INDUSTRY 4.0
The Challenges of Tomorrow

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OUTLINE

• PENDAHULUAN

• INDUSTRIAL REVOLUTION
  • i2.0 → i3.0
  • i3.0 → i4.0
  • i4.0 for INDONESIA

• IE SUBJECT for i4.0

• FUTURE PROFESSION
PENDAHULUAN

• Skema penelitian Lab Sistem Produksi ITB 1998

Seminar Sistem Produksi (SSP) 3-4 Dec 1999, tema “Menuju sistem manufaktur tangkas dan pola jaringan kerjasama manufaktur”
• The International Academy of Production Engineering (CIRP) describes manufacturing system as having an integrated group of functions, i.e. marketing, product design, process design, production planning, production process, and delivery to customer (Caggiano, 2014)

Are these functions still relevant to Industry 4.0?
Industry 4.0 defines as:

- An approach to control production process by providing real time synchronization of flows and by enabling unitary & customize production (Kohler & Weiz, 2016)

- A general concept enabling manufacturing with elements of tactical intelligence using advanced IOT, cloud & big data technology (Trappey et al., 2016)

- Internet & supporting technologies serve as backbone to integrate physical objects, human actors, intelligent machines, product lines and processes to form a new kind of intelligent, networked and agile value chain (Schumacher, Erol & Sihn, 2016)
The German Telecommunication Association reveals more than 100 different definitions of Industry 4.0 (Bidet-Mayer, 2016).

A generally accepted definition of the term does not exist (Hermann, Pentek, & Otto, 2015).

A generally accepted definition has not been published so far (Bauer et al., 2014).
• The main objectives of i4.0:

**Shorten time to market**
- Shorter innovation cycles
- More complex products
- Greater data volumes

**Increase flexibility**
- Individualized mass production
- Volatile markets
- High productivity

**Boost efficiency**
- Energy efficiency and resource efficiency are critical competition factors
Economic benefit of i4.0:

- **Germany**: 30% productivity increase, 2.6% cost reduction/year, €425B economic growth by 2025.
- **South Korea**: 25% productivity increase, 27% decrease of defectives, >0.5M jobs created, build 10k smart factories
- **India**: 9% increase in GDP (contributed by manufacturing industries).
- **France**: create 137k jobs in big data, double nano electronics production

I4.0 initiatives for given industries:

- **Industrial manufacturing**: Germany, China, S.Korea, Japan, India, Spain, USA
- **Electronics & ICT**: Germany, S.Korea, Japan, China, India, Taiwan, S.Africa
- **Automotive**: Germany, S.Korea, Japan, UK, USA, Portugal, S.Africa
- **Chemicals**: China, France, India, UK
- **Pharmaceuticals**: France, India, UK, Spain
- **Fashion apparel**: S.Korea, Spain, USA, Portugal

i4.0 strategy based on:

• **Opportunities:**
  • innovation ecosystems,
  • competitive industrial base,
  • investment on technologies,
  • integrate SME & entrepreneurship

• **Challenge:**
  • industrial readiness,
  • Skilled trusted workforce,
  • manageable social-cultural-regulation,
  • diversification & job creation
### PENDAHULUAN

- Manufacturing Competitiveness Index

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>2016 (Current)</th>
<th>Index score (100=High) (10 = Low)</th>
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REVOLUSI INDUSTRI

Industry 1.0
Revolusi industri
Mekanisasi produksi

Industry 2.0
Mass production
Interchangeable parts
Quality control
Standardization

Industry 3.0
Mass customization
Flexible Manufacturing
Computer integrated
Automation & robotic

Industry 4.0
Cyber-Physical
Internet of things
Collaborative manufacturing

i-
e-
INDUSTRY 2.0 → INDUSTRY 3.0

MASS PRODUCTION

Profit

Total cost

Set price

Satisfaction?

Finished good

Processes

Raw material

MASS CUSTOMIZATION

Designed Utility/Quality

Price

Target cost

Market specifications

ROI (Profit)
INDUSTRY 2.0 → INDUSTRY 3.0

ENABLERS:

• Kualitas, biaya & waktu pengiriman (QCD) sebagai kunci daya saing industri
• Teknologi mikroelektronika, komputer & control

DEVELOPMENT:

• Flexible Manufacturing Systems (FMS): Production automation & robotic, CAD/CAM, ASRS/AGV, CNC machines, computer integrated manufacturing CIM, ERP
• Product variety, multi-skilled trusted worker, design engineering
INDUSTRY 2.0 → INDUSTRY 3.0

- Industrial automation & robotics
INDUSTRY 3.0 → INDUSTRY 4.0

More on value creation & cost reduction

- Market specifications
- ROI (Profit)

Designed Quality
- Price
- Target cost
- Finished good
- Processes
- Raw material

Value added 1
Value added 2
Value added ...
Value added k

Designed Quality
- Price
- Target cost
- Process k
- Process ...
- Process 2
- Process 1
INDUSTRY 3.0 → INDUSTRY 4.0

More on value creation & cost reduction...
Core competence on process & worker

Value chain, networked, collaborative
INDUSTRY 3.0 → INDUSTRY 4.0

Outsourcing
Outsourcing
Outsourcing ...

\[ \text{Var}(y) = \left( \frac{\partial g}{\partial x_1} \right)^2 \text{Var}(x_1) + \left( \frac{\partial g}{\partial x_2} \right)^2 \text{Var}(x_2) + \ldots + \left( \frac{\partial g}{\partial x_n} \right)^2 \text{Var}(x_n) \]
Production processes and products are being digitized (cyber physical); manufacturers, suppliers and customers are establishing closer networks, and innovation cycles are being reduced.
INDUSTRY 3.0 → INDUSTRY 4.0

• Process outsourcing: a process selection model

Jerusalem et al., 2015
INDUSTRY 3.0 → INDUSTRY 4.0

- Process outsourcing: a process selection optimization mathematical model to maximize profit

\[
\begin{align*}
\text{Max } P &= U . I_{(N+1)} - \\
&= \sum_{i=1}^{N} \sum_{j=1}^{M} I_{ij} c_{ij} x_{ij} + A_p \left( \sum_{i=1}^{N} \sum_{j=1}^{M} I_{ij} \left( \frac{\partial Y}{\partial X_i} \right) \left( \frac{t_{ij}}{3} \right) \right) x_{ij} + \\
&\quad \sum_{i=1}^{N} \sum_{j=1}^{M} Q_{ij} x_{ij} + \sum_{i=1}^{N} \sum_{j=1}^{M} I_{ij} \left( 1 + \frac{f_i^R - r_{ij}^R}{1 - (f_i^R - r_{ij}^R)} \right) c_{ij}^R (f_i^R - r_{ij}^R) x_{ij} + \\
&\quad \sum_{i=1}^{N} \sum_{j=1}^{M} I_{ij} c_{ij}^S (f_i^S - r_{ij}^S) x_{ij}
\end{align*}
\]

Jerusalem et al., 2015
INDUSTRY 3.0 → INDUSTRY 4.0

ENABLERS:

• Computing power, storage capacities, data analytics, networking ability,

• Internet security & trust for collaboration

DEVELOPMENT:

• Collaborative manufacturing, shared manufacturing, strategic production network, project based manufacturing systems, i-logistics, i-commerce

• Compatibility, interoperability, traceability, standardization, multi-skilled trusted worker
DEVELOPING i4.0 for INDONESIA

i4.0 Implementation Roadmap:

• **GOALS**: industry development, technology innovation, productivity improvement, inclusion for SME

• **WHERE TO PLAY**: potential sector (automotive, ICT, etc.), technology choices (robotics, cloud, AR, 3D printing, etc.), area of application choice (production, logistics, etc.), geography domain (global, regional, local)

• **HOW TO WIN**: execution focus choice (government, corporation, SME, etc.), enabler choice (policy, infrastructure, R&D, market, etc.)
IE SUBJECTS for i4.0

Which subjects that are still relevant?
FUTURE PROFESSION

- Will IE profession be survive?

**New (future) job roles**
FUTURE PROFESSION

Top 10 skills

in 2020
1. Complex Problem Solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with Others
6. Emotional Intelligence
7. Judgment and Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive Flexibility

in 2015
1. Complex Problem Solving
2. Coordinating with Others
3. People Management
4. Critical Thinking
5. Negotiation
6. Quality Control
7. Service Orientation
8. Judgment and Decision Making
9. Active Listening
10. Creativity

Source: Future of Jobs Report, World Economic Forum
The critical parameters in the introduction of i4.0 are the design of the process landscape and the identification of the employee qualification profiles (KPMG, 2016)