Questionnaire

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Instruction

1. This questionnaires has been adopted, modified from the following sources

- *This "Industry 4.0 Readiness" study was commissioned by the IMPULS Foundation of the German Engineering Federation (VDMA) and conducted by IW Consult (a subsidiary of the Cologne Institute for Economic Research) and the Institute for Industrial Management (FIR) at RWTH Aachen University.*
- *https://i40-self-assessment.pwc.de/*

2. This questionnaires has been used to assess and collect information about industry readiness, maturity level to derive the needs of Industry 4.0 adoption for the research project "Curriculum Development of Master's Degree Program in Industrial Engineering for Thailand Sustainable Smart Industry -MSIE4.0" Project Number: 586137-EPP-1-2017-1-TH-EPPKA2-CBHE-JP.

3. This questionnaires has 23 pages consists of 3 parts

- Definitions of Industry 4.0, Industry 4.0 Adoption Scope and Readiness Scheme (page 1-4)

- Business Background (page 5)

- Part 1: Industry 4.0 Adoption Scope (page 6-11)

1. Business strategy, Business Models, Product & Service Portfolio
2. Transversal & Domain related Competences:Employee

- Part 2 : Industry 4.0 Readiness Scheme (page 12-23)

1.Smart products & Co-created Design:
-To what extent can your products be controlled with IT, making it possible for them to communicate and interact with higher-level systems along the value chain?
2. Smart factory (Intelligence Manufacturing System):
-To what extent does your company have digitally integrated and automated production based on cyber-physical systems?
3. Smart operations (Controlling, Adjusting & Monitoring Process Real Time):
-To what extent are the processes and products in your company digitally modeled and capable of being controlled through ICT systems and algorithms in a virtual world?
4. Data driven services (Integrated Business&Operational Data Management):
-To what extent do you offer data-driven services that are possible only through the integration of products, production, and customers?

Industry 4.0

Keywords

Internet of Things (IOT) | Cyber Physical System (CPS) | Automation
Digital transformation | Machine learning | Industrial Internet
Cloud-based Manufacturing | Smart Manufacturing/Smart Factory/Smart Product
Full digitalization | Self-organizing status | Real-time response
Intelligence Manufacturing System: Self-aware, Self-optimization, Self-configuration

Definition

Industry 4.0 revolves around "networks of manufacturing resources (manufacturing machinery, robots, conveyor and warehousing systems and production facilities) that are autonomous, capable of controlling themselves in response to different situations, self-configuring, knowledge-based, sensor-equipped and spatially dispersed and that also incorporate the relevant planning and management systems"

Part 1 :Assessment of Strategy Level

1. Business strategy, Business Models, Product & Service Portfolio

2. Employee

Business strategy, Business Models, Product & Service Portfolio
Industry 4.0 is about more than just improving existing products or processes through the use of digital technologies – it actually offers the opportunity to develop entirely new business models. For this reason, its implementation is of great strategic importance. We examine the current openness toward and the cultural interaction with Industry 4.0 using the following four criteria:

- Implementation status of Industry 4.0 strategy
- Operationalization and review of strategy through a system of indicators
- Investment activity relating to Industry 4.0
- Use of technology and innovation management

Transversal & Domain related Competences: "Employees help companies realize their digital transformation and are the ones most affected by the changes of the digital workplace. Their direct working environment is altered, requiring them to acquire new skills and qualifications. This makes it more and more critical that companies prepare their employees for these changes through appropriate training and continuing education"

- This analysis of employees dimension is to analyze employees skills in various areas and the company's efforts including needs to to acquire new skill sets

Part 2 : Assessment of Adoption level

- **1.Smart products & Co-created Design:**
  - To what extent can your products be designed, configured, and created by customer to suit their context, controlled with IT, making it possible for them to communicate and interact with higher-level systems along the value chain?
- **2. Smart factory (Intelligence Manufacturing System):**
  - To what extent does your company have digitally integrated and automated production based on cyber-physical systems?
- **3.Smart operations (Controlling, Adjusting & Monitoring Process Real Time):**
  - To what extent are the processes and products in your company digitally modeled and capable of being controlled through ICT systems and algorithms in a virtual world?
- **4. Data driven services (Integrated Business&Operational Data Management):**
  - To what extent do you offer data-driven services that are possible only through the integration of products, production, and customers?
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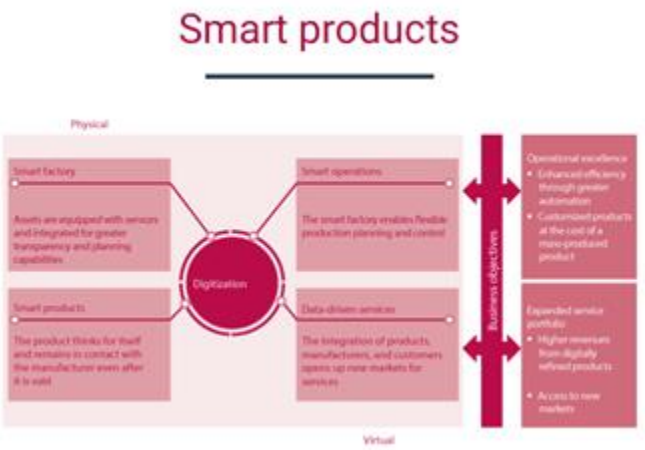
Source of Content: The readiness measurement model

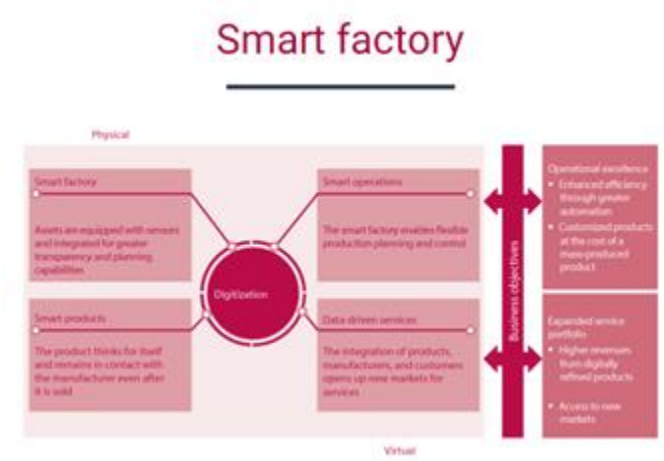
Note: This industry need assessment were derived and adopted from the "Industry 4.0 Readiness" study commissioned by the IMPULS Foundation of the German Engineering Federation (VDMA) and conducted by IW Consult (a subsidiary of the Cologne Institute for Economic Research) and the Institute for Industrial Management (FIR) at RWTH Aachen University.

1.Smart products and Co-created Design:



The smart co-created design product are a vital value of the company and the customer by allowing the customer to co-construct the service experience to suit their context. This requires value-based collaboration between stakeholders and users, in contrast to standard market research. The Co-design is the process where stakeholders (business or customers) can involve and participate during the design development process to ensure the results meet their needs and are usable.

Smart Product where physical products are equipped with ICT components (sensors, RFID, communications interface, etc.) to collect data on their environment and their own status. Only when products gather data, know their way through production, and communicate with the higher-level systems can production processes be improved and guided autonomously and in real time. It also becomes possible to monitor and optimize the status of the individual products. This has potential applications beyond production alone. Using smart products during the usage phase makes new services possible in the first place – through communications between customers and manufacturers, for example. This assessment in the area of smart products is determined by looking at the ICT add-on functionalities of products and the extent to which data from the usage phase is analyzed.



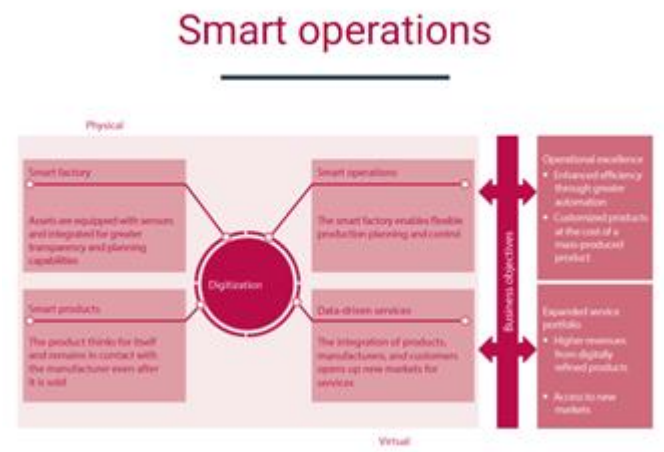
2. Smart factory (Intelligence Manufacturing System):

Successful implementation of Industry 4.0 enables distributed, highly automated production. Unlike in traditional production, smart workpieces will control and monitor the production process and, in the final expansion phase, guide themselves autonomously through production. This happens in the environment of the smart factory. The smart factory is a production environment in which the production systems and logistics systems largely organize themselves without human intervention.

The smart factory relies on cyber-physical systems (CPS), which link the physical and virtual worlds by communicating through an IT infrastructure, the Internet of Things. Industry 4.0 also involves digital modeling through the smart gathering, storage, and processing of data. In this way, the smart factory concept ensures that information is delivered and resources are used more efficiently. This requires the real-time, cross-enterprise collaboration between production systems, information systems, and people. These integrated systems produce huge amounts of data that are processed, analyzed, and integrated into decision-making models.

A company's progress in the area of the smart factory is measured using the following four criteria:

- Digital modeling
- Data usage
- Equipment infrastructure
- IT systems

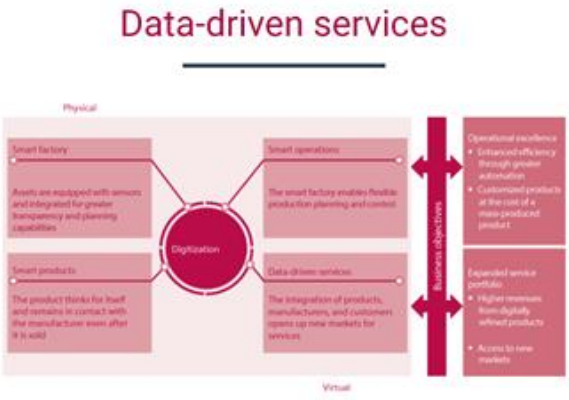


3. Smart operations (Controlling, Adjusting & Monitoring Process Real Time):

The hallmark of Industry 4.0 is the enterprise-wide and cross-enterprise integration of the physical and virtual worlds. The advent of digitization and the plethora of data it has brought to production and logistics have made it possible to introduce what are in some cases entirely new forms and approaches to production planning systems (PPS) and supply chain management (SCM). This technical requirements in production and production planning necessary is to realize the self-controlling workpiece known as smart operations.

Industry 4.0 readiness in the area of smart operations is determined using the following four criteria:

- Information sharing
- IT security
- Cloud usage
- Autonomous processes



4. Data driven services (Integrated Business&Operational Data Management):

The objective of data-driven services is to align future business models and enhance the benefit to the customer. The after-sales and services business will be based more and more on the evaluation and analysis of collected data and rely on enterprise-wide integration. The physical products themselves must be equipped with physical IT so they can send, receive, or process the information needed for the operational processes. This means they have a physical and digital component, which in turn are the basis for digitized services in the usage phase of the products.Readiness in the area of data-driven services is determined using the following three criteria:

- Availability of data-driven services
- Share of revenues derived from data-driven services
- Share of data used

Company Name		
Address :		
Capital (M Thai Baht /Euro) :		
Number of Employees including contracted, part time and temporary :		
Nearest Annual Revenue (M THB/Euro) :		
Department Name of answerer :		
Name of a person answered :		
Contact	E-mail :	Phone :

Industry Type

☐ Electronic	☐ Agro Processing	☐ Textile Industry
☐ Manufacturing	☐ Aerospace	☐ Automotives
☐ Automation	☐ IT	☐ PetroChemical
☐ Seafood Processing	☐ Wood/furniture	☐ Construction
☐ Logistic and Transport	☐ Commerce&Tourism	☐ Packaging

Please estimate the size of your company's domestic workforce.

☐ Up to 19 employees ☐ 20 to 99 employees ☐ 100 to 249 employees

☐ 250 to 499 employees ☐ 500 or more employees

Please estimate your 2017 revenues.

☐ Under 1 million (THB/euros) ☐ 1 million to under 10 million (THB/euros)

☐ 10 million to under 50 million (THB/euros) ☐ 50 million to under 100 million (THB/euros)

☐ 100 million to under 250 million euros(THB/euros) ☐ 250 million to under 500 million (THB/euros)

☐ 500 million euros (THB/euros)

Part1: Strategy Level

1. Strategy and organization

Industry 4.0 is about more than just improving existing products or processes through the use of digital technologies – it actually offers the opportunity to develop entirely new business models. For this reason, its implementation is of great strategic importance.

Q1.1 How would you describe the implementation status of your Industry 4.0 strategy?

- ☐ No strategy exists
- ☐ Pilot initiatives launched
- ☐ Strategy in development
- ☐ Strategy formulated
- ☐ Strategy in implementation
- ☐ Strategy implemented

Q1.2 Do you use indicators to track the implementation status of your Industry 4.0 strategy?

- ☐ Yes, we have a system of indicators that we consider appropriate
- ☐ Yes, we have a system of indicators that gives us some orientation
- ☐ No, our approach is not yet that clearly defined

Q1.3a Which technologies do you need in your company to enhance business competitiveness? (Can answer more than 1)

- ☐ Sensor technology
- ☐ Mobile end devices
- ☐ RFID
- ☐ Realtime location systems
- ☐ Big data to store and evaluate real-time data
- ☐ Cloud technologies as scalable IT infrastructure
- ☐ Embedded IT systems
- ☐ M2M communications

Q1.3b Which technologies do you currently using in your company? (Can answer more than 1)

- ☐ Sensor technology
- ☐ Mobile end devices
- ☐ RFID
- ☐ Realtime location systems
- ☐ Big data to store and evaluate real-time data
- ☐ Cloud technologies as scalable IT infrastructure
- ☐ Embedded IT systems
- ☐ M2M communications

Q1.4 In which parts of your company have you invested in the implementation of Industry 4.0 in the past two years, and what are your plans for the future?

	Investments in the past 2 years				Investments in the next 5 years			
	Large	Medium	Small	None	Large	Medium	Small	None
Research and development	○	○	○	○	○	○	○	○
Production /Manufacturing	○	○	○	○	○	○	○	○
Purchasing	○	○	○	○	○	○	○	○
Logistics	○	○	○	○	○	○	○	○
Sales	○	○	○	○	○	○	○	○
Service	○	○	○	○	○	○	○	○
IT	○	○	○	○	○	○	○	○

Q1.5 In which areas does your company have systematic technology and innovation management? (Can answer more than 1)

- ☐ IT
- ☐ Production technology
- ☐ Product development
- ☐ Services
- ☐ Centralized, in integrative management
- ☐ Do not have

To Enhance Business Models, Product & Service

Q1.6a What is the level of contribution of Industry4.0 that your organization need in order to increase the competitiveness, overall value creation of your products & service?

☐ 1 (Industry4.0 is **not** relevance to business and we are not need to adopt it in next 5 years)
☐ 2 (Industry4.0 is **somewhat** relevance to business and we will need to adopt it in next 3 years)
☐ 3 (Industry4.0 is relevance to business and we are will need to adopt it in next 3 years)
☐ 4 (Industry4.0 is **very** relevance to business and we will need to adopt since past 3 years)
☐ 5 (Industry4.0 is **strongly** relevance to business and we are need to adopt it since past 5 years)

Q1.6b What is the actual level of Industry4.0 that your organization is currently employing?

☐ 1 (We are not currently employing any of Industry4.0 because it is **not** relevance to business)
☐ 2 (We have adopted part of Industry4.0 because it is **somewhat** relevance to business)
☐ 3 (We have adopted part of Industry4.0 in the past 2 years because it is relevance to business)
☐ 4 (We have using Industry4.0 in the past 3 years because it is **very** relevance to business)
☐ 5 (We have fully employing Industry4.0 in the past 5 years because it is **strongly** relevance to business)

Q1.7 To which degree is the average product in your portfolio digitized (e.g. RFID for identification, sensors, IoT connection, smart products etc.)?

☐ 1 (All our product and services are completely digitized and our portfolio is **never** based solely on digitized serviced/product)
☐ 2 (at least 25% of our product and services are digitized and our portfolio is **somewhat** based on digitized serviced/product)
☐ 3 (at least 50% of our product and services are digitized and our portfolio is based on digitized serviced/product)
☐ 4 (at least 75% of our product and services are digitized and our portfolio is **strongly** based on digitized serviced/product)
☐ 5 (All our product and services are **completely** digitized and our portfolio is **completely** based on digitized serviced/product)

Q1.8 To which degree can your customers individualize the products they order?

☐ 1 (All our product and services are standardized mass production, cannot be defined by customer via configuration tools)
☐ 2 (at least 25% of our product and services can be defined by customer via configuration tools depending on lot size)
☐ 3 (at least 50% of our product and services can be defined by customer via configuration tools but cannot have lot size of 1)
☐ 4 (at least 75% of our product and services are defined by customer via configuration tools for customers, can have lot size of 1)
☐ 5 (All our product and services are **completely** defined customer by via configuration tools for customers, can have lot size of 1)

Q1.9 To which degree are the life cycle phases of your products digitized (digitization and integration of design, planning, engineering, production, services & recycling)?

☐ 1 (No digitization & integration – None of any phases are digitized or using any IoT/IT as our basis operation
☐ 2 (Low digitization & integration – Only some phases such as design, planning, engineering are partly digitized for basis operation (e.g., using IT and software designed specifically for company operation)
☐ 3 (Medium digitization & integration – Only design, planning, engineering phases are digitized (e.g., producibility can directly be evaluated via virtual prototyping, virtual design)
☐ 4 (High digitization & integration – All phases in the product life cycle are **mostly** digitized from design, planning, engineering, production, services & recycling (e.g., producibility can directly be tested during product development via virtual prototyping)
☐ 5 (Complete digitization & integration - All phases in the product life cycle are **completely** digitized from design, planning, engineering, production, services & recycling (e.g., Quality, Producibility, Productivity can directly be tested during product development via virtual prototyping, virtual process)

Q1.10 How important is the usage and analysis of data (customer data, product or machine generated data) for your business model?

☐ 1 (No data analytics are relevant or leveraged to our business model. Customer data, product or machine data are not relevance to our operation. We plan to analyze and monitor those data in the next 3-5 years)

☐ 2 (Customer data, product or machine generated data is **somewhat** relevance to business, can be value driver of the business model and we will analyzed and monitored these generated data in the next 1-3 years)

☐ 3 (Customer data, product or machine generated data is relevance to business, the value driver of the business model and we have analyzed and monitored these generated data in the past 1-3 years)

☐ 4 (All customer data, product or machine generated data is **very** relevance to business, the main value driver of the business model and we have analyzed and monitored these generated data in the past 2-3 years)

☐ 5 (Crucial - Data is the main value driver of the business model. All customer data, product or machine generated data is **strongly** relevance to business and we are continuously analyzing and monitoring these generated data in the past 3-5 years)

Q1.11 How intense is your collaboration with partners, suppliers and clients for development of products and services?

☐ 1 (No Collaboration - Product development is done completely in-house without any exchange of information with partners, suppliers or customers)

☐ 2 (Low - collaboration - Collaborative development of products together with partners are low in our supply chain networks, can be communicated but cannot be integrated)

☐ 3 (Medium - collaboration - Collaborative development of products together with partners has been employed our supply chain networks, but are not integrated, transparent for the customers)

☐ 4 (High - collaboration - Collaborative development of products together with partners has been employed throughout our supply chain networks, and are transparent for the customers in the past 1-3 years)

☐ 5 (Crucial - collaboration - Collaborative development of products together with partners has been employed throughout our supply chain networks, and are transparent for the customers in the past 3-5 years)

2. Transversal&Domain related competences: Employees

Employees help companies realize their digital transformation and are the ones most affected by the changes of the digital workplace. Their direct working environment is altered, requiring them to acquire new skills and qualifications. This makes it more and more critical that companies prepare their employees for these changes through appropriate training and continuing education.

Q2.1 How do you assess the skills of your employees when it comes to the future requirements under Industry 4.0?

	Not relevant	Non-existent	Existent, but inadequate	Adequate
IT infrastructure	○	○	○	○
Automation technology	○	○	○	○
Data analytics	○	○	○	○
Data security / communications security	○	○	○	○
Development or application of assistance systems	○	○	○	○
Collaboration software	○	○	○	○
Non-technical skills such as systems thinking and process understanding	○	○	○	

Q2.2 In which areas does your company need to have to attain Industry4.0?

(Can answer more than 1)

- ☐ IT
- ☐ Production technology
- ☐ Product development
- ☐ Services
- ☐ Centralized, in integrative management
- ☐ Do not have

Q2.3 What kind and level of competence that your company will need for new employees when it comes to the Industry 4.0?

	Low	Medium	Strong	Very Strong
IT infrastructure	○	○	○	○
Automation technology	○	○	○	○
Data analytics	○	○	○	○
Data security / communications security	○	○	○	○
Development or application of assistance systems	○	○	○	○
Collaboration software	○	○	○	○
Non-technical skills such as systems thinking and process understanding	○	○	○	○

Q2.4 Are you making efforts to acquire the skills that are lacking? Through special training seminars, knowledge transfer systems, coaching, etc.

- ☐ Yes
- ☐ No

Q2.5 Which of the following technological competence do you need for employee to enhance business operation? (Can answer more than 1)

- ☐ Sensor technology
- ☐ Mobile end devices
- ☐ RFID
- ☐ Real¬time location systems
- ☐ Big data to store and evaluate real-time data
- ☐ Cloud technologies as scalable IT infrastructure
- ☐ Embedded IT systems
- ☐ M2M communications

Part 2: Adoption Level

This is broken down into four dimensions of Industry 4.0, each containing questions on a different set of issues:

1. Smart products - Co-created Design concepts

The smart co-created design product are a vital value of the company and the customer by allowing the customer to co-construct the service experience to suit their context. This requires value-based collaboration between stakeholders and users, in contrast to standard market research. The Co-design is the process where stakeholders (business or customers) can involve and participate during the design development process to ensure the results meet their needs and are usable.

Smart Product where physical products are equipped with ICT components (sensors, RFID, communications interface, etc.) to collect data on their environment and their own status. Only when products gather data, know their way through production, and communicate with the higher-level systems can production processes be improved and guided autonomously and in real time. It also becomes possible to monitor and optimize the status of the individual products. This has potential applications beyond production alone. Using smart products during the usage phase makes new services possible in the first place – through communications between customers and manufacturers, for example.

Q1.1 Does your company allowing the customer to co design the product or service experience to suit their context?

	Yes	No	
Product	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Service	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Product/Service Integration	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%

Q1.2 Does your company allowing the customer to co-construct the product or service experience to suit their context?

	Yes	No	
Product	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Service	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Product/Service Integration	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%

Q1.3 Does your company offer products equipped with the following add-on functionalities based on information and communications technology?

	Yes	No	
Product memory	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Self-reporting	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Integration	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Localization	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Assistance systems	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Monitoring	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Object information	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%
Automatic identification	○	○	IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%

2. Smart factory -Intelligence Manufacturing System

A smart factory is a production environment in which the production systems and logistics systems largely organize themselves without human intervention. The smart factory relies on cyber-physical systems (CPS), which link the physical and virtual worlds by communicating through an IT infrastructure, the Internet of Things.

Industry 4.0 also involves digital modeling through the smart collection, storage, and processing of data. In this way, the smart factory concept ensures that information is delivered and resources are used more efficiently. This requires the real-time, cross-enterprise collaboration between production systems, information systems, and people.

Equipment infrastructure

Q2.1 How would you evaluate your equipment infrastructure when it comes to the following functionalities?

	No, not available	Yes, to some extent	Yes, completely
Machines/systems can be controlled through IT IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○	○	○
M2M: machine-to-machine communications IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○	○	○
Interoperability: integration and collaboration with other machines/systems possible IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○	○	○

Q2.2 How would you evaluate the adaptability of your equipment infrastructure when it comes to the following functionalities?

	Not relevant	Relevant, but not upgradable	Upgradable	High, because functionality already available
M2M: machine-to-machine communications IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○	○	○	○
Interoperability: integration and collaboration with other machines/systems possible IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○	○	○	○

Digital model of factory

Q2.3 The digitization of factories makes it possible to create a digital model of the factory. Are you already collecting machine and process data during production?

☐ Yes, all
☐ Yes, some
☐ No

IF Yes, please specify ☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%

Q2.4 How is the data you collect used? (Can answer more than 1)

☐ Predictive maintenance
☐ Optimization of logistics and production processes
☐ Creation of transparency across production process
☐ Quality management
☐ Automatic production control through use of real-time data
☐ Optimization of resource consumption (material, energy)

Q2.5 Which data about your machinery, processes, and products as well as malfunctions and their causes is collected during production, and how is it collected?

	Yes, manually	Yes, automatically	No
Inventory data	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Manufacturing throughput times	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Equipment capacity utilization	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Production residues/waste/WIP	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Quality MGMT	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Employee utilization	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Quality Control data	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Data about processing, process condition	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Production times	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Overall equipment effectiveness (OEE)	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	○
Other	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	☐ <25% ☐ 25-50% ☐ 51-75% ☐ ≥76%	

Q2.6 Which of the following systems do you use? Does the system have an interface to the leading system?

	In use		Interface to leading system	
	Yes	No	Yes	No
MES – manufacturing execution system	○	○	○	○
ERP – enterprise resource planning	○	○	○	○
PLM – product lifecycle management	○	○	○	○
PDM – product data management	○	○	○	○
PPS – production planning system	○	○	○	○
PDA – production data acquisition	○	○	○	○
MDC – machine data collection	○	○	○	○
CAD – computer-aided design	○	○	○	○
SCM – supply chain management	○	○	○	○

3. Smart operations - Controlling, Adjusting & Monitoring Process Real Time

One hallmark of Industry 4.0 is the enterprise-wide and cross-enterprise integration of the physical and virtual worlds. The advent of digitization and the plethora of data it has brought to production and logistics have made it possible to introduce what are in some cases entirely new forms and approaches to production planning systems (PPS) and supply chain management (SCM). The technical requirements in production and production planning necessary to realize the self-controlling workpiece are known as smart operations.

Vertical and horizontal integration

Q3.1 Where have you integrated cross-departmental information sharing into your system? Distinguish between enterprise-wide (internal) and cross-enterprise (external) information sharing.

	Internally between departments		Externally with customers and/or suppliers	
	Yes	No	Yes	No
Research and development	○	○	○	○
Production/manufacturing	○	○	○	○
Purchasing	○	○	○	○
Logistics	○	○	○	○
Sales	○	○	○	○
Finance/accounting	○	○	○	○
Service	○	○	○	○
IT	○	○	○	○
Nowhere	○	○	○	○

Distributed control

Q3.2 The vision of Industry 4.0 is a workpiece that guides itself autonomously through production. Does your company already have use cases in which the workpiece guides itself autonomously through production?

- ☐ Yes, cross-enterprise
- ☐ Yes, but only in selected areas
- ☐ Yes, but only in the test and pilot phase
- ☐ No

Q3.3 Does your company have production processes that respond autonomously/automatically in real time to changes in production conditions?

- ☐ Yes, cross-enterprise
- ☐ Yes, but only in selected areas
- ☐ Yes, but only in the test and pilot phase
- ☐ No

Data and communications security

Q3.4 How is your IT organized?

- ☐ No in-house IT department (service provider used)
- ☐ Central IT department
- ☐ Local IT departments in each area (production, product development, etc.)
- ☐ IT experts attached to each department

Q3.5 How far along are you with your IT security solutions?

	Solution implemented	Solution in progress	Solution planned	Not relevant for us
Security in internal data storage	○	○	○	○
Security of data through cloud services	○	○	○	○
Security of communications for in-house data exchange	○	○	○	○
Security of communications for data exchange with business partners	○	○	○	○

Q3.6 Are you already using cloud services?

	Yes	No, but we're planning to	No
Cloud-based software	○	○	○
For data analysis	○	○	○
For data storage	○	○	○

Q3.7 How would you rate the degree of the digitization of your vertical value chain (from product development to production)?

☐ 1 (No digitization at all - No automated exchange of information along the vertical value chain (e.g. manual machine programming based on paper plans. We plan to analyze and monitor those data in the next 3-5 years)
☐ 2 (Low digitization –some data flow exchange through internal IT within organization)
☐ 3 (Medium digitization –only data flow along within organization and will implement it throughout vertical value chain in the next 1-3 years)
☐ 4 (High digitization –data flow along the vertical value chain e.g. integration of ERP in the past 1-2 years)
☐ 5 (Complete digitization – Continuous data flow along the vertical value chain e.g. direct controlling of machines via CAD models, integration of ERP in the past 2-5 years)

Q3.8 To which extent do you have a real-time view on your production and can dynamically react on changes in demand?

☐ 1 (Not at all – Batch production for large lot sizes without insight into production status. No ability to react flexible on changes in demand)
☐ 2 (Low Virtual Factory – Batch production for large lot sizes with ability to react flexible on changes in demand, but No Real-time view on productions and no capabilities to dynamically change schedules)
☐ 3 (Medium Virtual Factory –Real-time view on some productions with capabilities to change schedules)
☐ 4 (High Virtual Factory –Real-time view on main productions with capabilities to dynamically change schedules)
☐ 5 (Virtual Factory – Real-time view on all productions with capabilities to dynamically change schedules)

Q3.9 To which degree do you have an end-to-end IT enabled planning and steering process from sales forecasting, over production to warehouse planning and logistics?

☐ 1 (Isolated planning processes – Neither IT-enabled nor integrated along the value chain (e.g. planning based on past experiences)
☐ 2 (Low Connected system – Comprising information from actual sale/contract to production planning)
☐ 3 (Connected system – Comprising information from sales forecasts to production planning)
☐ 4 (Integrated planning system – Comprising information from sales forecasts to production planning, warehousing)
☐ 5 (Fully Integrated end-to-end planning system – Comprising real-time information along the entire value chain from sales forecasts to production planning and Logistics)

Q3.10 How advanced is the digitization of your production equipment (sensors, IoT connection; digital monitoring, control, optimization & automation)?

☐ 1 (Purely physical factory – Production equipment is entirely cut off from IT systems and no real-time information can be gathered)
☐ 2 (Low digitized factory – Interconnected production equipment allows for IT-access and information is fed into some machine in the factory)
☐ 3 (Medium digitized factory – Interconnected production equipment allows for IT-access and information is fed for some part of the production in the factory)
☐ 4 (High digitized factory – Interconnected production equipment allows for IT-access and information is fed into a virtual representation only for the main productions of factory)
☐ 5 (Fully digitized factory – Interconnected production equipment allows for IT-access and information is fed into a virtual representation of the factory)

Q3.11 How would you rate the degree of digitization of your horizontal value chain (from customer order over supplier, production and logistic to service)?

☐ 1 (No digitization at all – No automated exchange of information along the horizontal value chain, e.g. no connection to supplier's IT)
☐ 2 (Low digitized factory – some automated exchange of information to supplier's IT or customer's IT)
☐ 3 (Medium digitization–data flow along the horizontal value chain with integration of logistic)
☐ 4 (High digitization–Continuous data flow along the horizontal value chain with integration of logistic)
☐ 5 (Complete digitization–Continuous data flow along the horizontal value chain with integration of logistic service into internal IT)

4. Data-driven services-Integrated Business and Operational Data Management

The objective of data-driven services is to align future business models and enhance the benefit to the customer. The after-sales and services business will be based more and more on the evaluation and analysis of collected data and rely on enterprise-wide integration. The physical products themselves must be equipped with physical IT so they can send, receive, or process the information needed for the operational processes. This means they have a physical and digital component, which in turn are the basis for digitized services in the usage phase of the products.

Q4.1 The process data gathered in production and in the usage phase enable new services. Do you offer such services?

- ☐ Yes, and we are integrated with our customers
- ☐ Yes, but without integration with our customers
- ☐ No

Q4.2 What share of your revenues come from these new data-driven services??

Often, data that is collected is just stored and then not used any further. What share of the data you collect are you already using?

- ☐ 0%
- ☐ 0% to 20%
- ☐ 21% to 50%
- ☐ Over 50%

Q4.3 Do you analyze the data you collect from the usage phase?

- ☐ Yes
- ☐ No – we collect the data but do not analyze it
- ☐ No – we do not collect data in the usage phase

Q4.4 To which extent do you use multiple integrated sales channels to sell your products to your customers?

- ☐ 1 (One channel - Traditional sales force approach, e.g. local sales force)
- ☐ 2 (One Channel – Integration of digital and non-digital sales)
- ☐ 3 (Several Channel –various digital and non-digital sales channels, e.g., sales force, web-shop, sales platforms)
- ☐ 4 (Multi Channel – Integration of various digital and non-digital sales channels, e.g., sales force, web-shop, sales platforms)
- ☐ 5 (Multi/ Omni-Channel – Integration of various digital and non-digital sales channels, e.g. store, sales force, web-shop, sales platforms)

Q4.5 How far do you integrate multiple channels (website, blogs, forums, social media platforms etc.) into your customer interactions for communicating news, receiving feedback, managing claims etc.?

☐ 1 (One-way communication – Usage of traditional communication channels for information purposes only (e.g. corporate website, newsletters)

☐ 2 (One-way communication – Usage of traditional communication channels to response to customer from e.g. corporate website)

☐ 3 (Reactive communication – Usage of digital channels to response to customer, e.g. use previous information from customers to product development)

☐ 4 (Proactive communication – Usage of digital channels to acquires customer interaction, e.g. some integrating customers into product development)

☐ 5 (Interactive communication – Usage of multiple digital channels to foster customer interaction, e.g. integrating customers into product development via social media platforms)

Q4.6 How advanced is the digital enablement of your sales force (mobile devices, access to all relevant system anywhere and anytime, full sales process possible at client site)?

☐ 1 (Traditional sales approach - Sales force works 'offline' without access to relevant systems, e.g. using centrally distributed paper documents)

☐ 2 (Connected sales approach - Sales force works 'online' with access to relevant systems, e.g. using centrally digitized document)

☐ 3 (Digital sales approach - Sales force is supported by digital devices and distribute to all relevant processes and systems using centrally integrated IT)

☐ 4 (High Digital sales approach - Sales force is supported by digital devices and access to all relevant processes and systems to customer and product data using horizontally integrated IT with customers and suppliers)

☐ 5 (Digital sales approach - Sales force is supported by digital devices and access to all relevant processes and systems at real-time access to customer and product data, possibility to configure personalized products & dynamically create orders etc)

Q4.7 To which extent do you analyze customer data to increase customer insight (e. g. personalized offers to customers based on their personal situation, preferences, location, credit score; consideration of usage data for design & engineering etc.)?

☐ 1 (Trivial data usage - Information is kept decentralized and in an unsystematic way by single units and is not analyzed further for, e.g. sales orders in excel sheets)

☐ 2 (Non trivial data usage – Some Information is kept centralized and in an systematic way by single units and is analyzed further for, e.g. sales orders in both files and excel sheets)

☐ 3 (Medium data usage - Main data collection are kept centralized and in an systematic way by single units and is analyzed further for, e.g. sales orders)

☐ 4 (High data usage – Most data collection are kept centralized in integrated systems to review products, sales and customer experience)

☐ 5 (Substantial data usage - Extensive data collection at all touch points that is fed into integrated systems to monitor, review and optimize products, sales and customer experience)

Q4.8 How far do you want to collaborate with partners regarding your approach of accessing customers (exchange of customer insights, coordination of marketing activities etc.)?

☐ 1 (Not at all - No collaboration with partners in approaching customers, e.g. separate customer databases and no coordination of marketing or sales activities)

☐ 2 (Somewhat – Some collaboration with partners in approaching customers for coordination of marketing or sales activities)

☐ 3 (Medium - Some collaboration with partners in approaching customers databases for some coordination of marketing or sales activities and production activities)

☐ 4 (Somewhat Unified approach – Customer access approach is partly backed up along with the partner network, e.g. common customer ID with partners and use of partner data)

☐ 5 (Unified approach – Customer access approach is completely backed up along with the partner network, e.g. common customer ID with partners and use of partner data)