IN4ACT WEBINAR SERIES

BEYOND THE HYPE OF INDUSTRY 4.0: SEPARATING REALITIES FROM MYTHS

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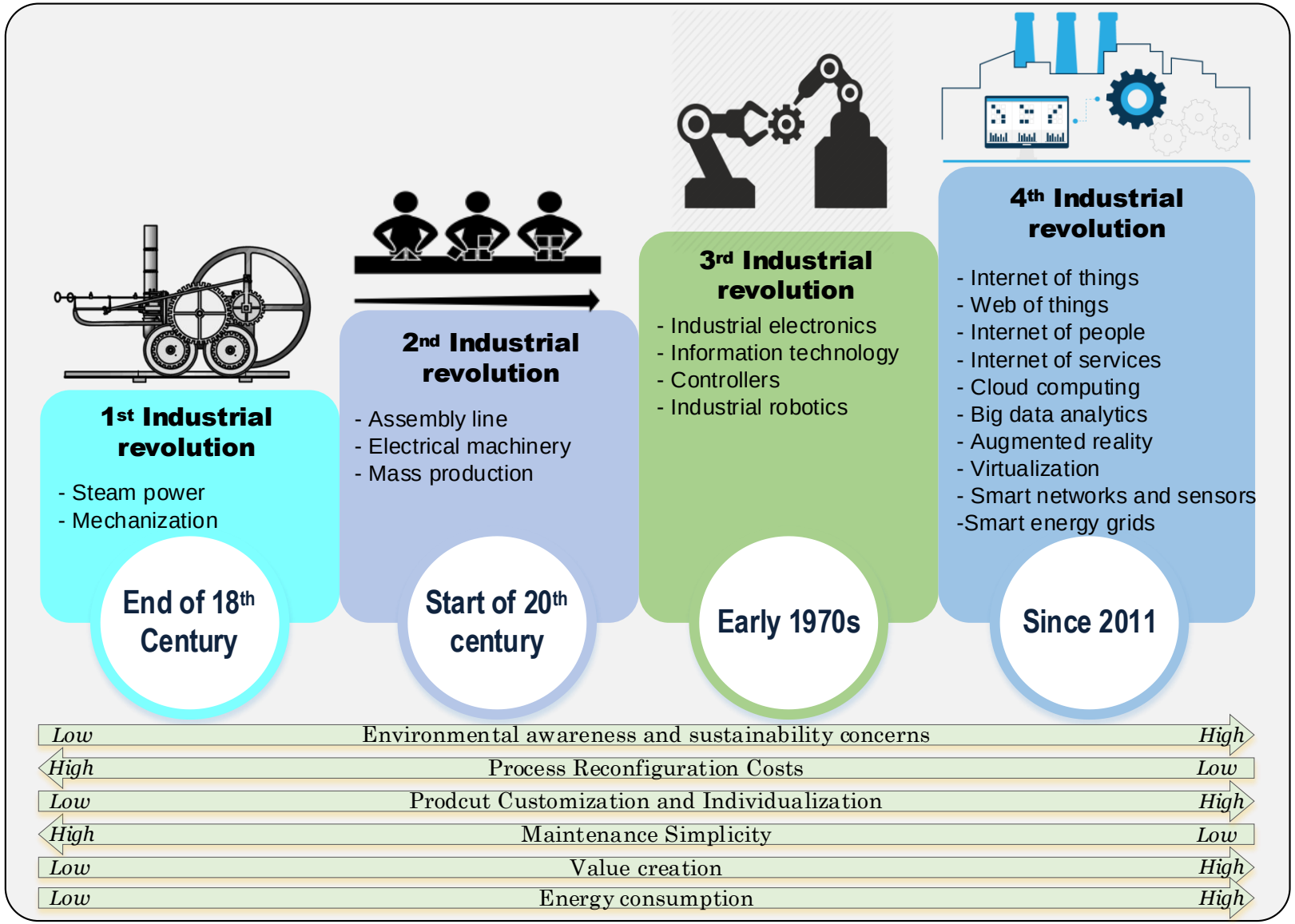
- **Industry 4.0 in historical perspective: Defining the ‘field’**
- **Industry 4.0 building blocks**
  - I. Technology trends of Industry 4.0
  - II. Design principles of Industry 4.0
  - III. Industry 4.0 archetype
- **Benefits of Industry 4.0**
  - I. Economic-productivity impacts
  - II. Environnemental sustainability impacts
  - III. Social sustainability impacts
  - IV. The negative impacts
- **Industry 4.0 Transformation**
  - I. The need for a strategic roadmap
  - II. Best practices for digital transformation success
  - III. Separating hype from reality

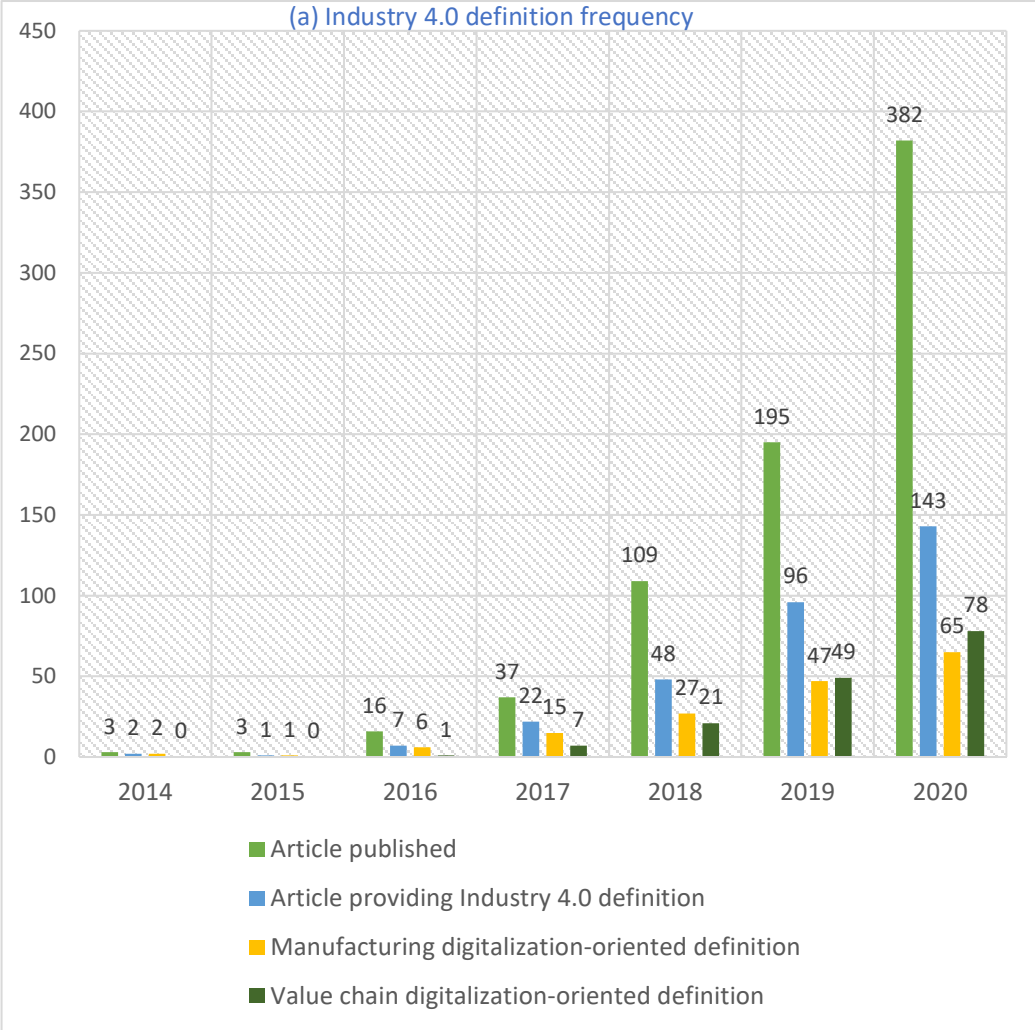
Industry 4.0 in historical perspective: Defining the ‘field’

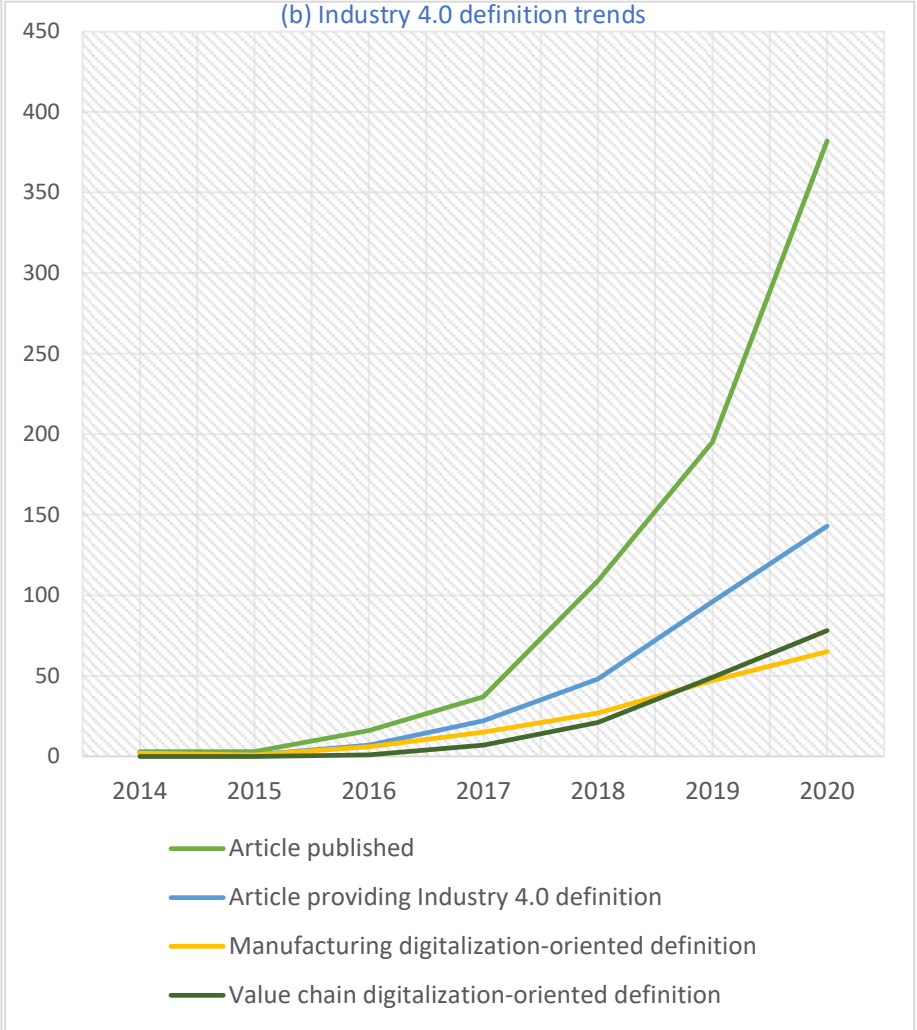
- The first reference to Industry 4.0 occurred in 2011, yet, it is misleading to assume that Industry 4.0 is a sudden revolution utterly unaware of the industrial and technological revolutions that arose earlier. In reality, Industry 4.0 builds entirely upon the foundations of previous industrial revolutions. However, Industry 4.0 is expected to deliver the highest degree of digitalization, automation, virtualization, and decentralization across all industries, when coming to its **maturity**.

- The earlier studies tend to narrate Industry 4.0 as the digitalization of manufacturing processes, limiting it to factories, mainly in the form of implementing advanced digital manufacturing technologies such as 3D printing, modeling, simulation, virtualization, and data management technologies. More recent perspectives regard Industry 4.0 as the **digital transformation** of industrial value chains, a paradigm shift across various industries.



Industry 4.0 in historical perspective: Defining the ‘field’





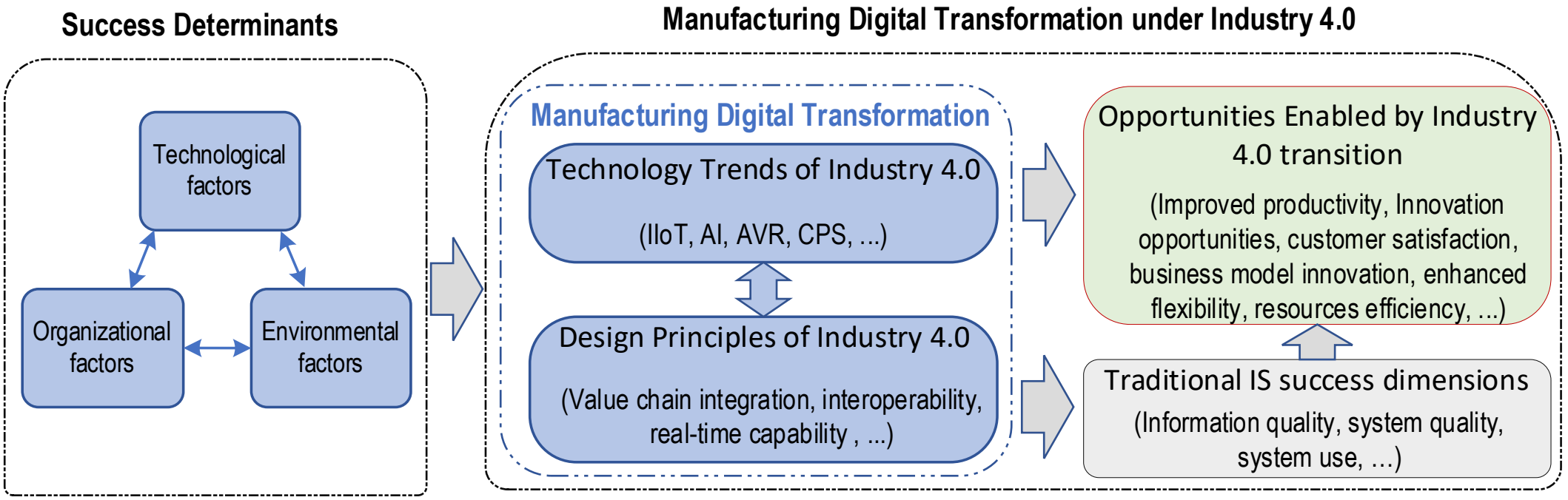
Nowadays, the scope of Industry 4.0 spans well beyond manufacturing sector, involving related concepts such as Healthcare 4.0, Construction 4.0, Energy 4.0, and Transportation 4.0, among many others.

Article categorization	Publication year						
	2014	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Article published	3	3	16	37	109	195	382
Article providing Industry 4.0 definition	2	1	7	22	48	96	143
Manufacturing digitalization-oriented definition	2	1	6	15	27	47	65
Value chain digitalization-oriented definition	0	0	1	7	21	49	78

Industry 4.0 building blocks

To address the elusive nature of Industry 4.0 and the underlying digital transformation, the literature commonly characterizes Industry 4.0 based on its building blocks; a wide variety of underlying **technology trends** and **design principles**.

- Technology trends of Industry 4.0 are advanced digital, information, and operations technologies that are indispensable to shaping the undergoing digital industrial transformation.
- Design principles are desirable conditions that enable industrial entities to achieve digital transformation success and unlock the potential benefits of Industry 4.0 technology trends.

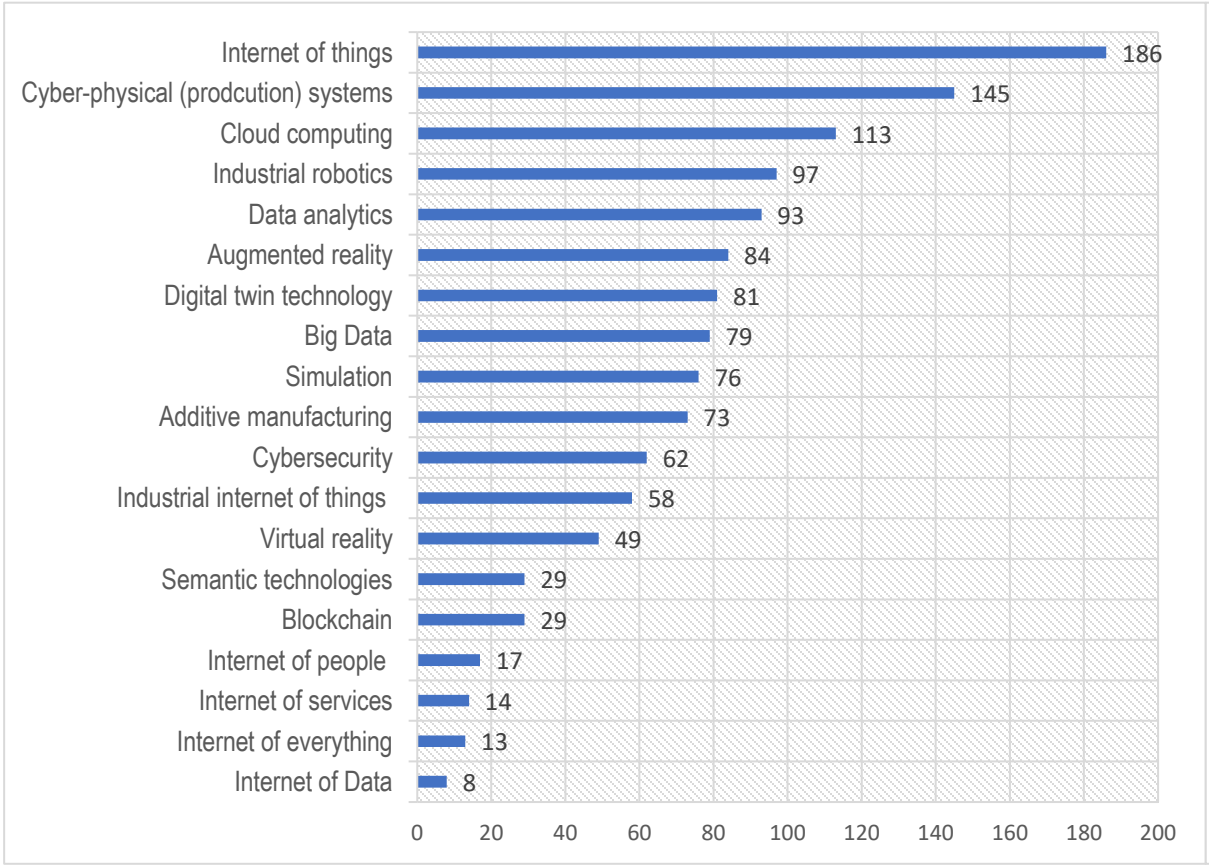


The framework of digital transformation success under Industry 4.0

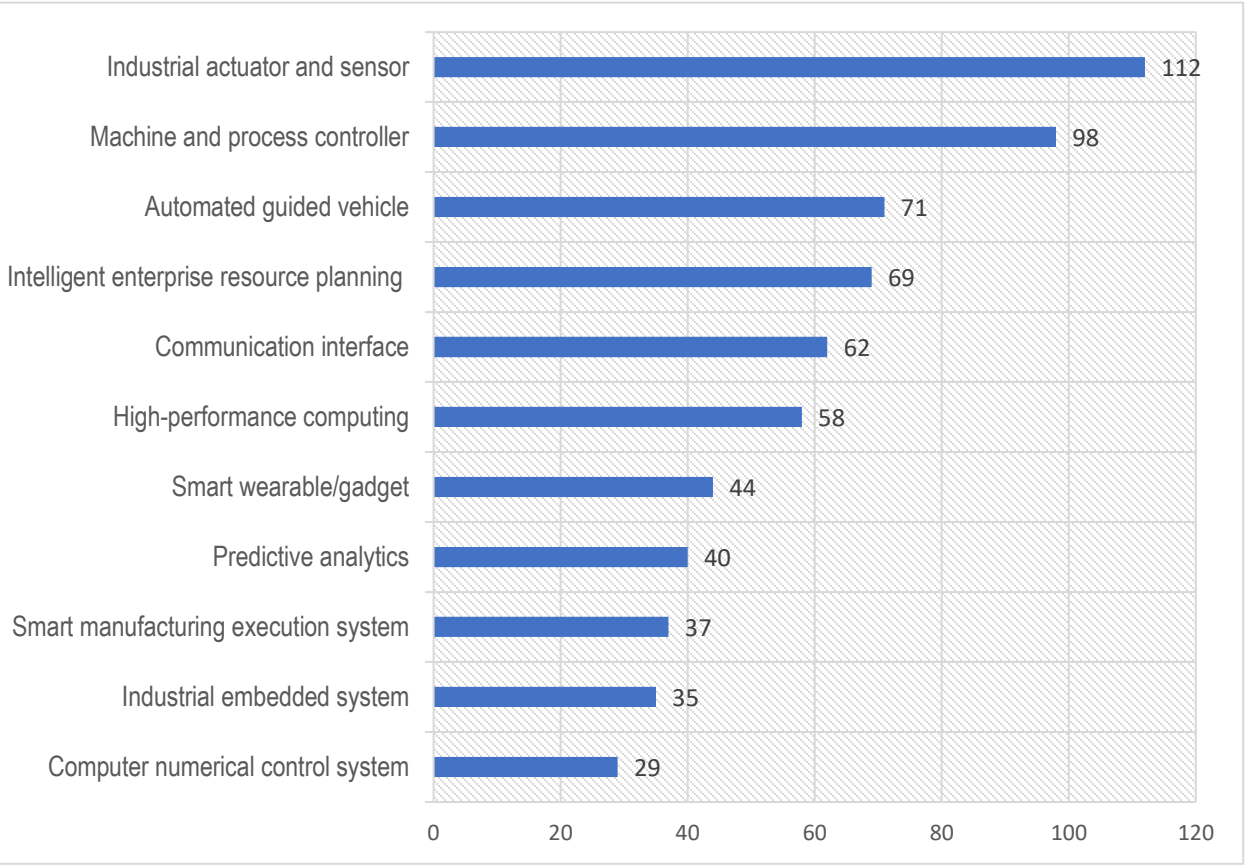
Technology trends of Industry 4.0

Industry 4.0 could be categorized into two clusters, termed **core technologies** and **facilitating technologies**.

- The core technologies of industry 4.0 are the modern technological innovations that have been in development within the past few decades but have matured enough to become commercially available within the last decade.
- The facilitating technologies of Industry 4.0 are the more traditional, prevailing, and mature information and operations technologies that enable the core technologies of Industry 4.0 to deliver their intended functions.

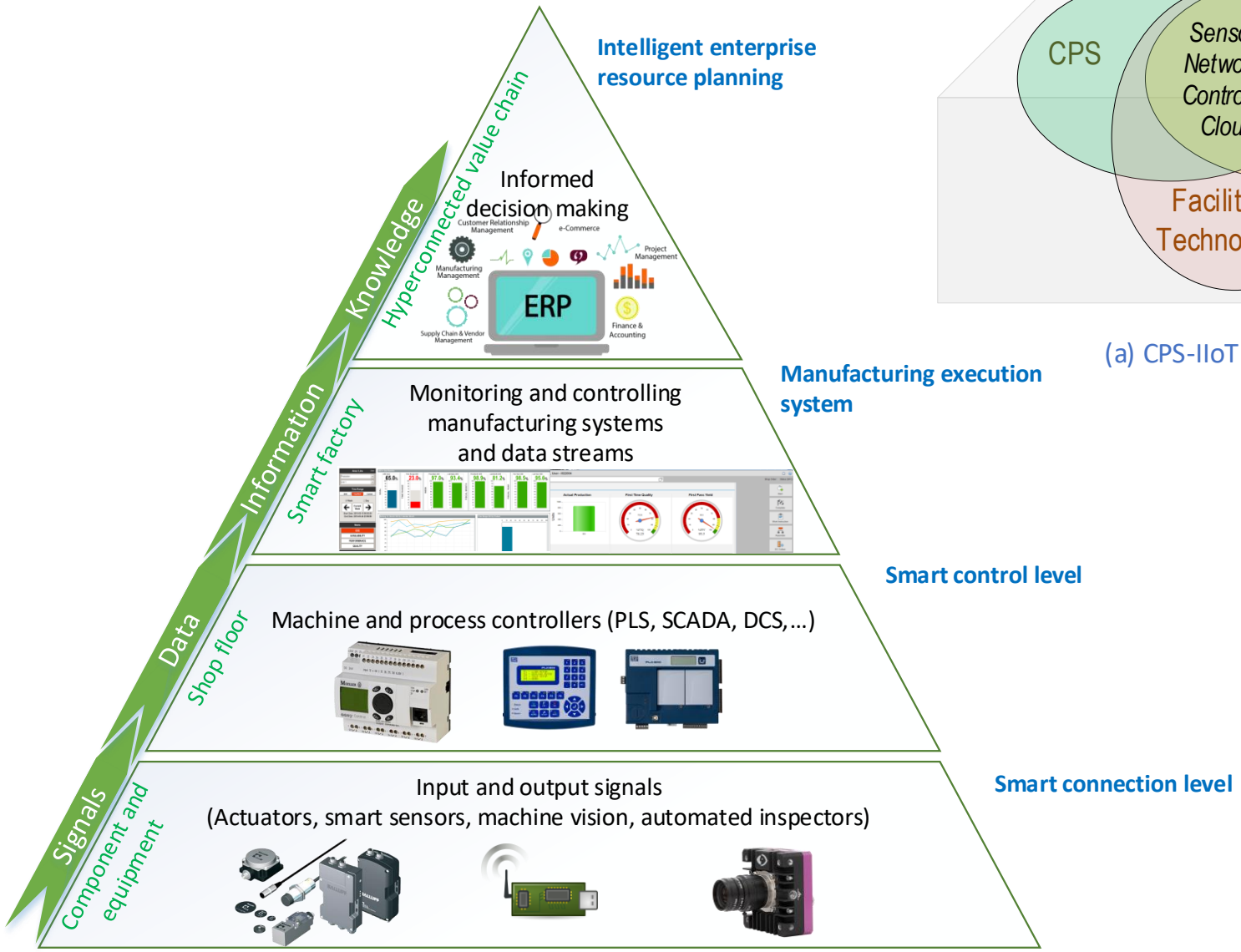


Core technologies

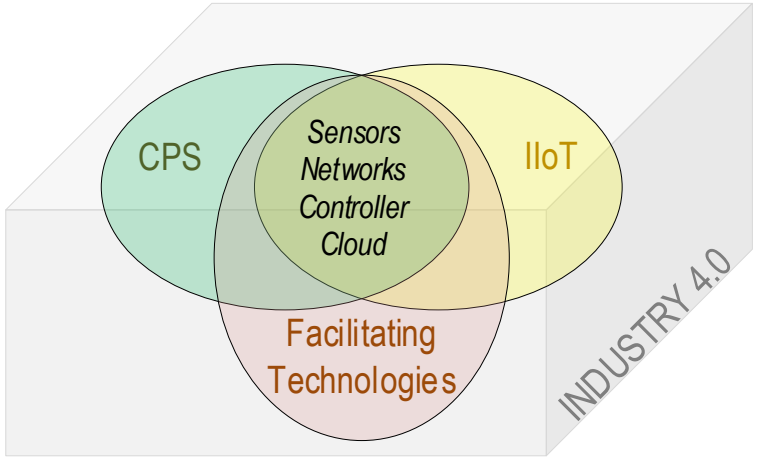


Facilitating technologies

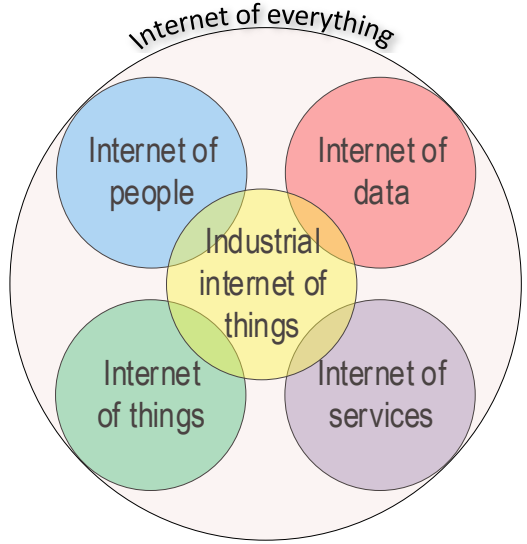
Technology trends of Industry 4.0



Industry 4.0 communication pyramid



(a) CPS-IIoT interaction



(b) Pillars of Internet of Everything

Industry 4.0 archetype

Design Principals of Industry 4.0

Vertical and horizontal integration | Virtualization | Interoperability | Modularity | Decentralization | Product and service individualization | Customer orientation | Real-time capability

Hyperconnected manufacturing management level

- Real time production flow monitoring
- Real-time equipment management
- Time-in-system analysis
- Production scheduling
- Setup and configuration
- Deliveries optimization
- Reliability analysis
- Energy Audit
- Capital investments evaluation

Digital Supply Network Level

Intelligent stakeholder management
-Effective communication
-CSR strategy development
-Relationship building

Digital collaboration
-Quantitates -Joint NPD
-Capacities -Delivery dates

Smart stakeholders

Smart suppliers

Real time inventory management and control across supply chain
-Quantitates
-Spare parts
-Logistics
-Orders

Smart logistics

Smart (connected) customers

Smart products

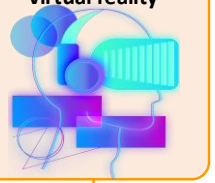
Customer integration
-Future demand -Preferences
-Quantities -Financial transaction

Smart Factory Level

Additive/Advanced manufacturing

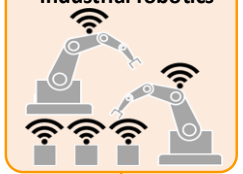
- Individualized-mass production
- Reduced time-to-market
- Manufacturing energy efficiency

Augmented and virtual reality



- Human error reduction
- Maintenance assistance
- Safety management
- Design and visualization
- On-the-job training

Automation and industrial robotics



- Shorter cycle times
- Reduced waste
- Increased safety
- Improved quality
- increased energy efficiency

Big data analytics

- Informed decision-making
- Customer behavior prediction
- Market sensing

Blockchain

- Smart contracting
- Financial transaction security
- Assets history management
- Energy accounting

Cloud data and computing

- Disaster recovery
- Scalability
- Data accessibility
- Cost effectiveness

Cybersecurity

- Data Security
- Dependability improvement

Cyber-physical production systems

- Real-time production monitoring
- AI-powered autonomous diagnostic
- Higher value creation
- Anomaly proactiveness
-Continuous energy consumption monitoring

Internet of services

- Product-as-a-service business model
- Product utilization optimization
- Higher value creation

Internet of people

- Improved customer engagement
- Improved customer support
- customer behavior monitoring

Industrial internet of things

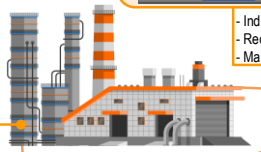
- Improved machine repeatability
- Informed decision-making
-Real-time competitive edge
-Real-time production monitoring
- AI-powered autonomous diagnostic

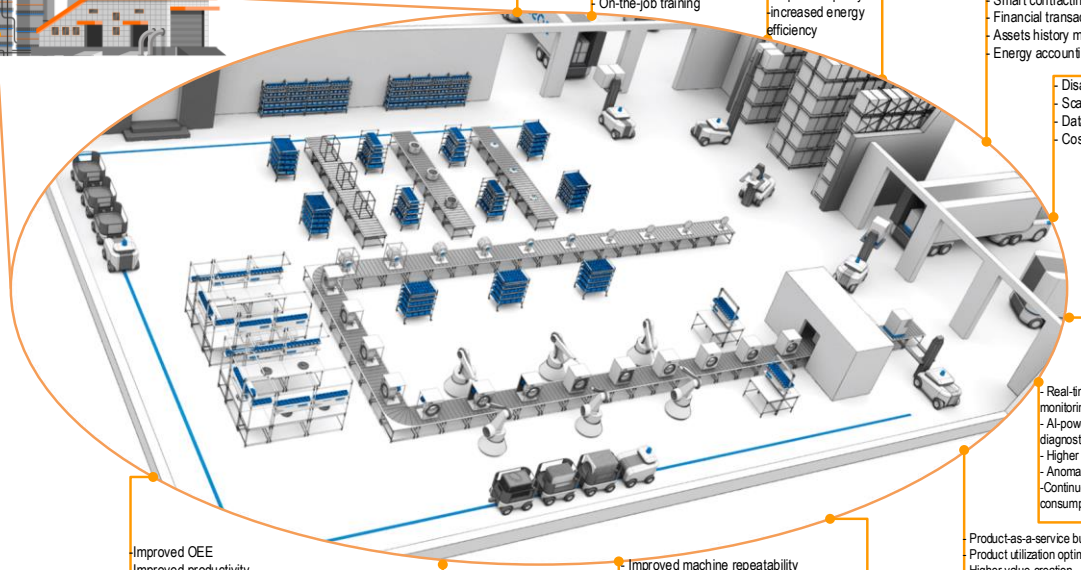
Semantic Technologies

-Data, content, and processes interconnectedness
-Flexible integration
-Machine learning
-Contextual computing

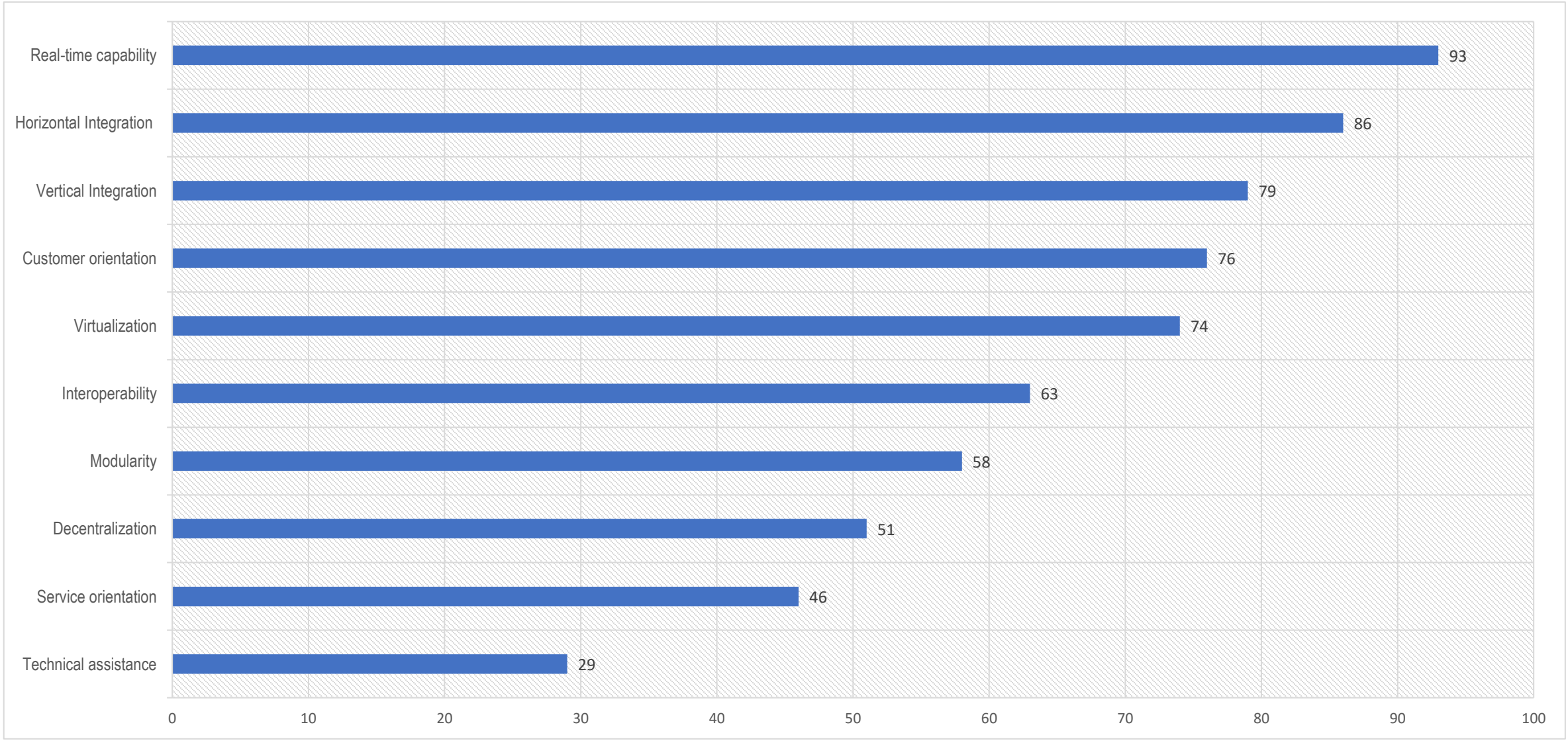
Simulation and Modelling (Digital twin)

-Improved OEE
-Improved productivity
-Risk minimization
-Improved customer service
-Improved production reliability



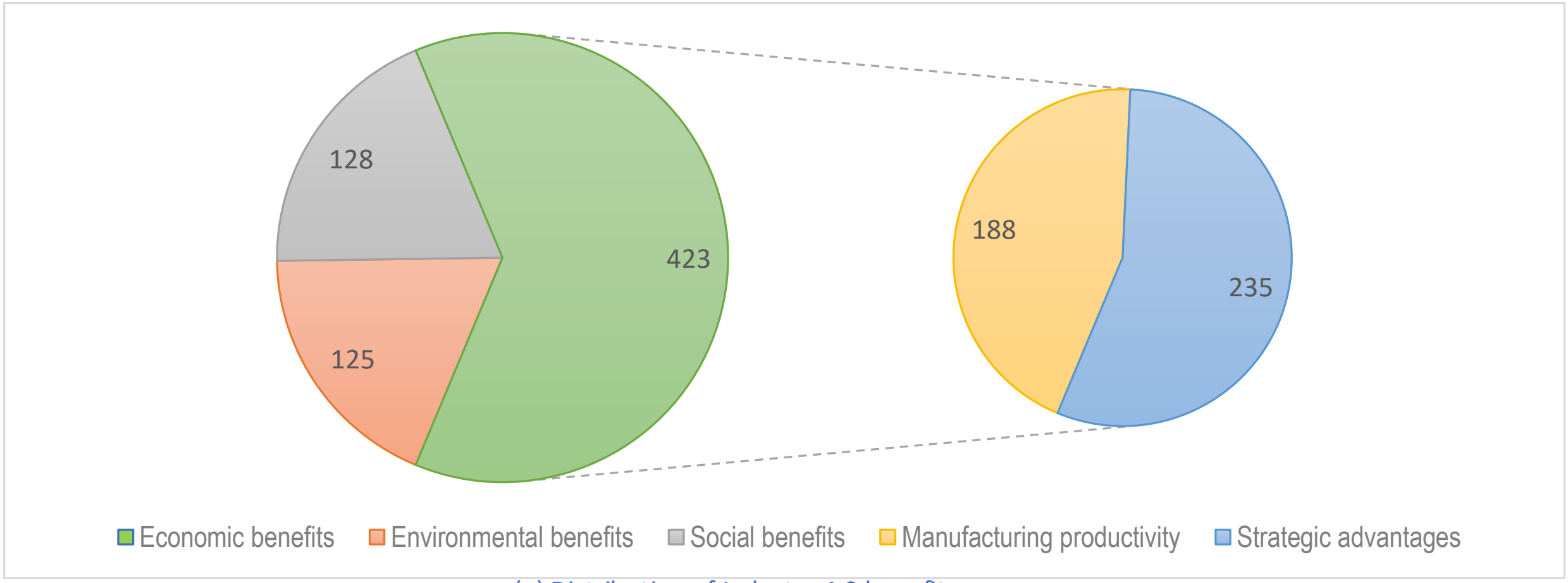


Industry 4.0 design principles



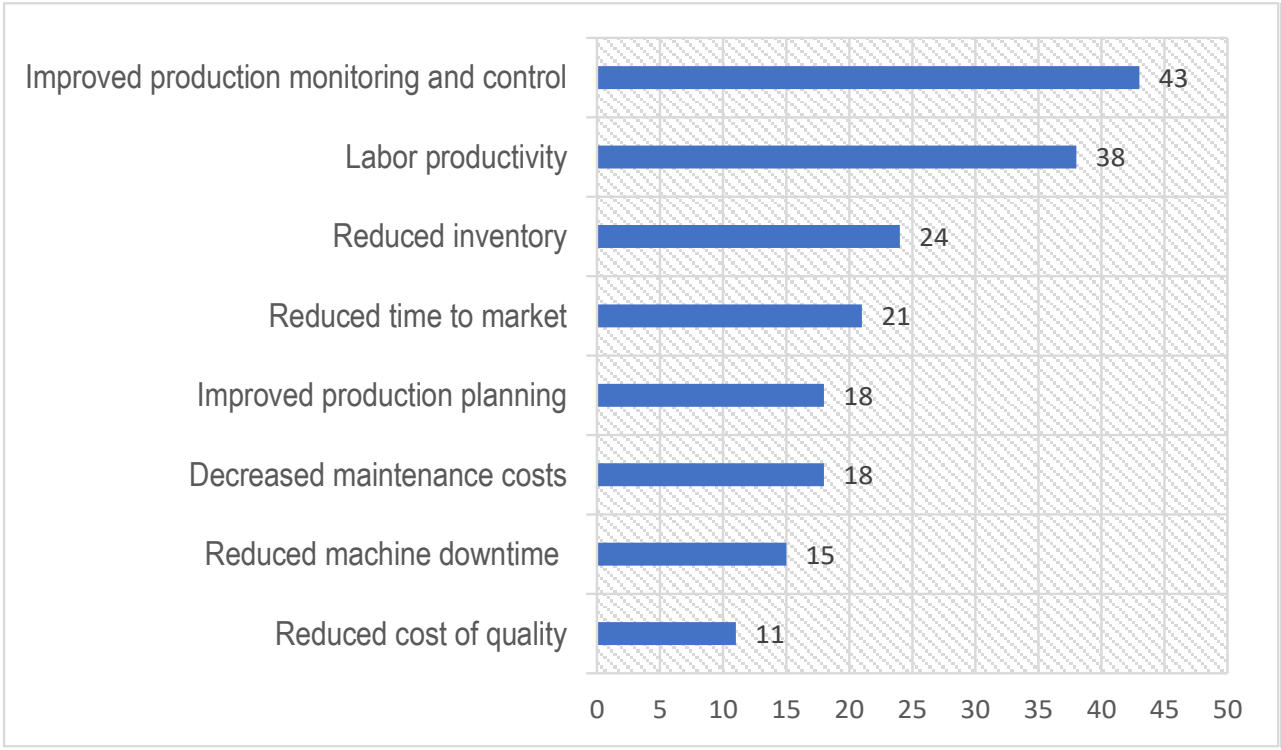
Benefits of Industry 4.0

There are different perspectives on the possible benefits of Industry 4.0 that drive the digital industrial revolution.



(a) Distribution of Industry 4.0 benefits

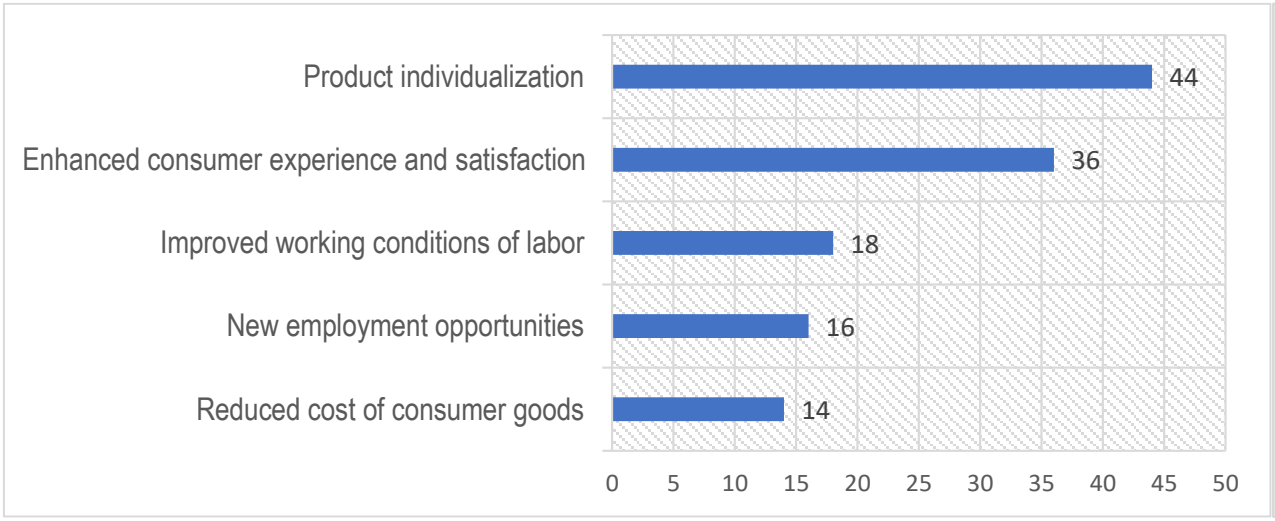
Economic-productivity impacts



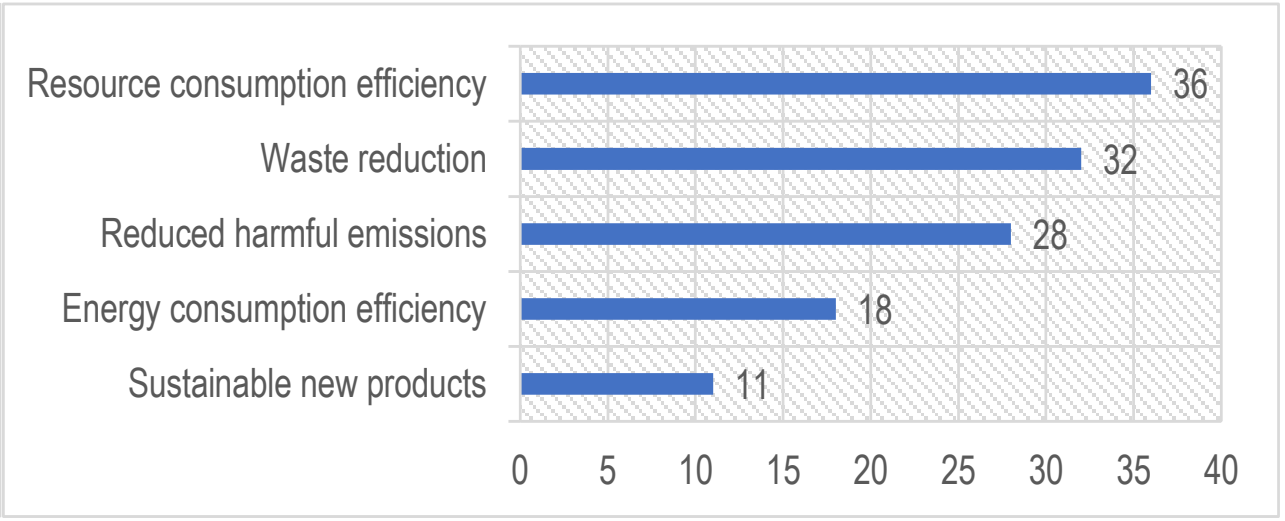
(b) Industry 4.0 opportunities for manufacturing productivity

(c) Industry 4.0 opportunities for business competitiveness

Environmental and social sustainability impacts



(d) Social benefits of Industry 4.0



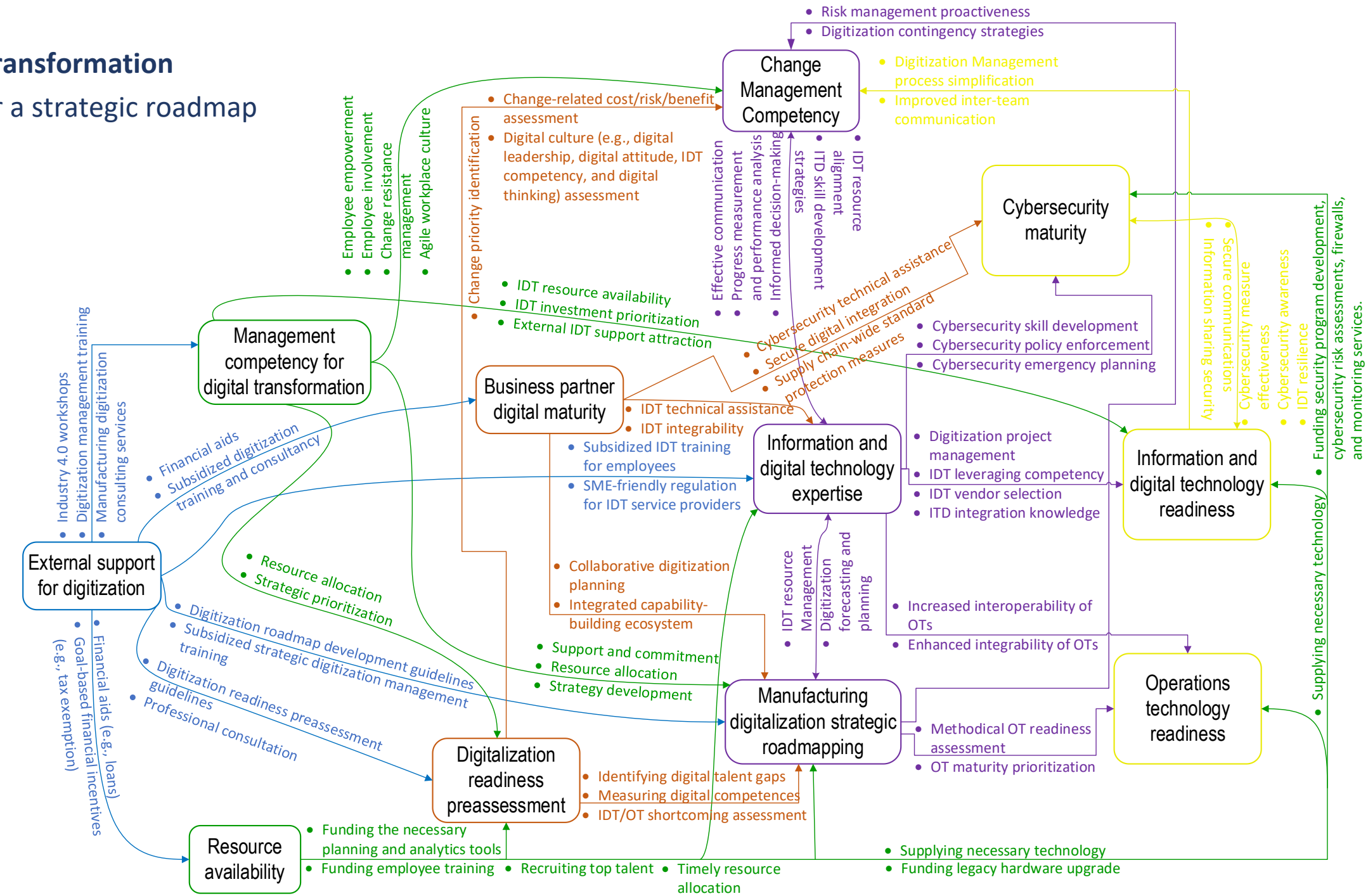
(e) Environmental benefits of Industry 4.0

The negative impacts of Industry 4.0

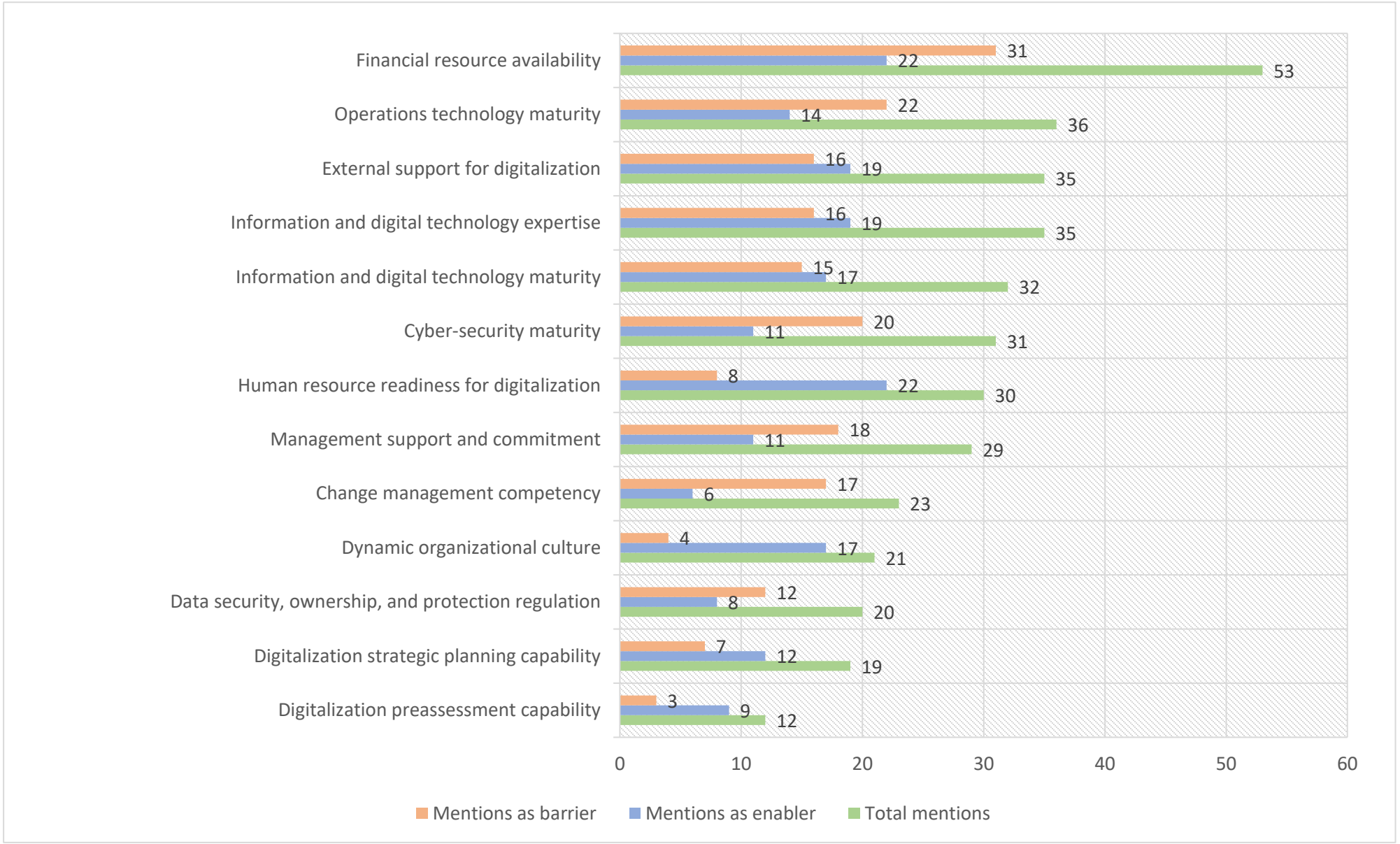
- Inventions often create more opportunities, and with that, jobs. Nevertheless, Industry 4.0 may very well lead to mass unemployment, at least in the short run.
- Industry 4.0, if governed and managed poorly, will lead to the polarization of the labor market. A skilled elite group of people who can use technology to be more productive tend to replace the labor of others and are paid accordingly, substantially resulting in income inequality.
- The digital transformation under Industry 4.0 is hugely resource and knowledge-intensive. Industry 4.0 leaders are usually the overpowering mega-corporations. The difference in Industry 4.0 transformation competency could increase the technological gap, hence inequality between corporations and even countries.
- More affordable, smarter, and personalized products, thanks to the advantages of Industry 4.0, mean shorter product lifecycle and overconsumption and rebound effect. A prolonged pattern of overconsumption and rebound effect, in turn, leads to environmental degradation and the eventual loss of resource bases.

Industry 4.0 Transformation

I. The need for a strategic roadmap



Best practices for digital transformation success



Industry 4.0 Transformation

I. Separating hype from reality

- Industry 4.0 technologies are being adopted across the Industry. The adoption rate is increasing, but the overall rate is still very low. There is a massive discrepancy in the level of Industry 4.0 digital transformation across various industries, businesses of various sizes, and countries.
- The scope of Industry 4.0 spans beyond focal firms. Industry 4.0 is also transformative, as it completely changes the rules of business. However, the digitalization journey under Industry 4.0 can be started in the form of smaller digitalization projects at the corporate or value chain levels. When it comes to Industry 4.0, businesses need to have a clear picture of the digital transformation and its underlying requirements, current risks, and opportunities. Businesses also need to understand what their peers and competitors are currently doing and plan to do in the future to drive value and capture competitive advantage under the digitalization scenario.
- Many of the manufacturing-productivity benefits of Industry 4.0 is empirically proven. Nonetheless, the majority of the socio-environmental implications of Industry 4.0 are theoretical speculations.
- The majority of Industry 4.0 technologies have been available for industrial use during the past few decades. However, they have become more mature and commercially viable during the last few years. Digital transformation is not merely about purchasing and implementing these technologies. Without developing and materializing the core design principles of Industry 4.0, these technologies cannot deliver the intended benefits.

Thank You

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