach, Phases and Instruments



Phase 1: Company Analysis

Pre-structured Interviews Interviews Map
the Current State of the Company



A) Organization and tasks

- Organisation, R&R
- Tasks and focus of departments
- Qualification of employees

B) Infrastructure and I/O

- Important resources (machines, licenses, etc.)
- Input and outputs from relevant departments

C) Core processes and comm.

- Important processes/products in/from departments
- Communication structures

D) Defects and deviations

- Typical issues and deviations in different departments
- Issues between departments as well as customers/suppliers

E) Strength/Weaknesses

- Strength/weaknesses of departments, products, company
- Strength/weaknesses to customers or with suppliers

F) Strategic fields of action

- Strategic change requests
- Future market potential
- Different view points from employees and executives

Phase 2: Identify Opportunities

Quick-Check I4.0 for Production

Six application levels with five technological and sequential development stages support brainstorming of ideas



Quickcheck Industry 4.0 Production		Industrie 4.0				
1	Data processing in the production	No processing of data	Storage of data for documentation	Analyzing data for process monitoring	Evaluation for process/planning control	Automatic process planning/control
2	Machine-to-machine Communication (M2M)	No communication	Field bus interfaces	Industrial ethernet interfaces	Machines have access to internet	Web services (M2M software)
3	Company-wide networking with the production	No networking of production with other business units	Information exchange via mail/telecommunication	Uniform data formats and rules for data exchange	Uniform data formats and interdivisionally linked data servers	Inter-divisional, fully networked IT-solutions
4	ICT infrastructure in production	Information exchange via mail/telecommunication	Central data servers in production	Internet-based portals with data sharing	Automated information exchange (e.g. order tracking)	Suppliers/customers are fully integrated into the process design
5	Man-machine interfaces	No information exchange between user and machine	Use of local user interfaces	Centralized/decentralized production monitoring/control	Use of mobile user interfaces	Augmented and assisted reality
6	Efficiency with small batches	Rigid production systems and a small proportion of identical parts	Use of flexible production systems and identical parts	Flexible production systems and modular designs for the products	Component-driven, flexible production of modular products within the company	Component-driven, modular production in value-adding networks

Quick-Check-interviews or workshops reveal

Current state ———

Future state - - - -

Quick-Check Production: Data processing

Example: Inventory Management





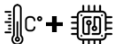




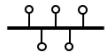














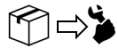


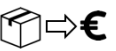



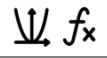
No processing of data	Storage of data for documentation	Analysing data for process monitoring	Evaluation for process planning / control	Automatic process planning / control
<p>Manual disposition (order point) for C-parts in traditional containers</p> <p>6)</p>	<p>Documentation of replenishment; manual ordering process</p> <p>7)</p>	<p>Data Analytics with data based inventory reduction</p> <p>8)</p>	<p>Know-how automation for inventory planning (Cognitive Computing)</p> <p>9)</p>	<p>iBin: automatized inventory detection and trigger for purchase orders</p> <p>10)</p>
<p>Human Manual process</p> <p>Technology: Traditional</p> <p>Organisation: Skilled labor required</p>	<p>Human: Manual process</p> <p>Technology: traditional</p> <p>Organisation: Standardized work</p>	<p>Human: Competency in data</p> <p>Technology: ERP & Software</p> <p>Organisation: Consistent Master data</p>	<p>Human: Acceptance by worker</p> <p>Technology: Data Analytics Tool</p> <p>Organisation: Clarified legal basis</p>	<p>Human: Only for escalation</p> <p>Technology: RFID, optical camera, ERP</p> <p>Organisation: Skilled labor, consistency</p>

Phase 2: Identify Opportunities

Quick-Check I4.0 for Product / Business Model

Six application levels are also available for new products or business models, each with five consecutive development stages for brainstorming








Quickcheck Industry 4.0						
Product						
					Industrie 4.0	
1	Integration of sensors/ actuators	 No use of sensors/actuators	 Sensors/actuators are integrated	 Sensor readings are processed by the product	 Data is evaluated for analyses by the product	 The product independently responds based on the gained data
2	Communication/ Connectivity	 The product has no interfaces	I/O  The product sends or receives I/O signals	 The product has field bus interfaces	 The product has Industrial Ethernet interfaces	 The product has access to the internet
3	Functionalities for data storage and information exchange	 No functionalities	 Possibility of individual identification	 Product has a passive data store	 Product with data storage for autonomous information exchange	 Data and information exchange as integral part
4	Monitoring	 No monitoring by the product	 Detection of failures	 Recording of operating condition for diagnostic purposes	 Prognosis of its own functional condition	 Independently adopted control measures
5	Product related IT-services	 No services	 Services via online portals	 Service execution directly via the product	 Independently performed services	 Complete integration into an infrastructure of IT services
6	Business models around the product	 Gaining profits from selling standardized products	 Sales and consulting regarding the product	 Sales, consulting and adaption of the product to meet customer specifications	 Additional sale of product-related services	 Sale of product functions

Quick-Check Product: Monitoring

Example: Product Safety in Transportation



No monitoring by the product	Detection of failures	Recording of operating condition for diagnostic	Prognosis of its own functional condition	Independently adopted control measures
<p>Passive security with warning, sturdy packaging, bubble wrap</p>  <p>1)</p> <p>Enviro Pack GmbH</p> <p>Human Manual process</p> <p>Technology: Proper packaging</p> <p>Organisation: Skilled labor required</p>	<p>Tilting indicator for transport control</p>  <p>2)</p> <p>TransPack-Krumbach GmbH</p> <p>Human: Manual process</p> <p>Technology: Tags</p> <p>Organisation: Control of tags</p>	<p>DropTagEVENT: Low-cost tool for condition monitoring</p>  <p>3)</p> <p>Cambridge Consultants Ltd & Inc</p> <p>Human: Act based on data</p> <p>Technology: Sensor, App, Server</p> <p>Organisation: Consistent Master data</p>	<p>Packaging provides prognosis about functionality of goods</p>  <p>4)</p> <p>DB Schenker Security Guard</p> <p>Human: Escalation only</p> <p>Technology: Sensors, Software</p> <p>Organisation: Reliable data/limits</p>	<p>Packaging with self-correction in case of environmental issues</p>  <p>5)</p> <p>Human: Escalation only</p> <p>Technology: Innovation required</p> <p>Organisation: Customer acceptance</p>

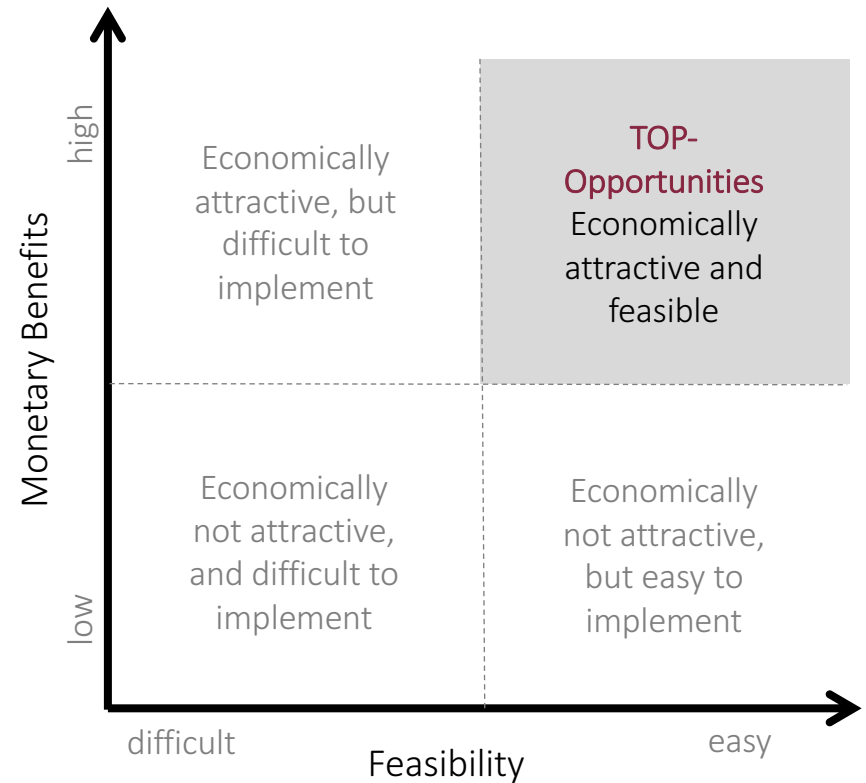
Phase 3: Choose and Evaluate Opportunities

Evaluation Catalogue and Benefit-Feasibility-Matrix



Economic benefits – Smart Production			
Criteria	Key Questions	Relevance	0=low, 6=high
Direct monetary benefits	What are the direct monetary benefits of the actions planned?		
Turnover	What are the effects on turnover if the planned measures will realize?		
Cost reduction	What is the cost effects if the planned measures will realize?		
Governmental grants	What is the effect of governmental grants or tax relief if measures are realized		
Indirect monetary	What are the indirect monetary benefits of the		






⇒ **Key questions** support a factual assessment of cost-effectiveness and feasibility of the planned measures



Phase 3: Choose and Evaluate Opportunities

Derive and Evaluate Necessary Pre-requisites
for Industry 4.0 Transformation



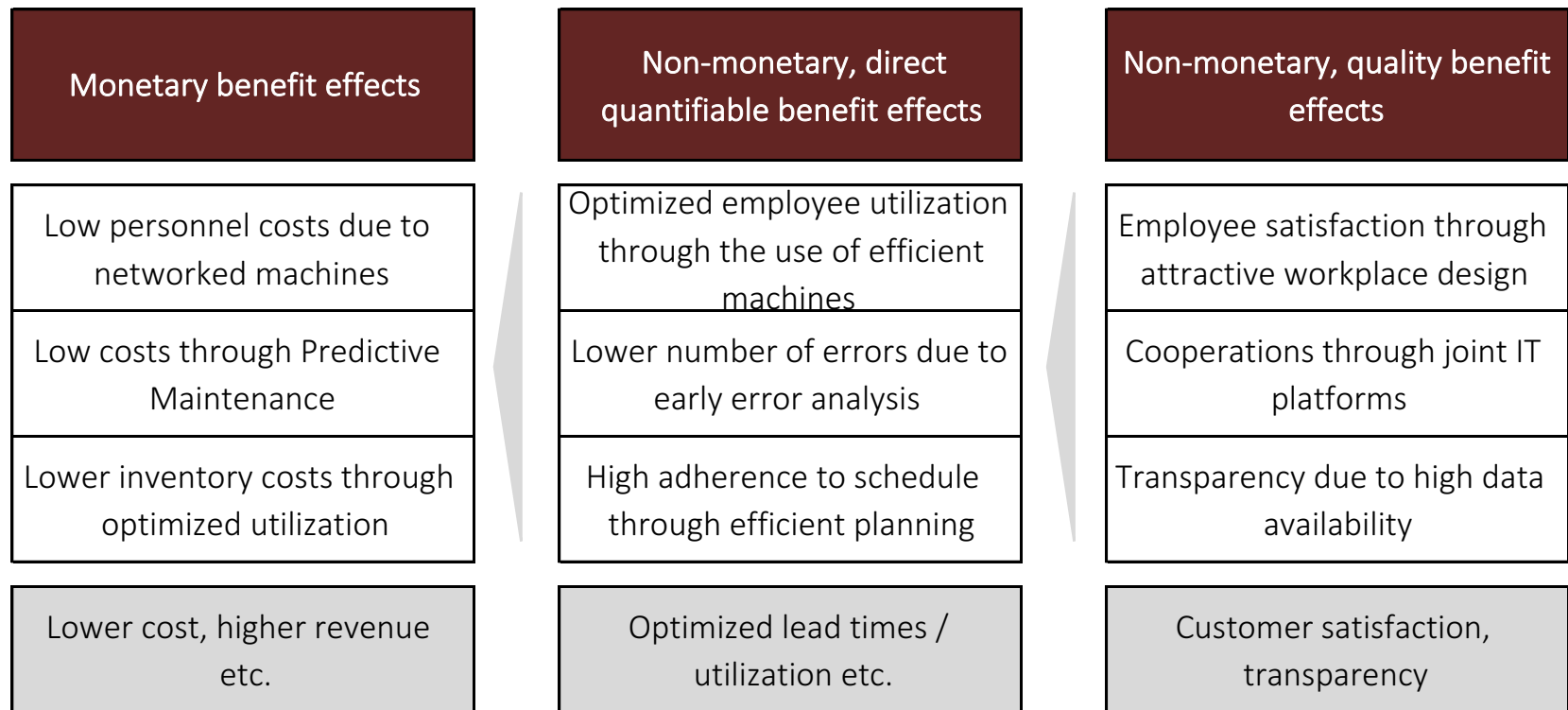
	Human	Technology	Organization
 Level 1 Production/ Product	<ul style="list-style-type: none"> Competence in dealing with physical thing, e.g. Operation of machines 	<ul style="list-style-type: none"> Functional product, e.g. Pump Functional production/service technology, e.g. punching machine and corresponding maintenance services 	<ul style="list-style-type: none"> Targeted business organization, e.g. lean production
 Level 2 Sensor and Actuator	<ul style="list-style-type: none"> Competence in data analysis Competence in sensor technology Cross-employee IT competencies (networking of systems) 	<ul style="list-style-type: none"> Actuating Identifiers (Barcode, RFID etc.) Sensors 	<ul style="list-style-type: none"> Data consistency Clearly clarified legal basis regarding automated data usage Uniform IT system landscape
 Level 3 Connectivity	<ul style="list-style-type: none"> Generalists with a holistic understanding of complex systems Competence in data protection Competence in data security Competence in network technology Cross-employee IT competencies (networking of systems) 	<ul style="list-style-type: none"> Connection of production facilities Broadband network internal/external Cloud Server Fieldbus Internet interface to attachments IT security system Local data storage (e.g. SD Card) 	<ul style="list-style-type: none"> Acceptance in the added value network Acceptance by the customer Data consistency Clearly clarified legal basis (data use in automated data exchange, on the internet regarding the ownership of data)
 Level 4 Analytics	<ul style="list-style-type: none"> Establishment of the job profile "Data Scientist" Extended competence in data protection Extended competence in data security Competence in data analysis 	<ul style="list-style-type: none"> Algorithms for data analysis Datawarehouse Data interface between machine and database Suitable analytics software 	<ul style="list-style-type: none"> Clearly clarified legal basis regarding personal data
 Level 5 Digital solution	<ul style="list-style-type: none"> Extended competence in algorithms Extended competence in data analysis Generalists with a holistic understanding of complex systems 	<ul style="list-style-type: none"> Remote Module 	<ul style="list-style-type: none"> Acceptance by the customer Suitable software

Workshop with key questions will reveal required measures and additional investments to create **pre-requisites** in terms of

- Human
- Technology
- Organization

Phase 3: Choose and Evaluate Opportunities

Monetary and Non-monetary Benefit Effects



⇒ Better transparency in cost-benefit ratio through consideration of non-monetary benefit effects

Phase 3: Choose and evaluate Opportunities

Financial Evaluation of Non-monetary Benefits



	Monetary benefits	Non-monetary, direct quantifiable benefit effects	Non-monetary, quality benefit effects	
Revenue increase in T€ per year	Existing customers		Transparency	
	Revenue existing customers in Mio. € per year			
	Actual	Desired		Delta
80	80.67	1%		
Cost cutting in T€ pro Jahr	Existing customers			
	Revenue new customers in Mio. € per year			
	Actual	Desired		Delta
10	10.08	1%		
Monetary effect in T€ per year	Route optimization			
	Travel cost per maintenance per day in €			
	Actual	Desired	Delta	
20	18.74	-6%		
Storage costs	Calculated storage costs in T€ per year			
	Actual	Desired	Delta	
	210	206.91	-1%	
Redamation costs	Calculated redamation costs in T€ per year			
	Actual	Desired	Delta	
		Product quality		
		Downtime plant in h per year		
		Actual	Desired	Delta
		10	9.6	-4%
		Maintenance planning		
		Number of maintenances per day		
		Actual	Desired	Delta
		20	23.75	19%
		Warehousing		
		Inventory turnover rate on filter		
		Actual	Desired	Delta
		3	3.19	6%
		Long-term optimization		
		Redamation quote		
		Actual	Desired	Delta
		Needed maintenances per day		
		Actual	Desired	Delta
		8	10	25%

Phase 4: Establish and Realize Roadmap

Roadmap for stepwise introduction



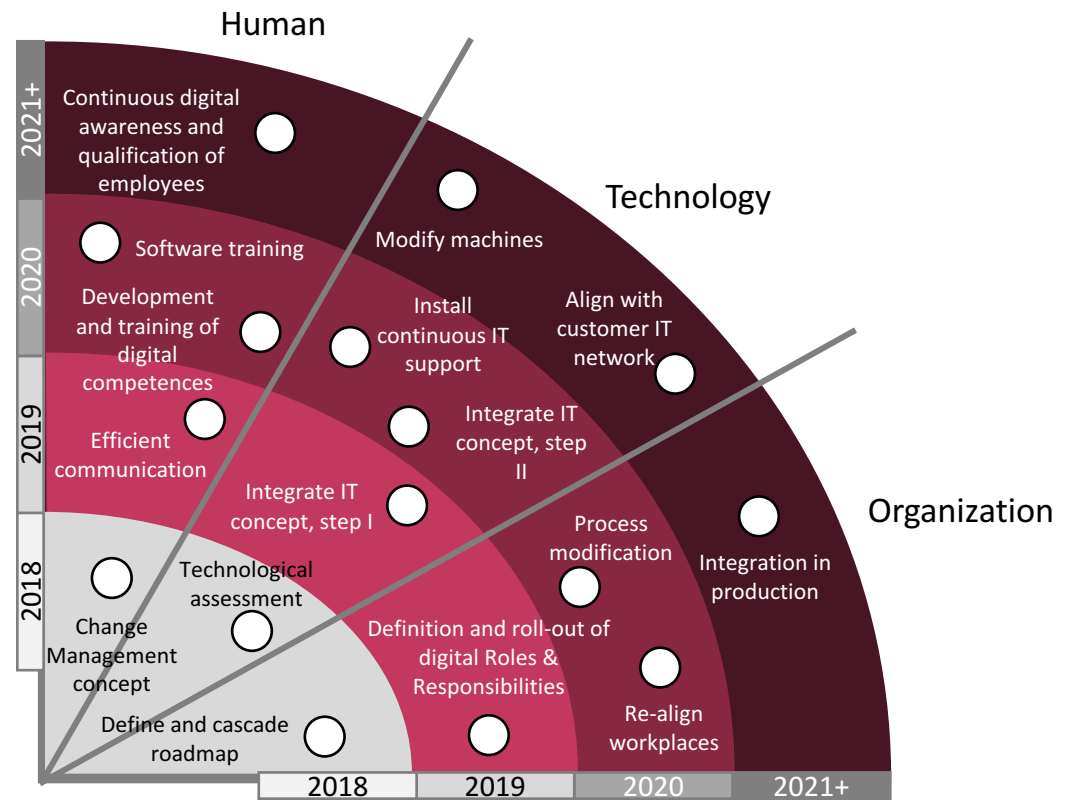
A Roadmap Industry 4.0

⇒ visualizes the long-term transformation strategy

⇒ is flexible and may be continuously adapted by organizational learning

⇒ details necessary measures into

- manageable steps and
- financially viable sub-projects



○ = stepwise measures for integration of Industry 4.0

Summary

Important Aspects of Creating and Implementing Industry 4.0 Roadmaps

- Industry 4.0 offers future opportunities through clever combination of
 - Digitization
 - Connectivity and
 - Disruptive technologies / software
- Benefits need to be individually and monetarily assessable
- Quick-Check I4.0 supports and simplifies brainstorming for ideas
- Industry 4.0 roadmap consolidates a transformation strategy
- The time factor competition plays a crucial role in competition
- Similar to Lean, Industry 4.0 will fail without strong commitment from leadership

Thank you for your attention!

Q&A

References

Used/Recommended Literature

Maturity Models

- BCG (2017): Digital Acceleration Index, download at 21.10.17, link: <https://www.bcg.com/capabilities/technology-digital/digital-acceleration-index.aspx>
- McKinsey Digital (2015): Digitaler Kompass Industrie 4.0, Industry 4.0 How to navigate digitization of the manufacturing sector, download at 21.10.17, link: https://www.mckinsey.de/files/mck_industry_40_report.pdf
- PWC (2014): Strategy&, Chancen und Herausforderungen der vierten industriellen Revolution, download at 24.10.17, link: <https://www.strategyand.pwc.com/media/file/Industrie-4-0.pdf>
- Seiter, M. et al (2016): Roadmap Industrie 4.0: Ihr Weg zur Erfolgreichen Umsetzung von Industrie 4.0, Verlag tredition GmbH, Hamburg, 2016
- Schuh, G. et al (2017): Industrie 4.0 Maturity Index: Die digitale Transformation von Unternehmen gestalten, Acatech Studie, download at 21.10.17, link: http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Publikationen/Projektberichte/acatech_STUDIE_Maturity_Index_WEB.pdf
- VDMA (2017): Leitfaden Industrie 4.0: Orientierungshilfe zur Einführung in den Mittelstand, download at 21.10.17, link: <http://industrie40.vdma.org/documents/266693/9670777/4%20I40%20konkret%20B-und-R.pdf/6a2d2f93-cd8a-4c11-9287-a63cd7a4dc43>

Business Model Canvas

- Osterwalder, A., Pigneur, Y. (2011): Business Model Generation: Ein Handbuch für Visionäre, Spielveränderer und Herausforderer, Campus Verlag, Frankfurt am Main, 2011

Financing and Investment

- Becker, H.P. (2015): Investition und Finanzierung: Grundlagen der betrieblichen Finanzwirtschaft, 7. Auflage, Verlag Springer Gabler, Wiesbaden, 2015
- Seiter, M. et al (2007): Wirtschaftlichkeitsanalyse mit dem Extended Performance Analysis- Ansatz EPA – Am Beispiel von RFID Investitionen, IPRI Research Paper Nr. 10, Stuttgart, 2007

Other References

- 1) Enviro Pack GmbH: https://www.enviropack.de/sperrschicht-luftpolsterfolien.html?gclid=Cj0KCQjwglPOBRDnARIsAHA1X3Q9YjidXk1UddUPs0tJPFLyKoy7qnuqryrybpYfM-Dz7a8Fa-jGwQaAjhnEALw_wcB
- 2) TransPack-Krumbach GmbH: https://www.transpack-krumbach.de/transportkisten-ladungssicherung-export/transportueberwachung/tiltwatch-kippindikator?gclid=CjwKEAjwtglPOBRDn2eXxsN7S4RcSJABwNV90XbOACS0sujUfwxepREZOFShnicqjWYs0MRvjFmAlThoCLRpw_wcB
- 3) Cambridge Consultants Ltd & Cambridge Consultants Inc: <https://www.cambridgeconsultants.com/droptag>
- 4) DB Schenker Security Guard: AKJ Automotive Presentation, DB Schenker
- 5) Vontobel Holding AG: <https://rogerstuder.vontobel.com/wp-content/uploads/sites/379/zukunft-der-digitalen-welt-wie-wir-dem-digitalen-wandel-begegnen-muessen-e1443169203873.jpg>
- 6) Ultimo Beratungsgesellschaft mbH: <http://www.ultimo.co.at/theorie.htm>
- 7) BEYER-Mietservice KG: <https://www.beyer-mietservice.de/unternehmen/news/berufliche-perspektiven.html>
- 8) SAP Deutschland SE & Co. KG: <https://www.sap.com/germany/products/analytics/business-intelligence-bi.html>
- 9) Creative Market: <https://creativemarket.com/sjagiello/574425-Cognitive-Computing-Icons>
- 10) Würth Industrie Service GmbH & Co. KG: https://www.wuerth-industrie.com/web/de/wuerthindustrie/cteile_management/kanban/ibin_intelligenterbehaelter/ibin.php