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Quality and lean management in the digital era: The impact on the sustainable development of SMEs

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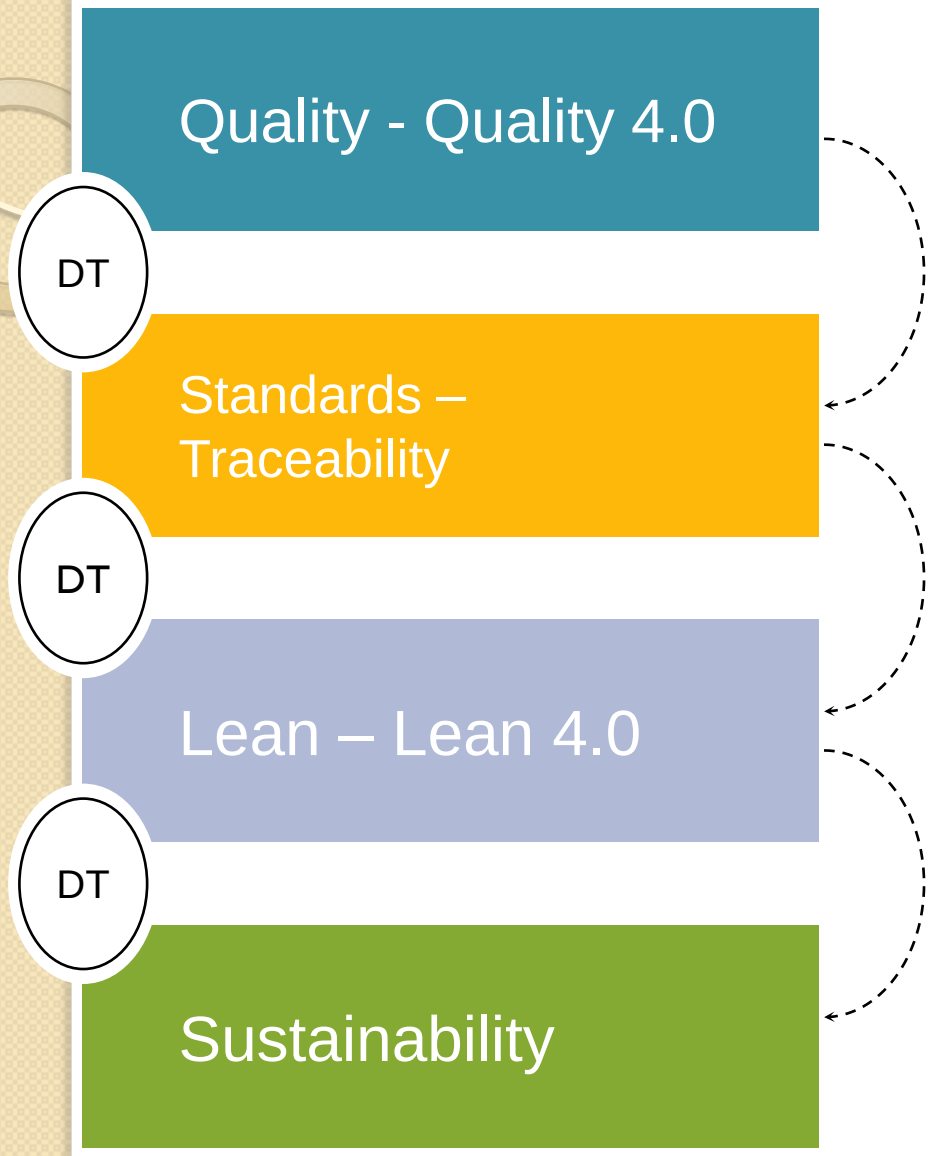
The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A "Greece-Bulgaria 2014-2020"



Digital
Transformation

Session topics

- Industry 4.0
- Quality
- Quality 4.0
- Standards
- Traceability
- Lean
- Lean 4.0
- Digital transformation
- Sustainability

Industry 4.0

- ✓ Term first introduced in 2011 at the Hannover Fair, Germany, as part of the German Government's initiative to increase competitiveness through the use of innovative technologies and tools
- ✓ I4.0 technologies: cloud computing, big data, cognitive computing, artificial intelligence, machine learning, Internet of Things, robotics, unmanned aerial vehicles (UAV-drones)
- ✓ New business models where Cyber-Physical Systems (CPS) are interconnected

Industry 4.0

- Three key features:
  - Interconnection → refers to the interconnectivity of any type of machines, resulting in the formation of a digitized value chain
  - Integration → the ability to perform vertical, horizontal and end-to-end fusion
  - Big Data → the ability to manage quickly and efficiently the growing databases
- Physical and virtual worlds are merged.
- New opportunities, business models and practices are adopted from organizations, increasing their organizational efficiency levels

Industry 4.0 & Quality

- The I4.0 technologies impact the way organizations operate on a daily basis, resulting in changes in methods and practices, and in improvements in the quality of both products and processes
- In the advent of I4.0, the concept of quality is renewed, continuing to be used as a factor of competitive advantage for organizations
- A focus shift from the quality of mass production to the quality in personalised products takes place.
- Quality as a concept will include personalised service quality and a new emphasis will be given to design, safety and service quality
- Example of the impact of I4.0 technologies to quality operation: real-time sensors provide data for monitoring processes faster and more accurately, followed by a further analysis in order to predict quality issues

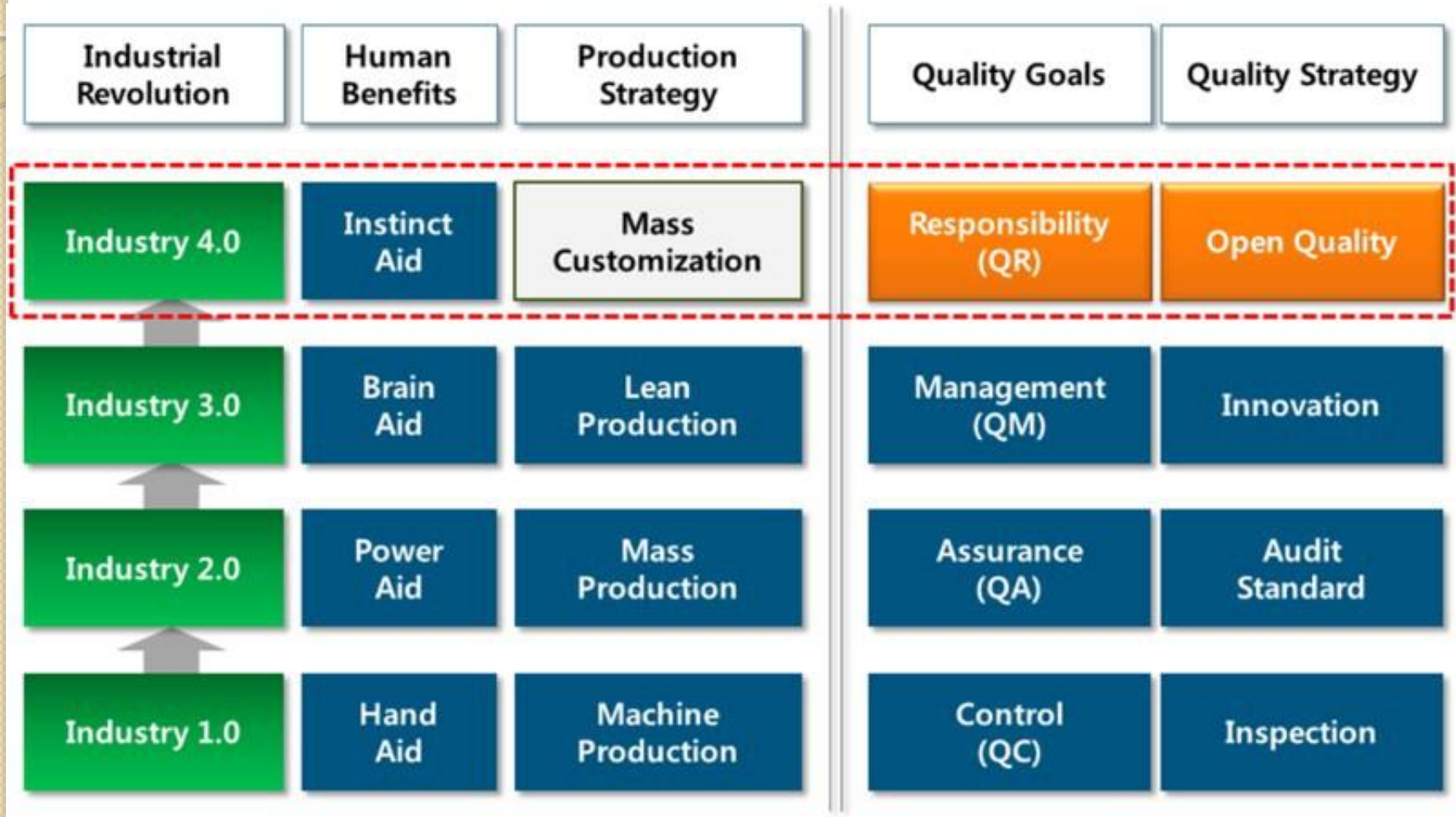
Evolution of Quality Management

Table 1: Transformation of approaches to quality management

Industrial Revolution	Operation Strategy	Quality Concept	Quality Management Goal	Approach to Management	Quality Management Strategy
4.0	Mass customization and personalized production system	The ability to anticipate and meet the needs of customers, taking into account the interests of other stakeholders	The anticipation of expectations of customers and other stakeholders	Responsible quality management	Partnership shared values, accountability
3.0	Lean production	Quality as requirement conformity	Customer satisfaction with the cost-efficiency	Quality Management	Innovation, efficiency
2.0	Mass production	Quality as a set of product properties	Minimization of defects	Quality assurance	Audit, standardizatio n
1.0	Factory production	Quality as synonymous of excellence	Sorting of products	Quality control	Inspection

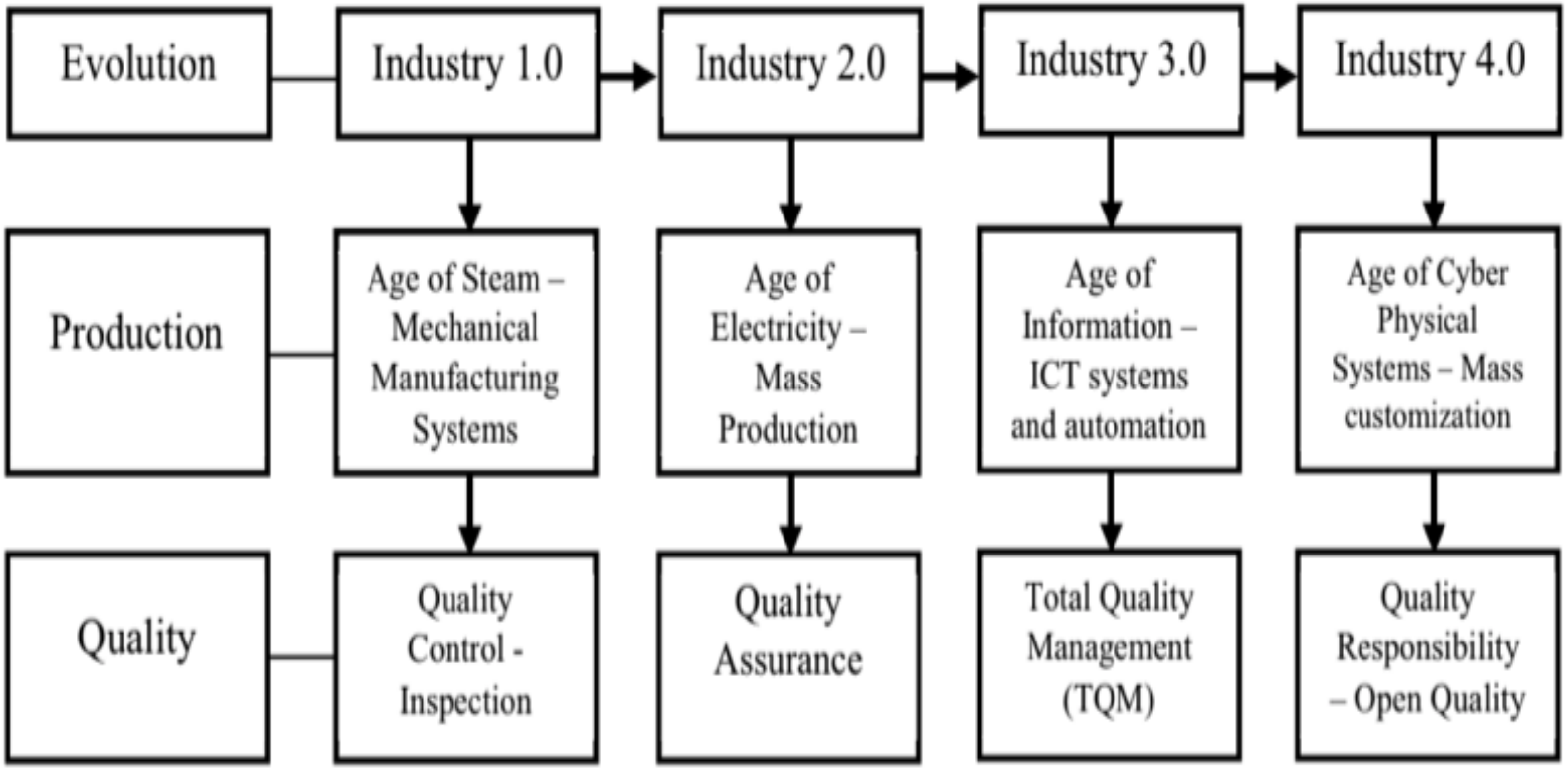
Source: Salimova, T., & Vatolkina, N. (2018). Quality management in the transition to Industry 4.0. *Standards and Quality,* 6, 58-62

Industrial revolutions, quality goals, and quality strategies



Source: Park et al. (2017). Building a new culture for quality management in the era of the Fourth Industrial Revolution. *Total Quality Management and Business Excellence, 28(9),* 934-945

Quality vs Industry



Source: Broday, E.E. (2022), "The evolution of quality: from inspection to quality 4.0", International Journal of Quality and Service Sciences, Vol. 14 No. 3, pp. 368-382.

Five generations of quality

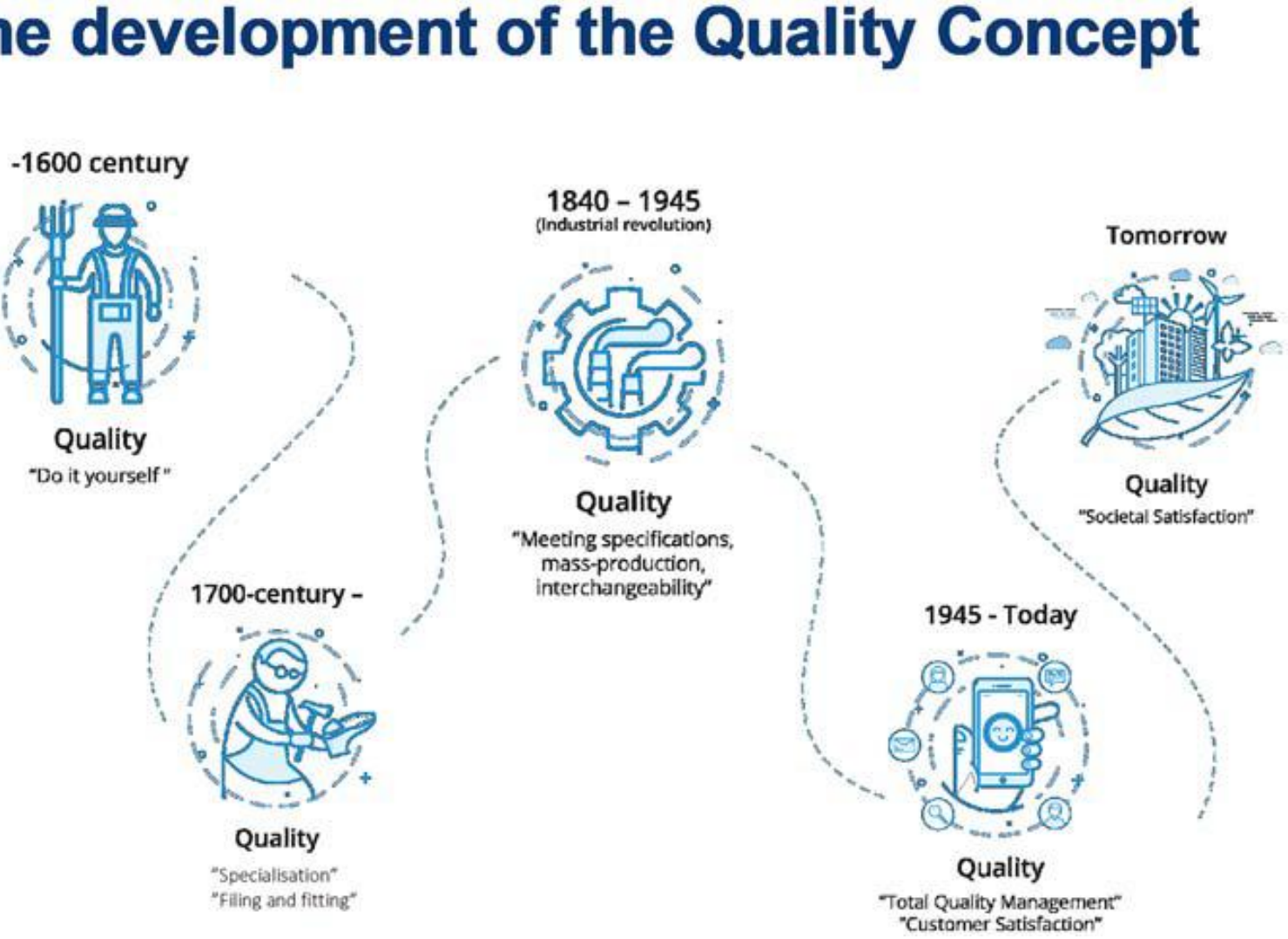
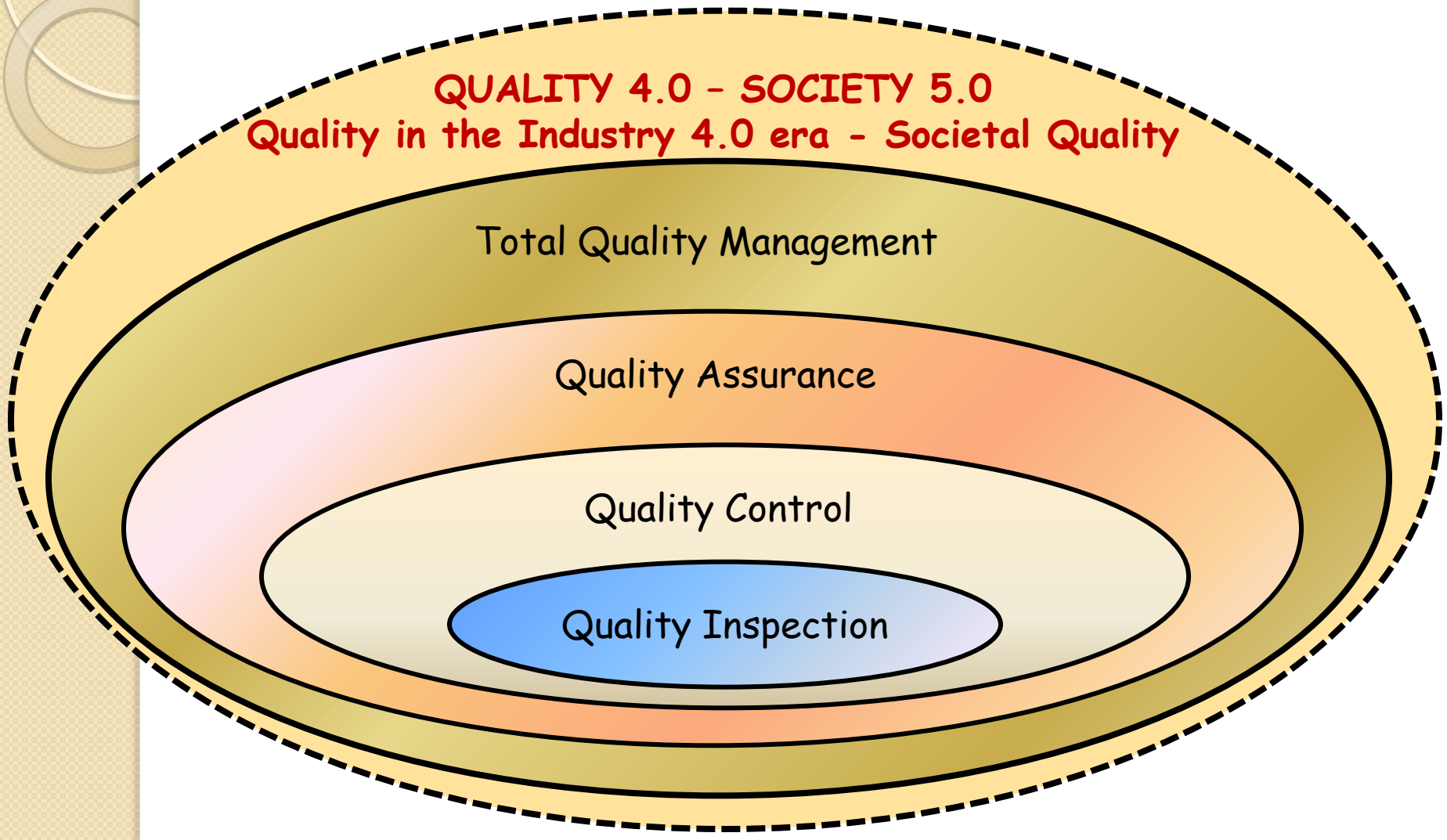


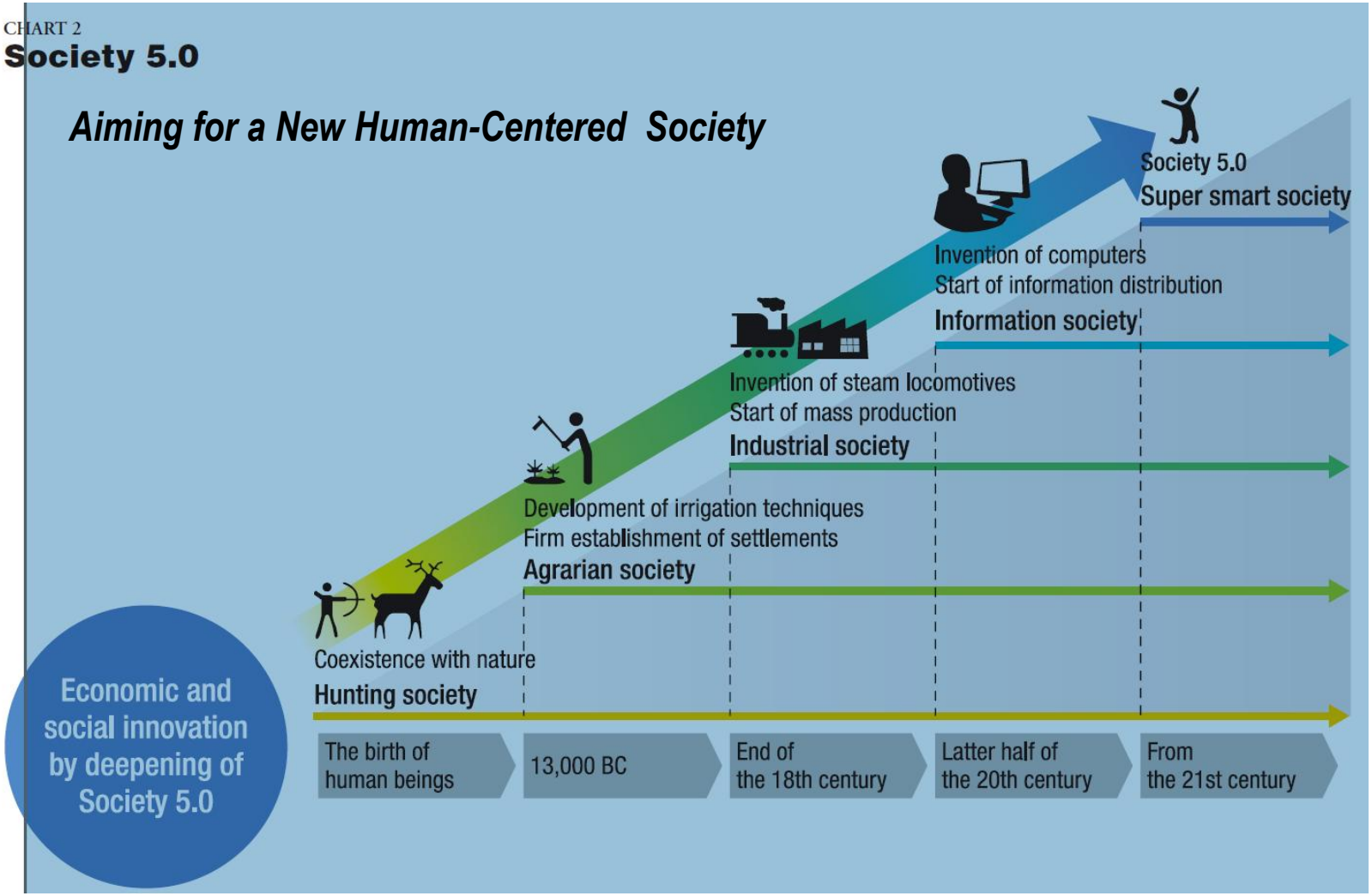
Figure 1. The development of the quality concept through five generations of quality, now approaching Quality 5.0

Quality maturity layers



Source: Tsiotras, G. (2020), *Total Quality Management*, Broken Hill Editions Ltd, Cyprus; Sader, S., Husti, I., and Daroczi, M. (2022), A review of quality 4.0: definitions, features, technologies, applications, and challenges, Total Quality Management & Business Excellence, 33:9-10, 1164-1182; Deleryd, M., and Fundin, A. (2020) Towards societal satisfaction in a fifth generation of quality – the sustainability model, Total Quality Management & Business Excellence, doi: 10.1080/14783363.2020.1864214 & own elaboration

Society 5.0



Source: **Mayumi Fukuyama Society 5.0: Aiming for a New Human-Centered Society** Japan SPOTLIGHT • July / August 2018
Prepared by the author based on material from the Japan Business Federation (Keidanren) "Japan's initiatives - Society 5.0": Y. Harayama, "Society 5.0: Aiming for a New Human-centered Society", Hitachi Review, vol. 66, no. 6, 2017, pp. 556–557.

Quality definition(s)

Value for money

Zero defects

Usability

Better than competitors

Fitness for use

Conformance to requirements

Quality 4.0 origin

- Q4.0 stemmed from the I4.0 and it refers to the digitalization of quality. It deals with aligning the practices of quality management with the emergent capabilities of I4.0 to help drive companies toward achieving excellence. As stated by ASQ, “Quality 4.0 is a term that references the future of quality and organizational excellence within the context of I4.0”.
- Quality 4.0 (Q4.0) appeared as a new approach where I4.0 technological advancements and tools are used by organizations to improve their ability to deliver high-quality products consistently.
- Quality as a concept is more data driven now, due to the availability of sensors and big data analytics, resulting in a shift from product to services.
- Rethinking the key concepts of quality management led to the fact that in 2017, B. Pederson introduced the concept of Q4.0 and Park et al (2017) introduced the concept of open quality.

Definitions of Quality 4.0 (i)

- Antony (2020) & Sony et al. (2020) → "serves to align the quality management with I4.0 to enable efficiency, innovation, performance and enhance business models with enterprises. It uses the I4.0 technologies such as CPS, IOT and IoS to fulfill the requirements of industries in terms of quality of design, quality of performance and quality of conformance"
- Sony et al (2020)→"a new method by which digital tools can be used to drive improvements across the value chain"
- Armani et al (2020) → "is the digitalization of quality management to encompass technology, processes and people"
- Ramezani and Jassbi (2020) → "is a branch of I4.0 that aims to boost quality through the deployment of smart solutions and intelligent algorithms"
- Jacob (2017) → Q4.0 should be considered as a large-scale transformation with implications on culture, leadership, collaboration and compliance towards maximizing value for organization.

Definitions of Quality 4.0 (ii)

- Tomic (2020) → "is a subset of I4.0 that serves to integrate the traditional quality tools with I4.0 features for achieving better operational excellence and performance"
- Radziwill (2020) →"an I4.0 approach that prioritizes quality and performance goals looking at how individuals, systems and emerging technologies interact to improve connectedness, intelligence and automation"
- Watson (2019) → "a holistic sociotechnical system that is purposefully designed to discover and apply profound knowledge in pursuit of continual improvement and consistently achieve an organization's purposeful objectives. Quality shifts from production to system design and integration with the business environment"
- Salimova et al. (2020) → "the adaptive capacity of a product at any stage of its life cycle to meet the needs of customers, taking into account the interest of other stakeholders along the value chain"

Quality 4.0 conceptualization

- There is no consensus on the definition of Q4.0
- Based on the definitions, traditional methods in quality management are not replaced, but improved, through the digitalization of processes and systems
- Two new trends are considered: a) digitalization of production and b) digitalization of consumption
- Q4.0 is NOT only

1. only about technology and innovation
2. only the implementation of an Enterprise Quality Management System
3. distinct from traditional quality
4. only the responsibility of IT

Transformation of QM principles (i)

1. Shared leadership -> Distribution of responsibility for quality to all team members
2. Talent Management -> Development of talent as the basis for identifying and developing leaders and implementing the idea of shared leadership
3. Customers' engagement -> Customer actively participate in creating value in the production
4. Project management & networking -> moving from a value chain to a value network
5. Managament of data & innovation -> Decisions based on real-time data, flexibility and adaptability

Transformation of QM principles (ii)

6. Capacity building through partnerships with stakeholders -> Organizational capacity based on open network of partners and stakeholders

7. Value-based management

8. Responsibility for a sustainable future -> focus on sustainable development

Drivers for adoption of Quality 4.0

- The need for reliable and accurate data for quality management (Sony et al, 2021)
- Increased customer willingness and improved customer satisfaction
- Productivity improvement through technologies
- New methods for quality inspection and control
- Big Data driven quality management
- Cost and time savings

Ingredients for Implementation of Quality 4.0 (i)

1. Handling big data → Big data can be generated and be used in Q4.0 for improved quality of design, quality of conformance and quality of performance of products and services.

2. Prescriptive analytics algorithms → strategically handling prescriptive analytics algorithms will boost the chances of the success of Q4.0

3. Vertical, horizontal and end-to-end integration → a quality management system should concentrate on all three types of integration to create an efficient and effective Q4.0 programme by strategically extracting, analysing and deciding on the data based on all three forms of integration

4. Operational strategy → by using modern technologies of I4.0, an organization can create better quality products and services and thereby create a price-value advantage over competitors.

Ingredients for Implementation of Quality 4.0

5. Leadership → Q4.0 requires a process of innovation and learning because the core concept of Q4.0 is about bringing the practice of quality management with the emerging capabilities of I4.0. Thus, Q4.0 requires a leadership style that considers innovation and learning.

6. Training → The use of tools in Q4.0 will have to be developed for quality planning, quality control, and quality improvement, and the employees will have to be trained in a strategic manner continuously.

7. Organizational culture → By virtue of connecting data, analytics and processes, and thereby improving visibility, connectivity, collaboration and insights, the four types of organizational culture such as clan, adhocratic, hierarchy and market will play an important role in Q4.0

8. Top management support → refers to the degree to which top management understands the importance of the Q4.0 and the extent to which top management is willing to support Q4.0 implementation within the organization. A transparent and visible top management support encourages positive user attitudes towards Q4.0 system.

Ingredients for Implementation of Quality 4.0

- **Five out of eight essential ingredients for Q4.0 success mentioned by Sony et al (2020) are related to human factors**. Quality practices and decisions are predominantly the responsibility of people. The key aspects that link people and Q4.0 are identified as leadership, culture, and competency

- **Q4.0 is much more than technology. It is the symbiotic relationship between humans and technology** in a goal-oriented manner to meet the quality strategy and objectives of the organization. Thus, Q4.0 can be treated as a social-technical system.

Barriers to Q4.0

- The resistance from organizations to adopt new technologies and the absence of support from leadership (American Society for Quality 2020, Mckendrick, 2020, Sony et al, 2021).

- Limitations in assessing the readiness (Kovrigin and Vasiliev, 2020) and the lack of a standardized and accepted framework for implementing Q4.0 (Dias, 2021).

- Escobar et al (2021) cited that the greatest challenge for Q4.0 is the lack of people sufficiently qualified to handle these new technologies.

Implications of Quality 4.0 (i)

- The impact of Q4.0 on the learning and growth dimensions would be in terms of improving the knowledge and skill set of employees, which will help them to adapt toward the higher-order skillset.
- The impact of Q4.0 on the financial performance of the organization would be an increase in total revenue and growth, gross profit margin, gross net profit margin and high inventory turnover ratio
- The impact on the customer value proposition would be in terms of a better understanding of customer needs, data-driven product development, automated manufacturing and continued product usage data monitoring
- The capacity of maintaining quality throughout the process. Organizations have real time data, with detailed documentation throughout the process, maintaining quality assurance.

Implications of Quality 4.0 (ii)

- Improvement of quality in various ways:
  - online platforms can allow people to do their jobs quicker, smarter, and at reduced cost
  - wired communications are suitable for high-performance, time-sensitive automation activities
  - factors such as the environment are typically tracked, and one can identify their significant effect on quality fluctuations

Challenges towards the adoption of Q4.0

- Challenges are consistent with the challenges in the implementation of I4.0
- Hard challenges → data and process related
- Soft challenges → people and organization related

Hard Challenges

- application of innovative QM methods
- integration and connectivity
- increase in complexity
- supply chain traceability
- outdated systems/ infrastructure
- fragmented data sources and systems
- cybersecurity
- data integrity and quality

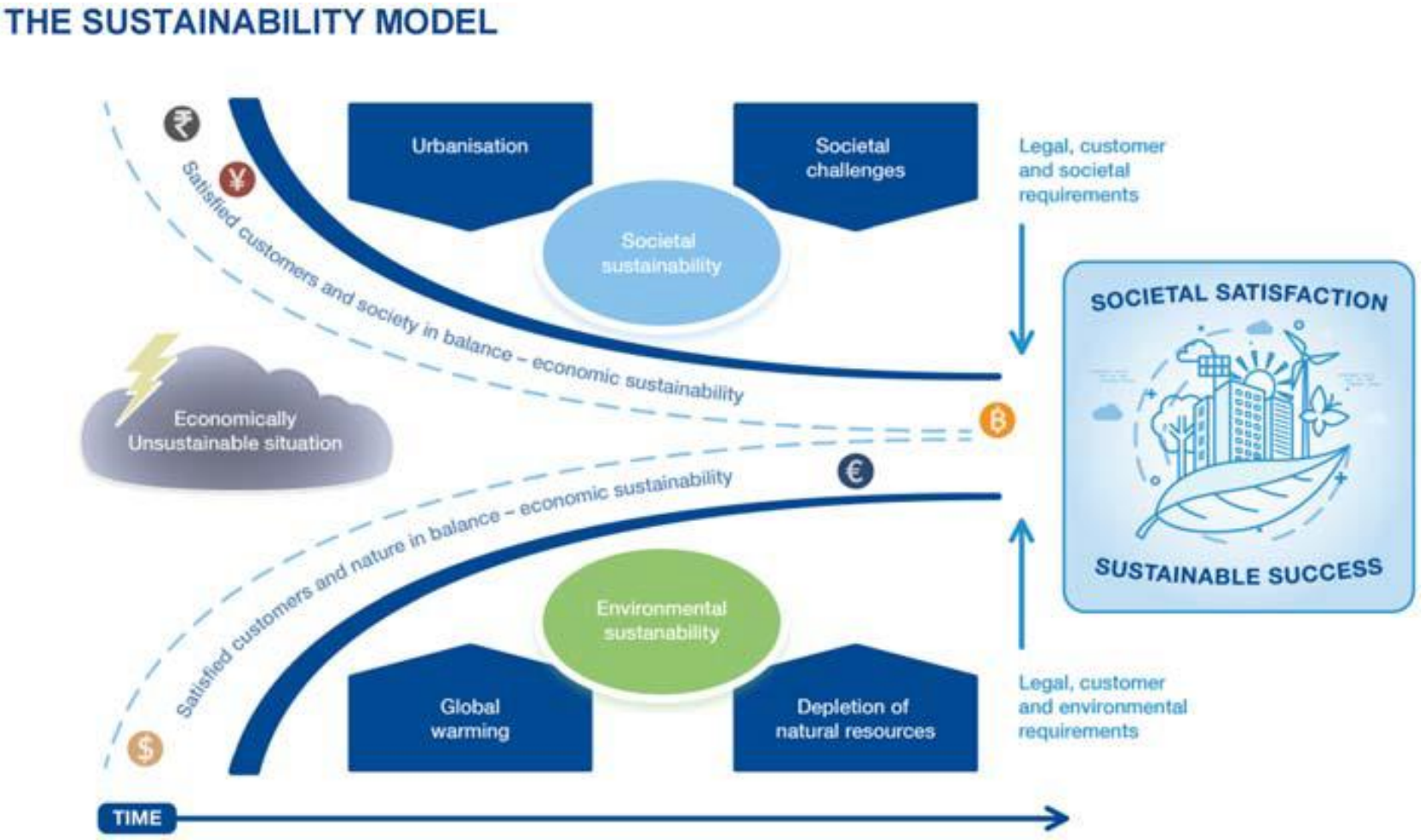
Soft Challenges

- lack of digital strategy
- lack of top management support
- shortage of digital skills
- lack of knowledge
- lack of quality culture
- resistance from organizations
- financial constraints
- lack of resources
- maintaining quality

Future Research Directions

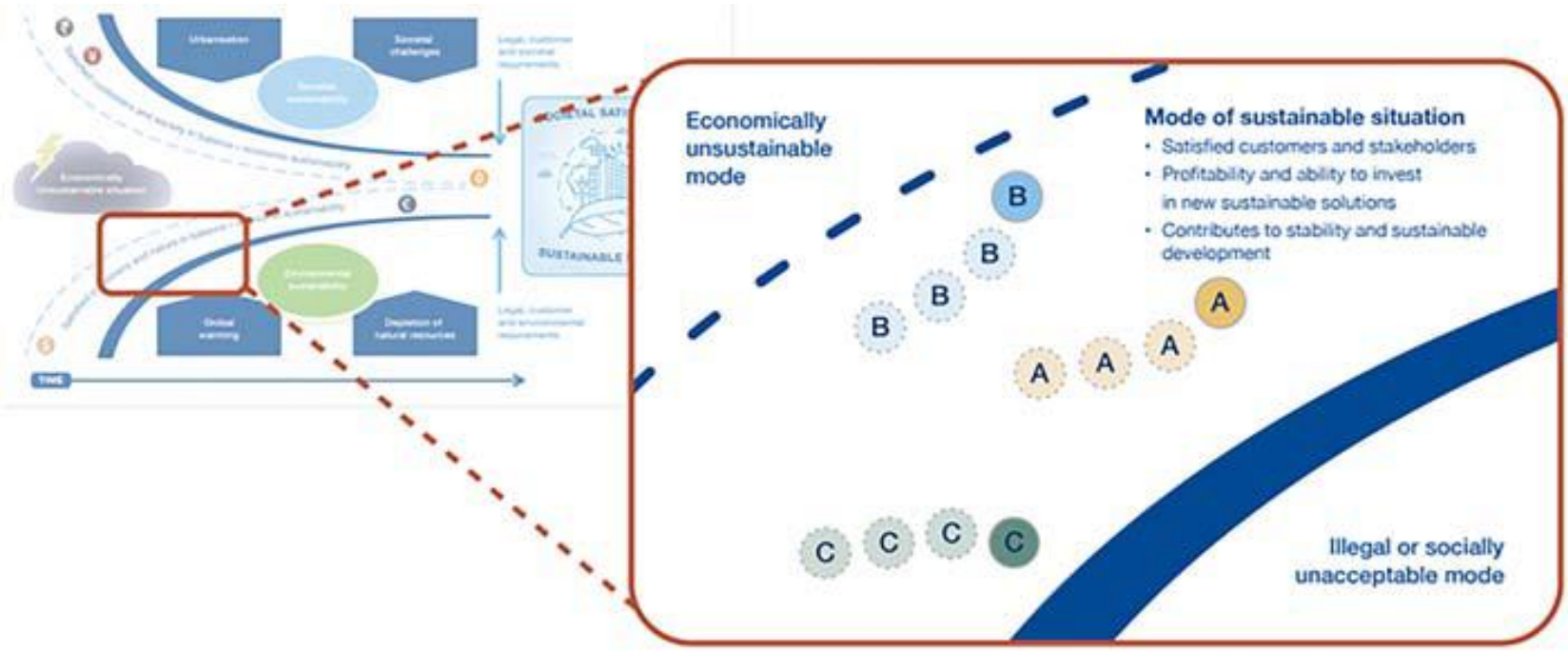
- Development of maturity models for Q4.0 adoption, in order to assess the maturity levels and determine the gaps needed to address
- Focus on the impact in different sectors in different ways of Q4.0 implementation
- Clarification of the challenges of implementing Q4.0 strategies or upgrading traditional quality management techniques

Societal quality - Sustainability



The sustainability model: Balancing economic, societal, and environmental sustainability to achieve societal satisfaction and sustainable success – the new ultimate measurement of quality and purpose of organisations. *(Deleryd & Fundin, 2020)*

The road to sustainability



All organisations, private or public, large or small, are in the 'sustainability race' towards societal satisfaction and sustainable success.

As organisation C is close to illegal and organisation B is close to financial challenges, organisation A is in the best position to offer sustainable solutions.

(Deleryd & Fundin, 2020)

Information management

standards and systems

IT transformation process

IT Service management frameworks (1)

- **ITIL:** Aligns IT with business needs. The most widely used framework for IT process management is ITIL v3, which has five parts: **S**trategy, **D**esign, **T**ransition, **O**perations and **C**ontinual **S**ervice **I**mprovement.
- **Microsoft Operations Framework** (MOF).

  guides IT professionals through the processes of creating, implementing and managing efficient and cost-effective services.

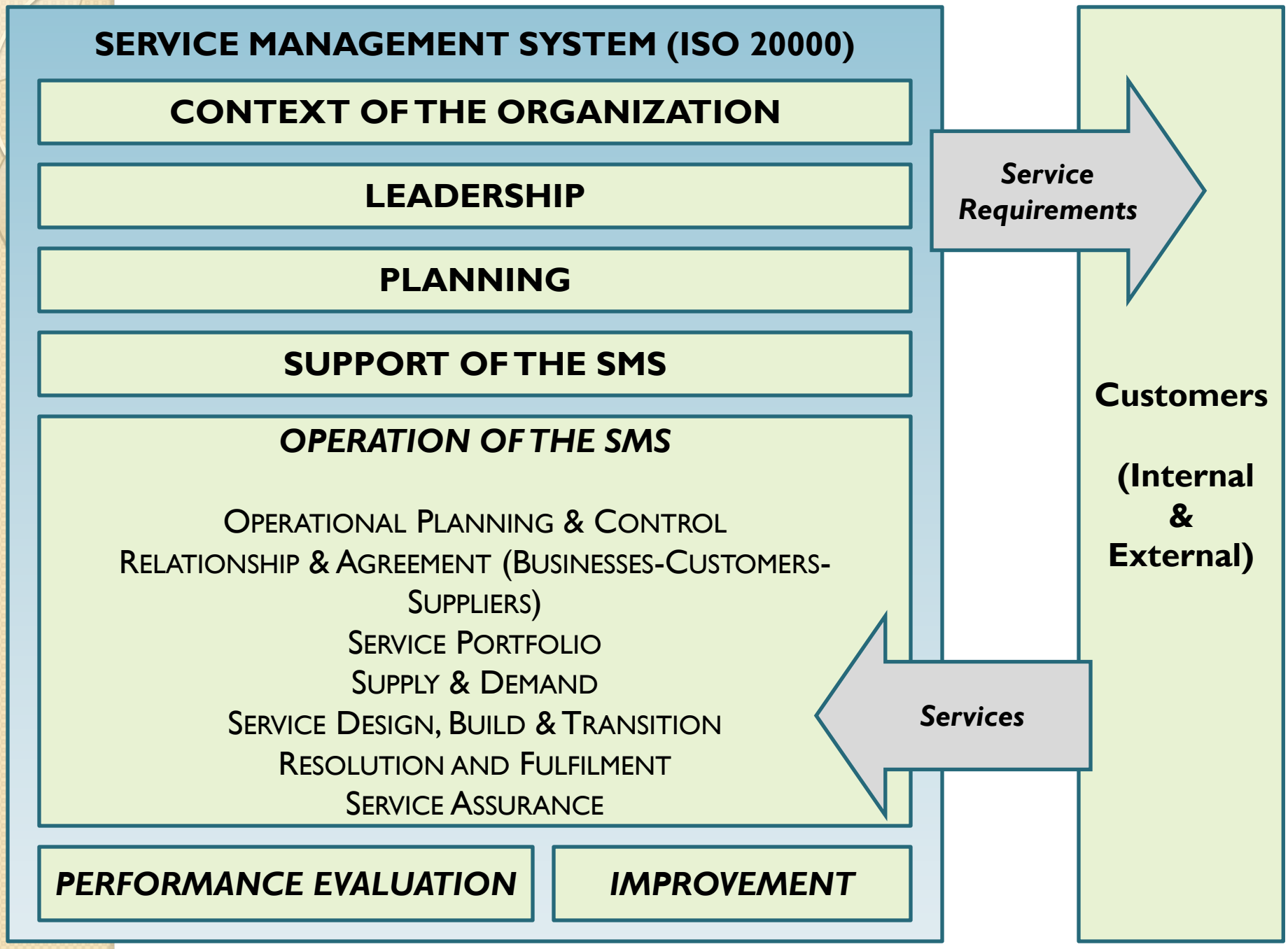
  Like ITIL, MOF includes guidelines for the entire lifecycle of an IT service, from concept to retirement or replacement.

IT service management frameworks (2)

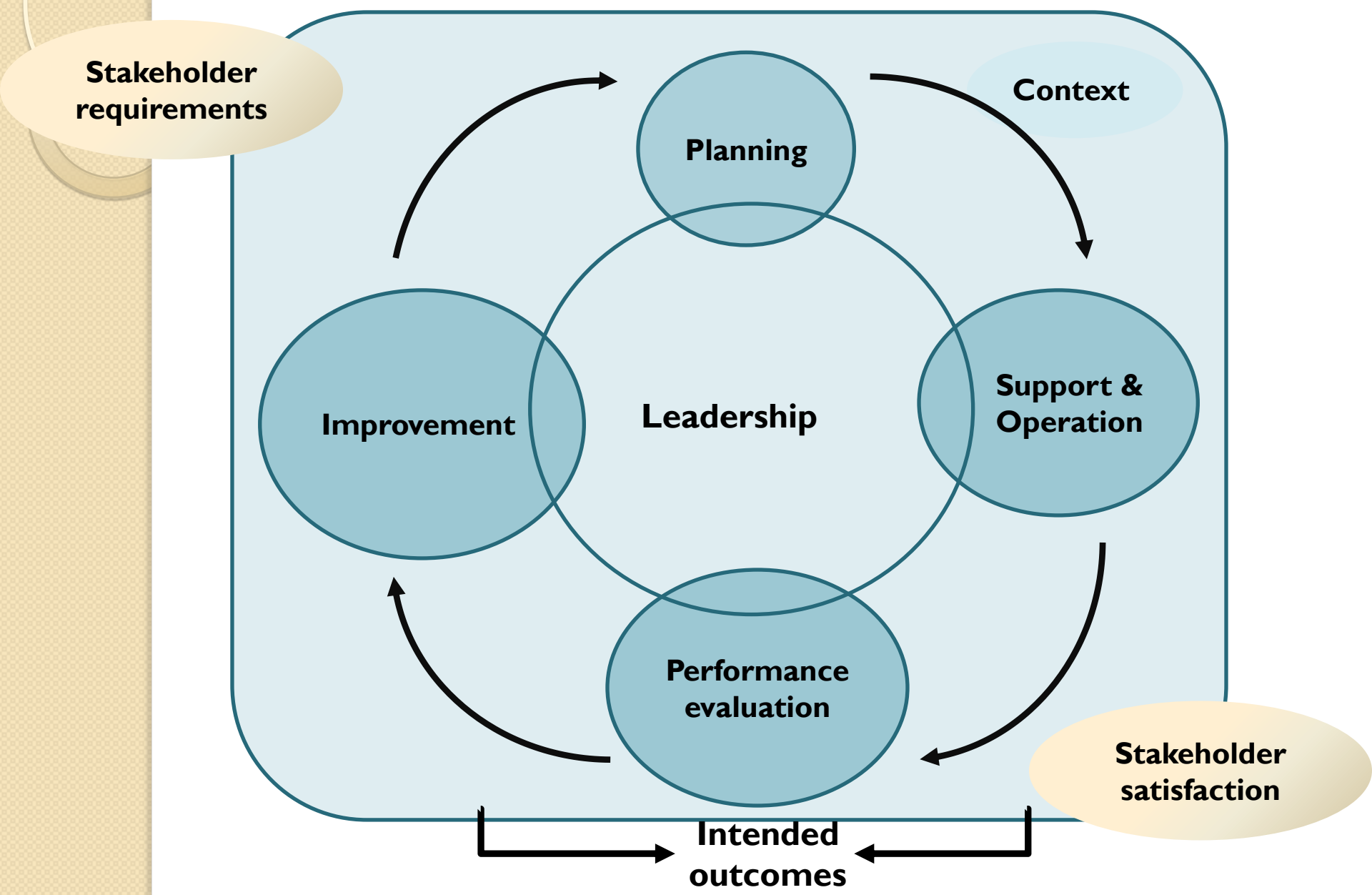
- **COBIT:** Control Objectives for Information and Related Technologies

  a framework for developing, implementing, monitoring and improving IT governance and management practices.
- **ISO 20000**

  Supports ITIL and MOF.


SERVICE MANAGEMENT SYSTEM (ISO 20000)
CONTEXT OF THE ORGANIZATION
LEADERSHIP
PLANNING
SUPPORT OF THE SMS
OPERATION OF THE SMS
OPERATIONAL PLANNING & CONTROL
RELATIONSHIP & AGREEMENT (BUSINESSES-CUSTOMERS-SUPPLIERS)
SERVICE PORTFOLIO
SUPPLY & DEMAND
SERVICE DESIGN, BUILD & TRANSITION
RESOLUTION AND FULFILMENT
SERVICE ASSURANCE
PERFORMANCE EVALUATION
IMPROVEMENT
Service Requirements
Services
Customers
(Internal & External)

pdca & context



ITSM processes (1)

To manage IT services an organization must control the service capabilities, how it performs, changes and what happens when it experiences problems

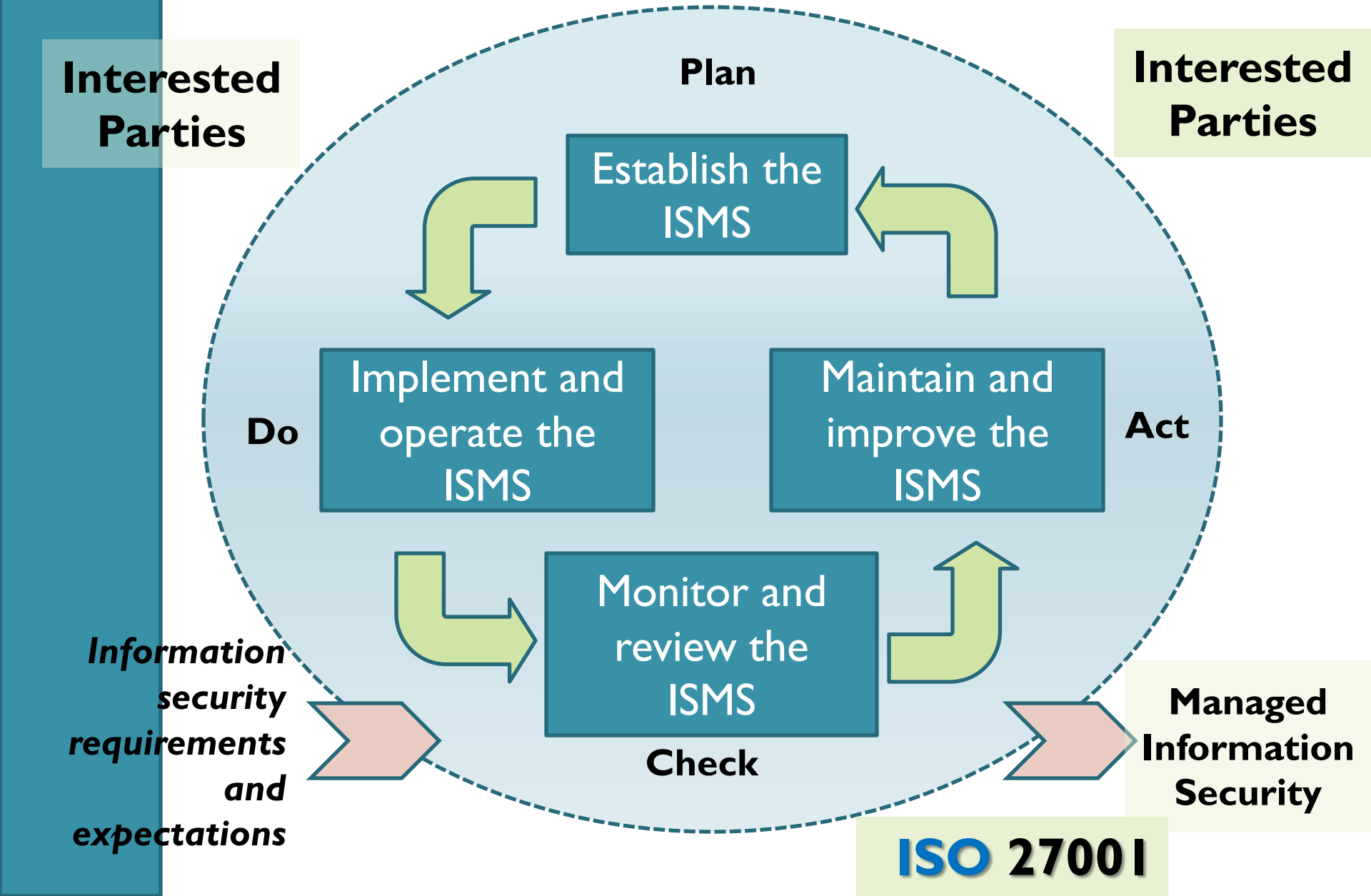
- **Change management.** When a service is out of step with business expectations, it must be modified, expanded or otherwise altered. IT must determine how these changes will affect the service deployment, implement them appropriately, then monitor if the changes have the intended effect. **Release management** can be grouped with change management or treated as a separate process.
- **Asset management.** Services require software and hardware assets to function. These assets should be tracked, updated appropriately and mapped to show how they interact. **Configuration management**, capacity management and asset management deal with these concerns and can be blended or separate processes.
- **Project management.** IT services transition between various stages of the lifecycle at different times and different speeds. Project management skills enable IT organizations to maintain orderly services and avoid problems such as outdated systems or **shadow IT**.

ITSM processes (2)

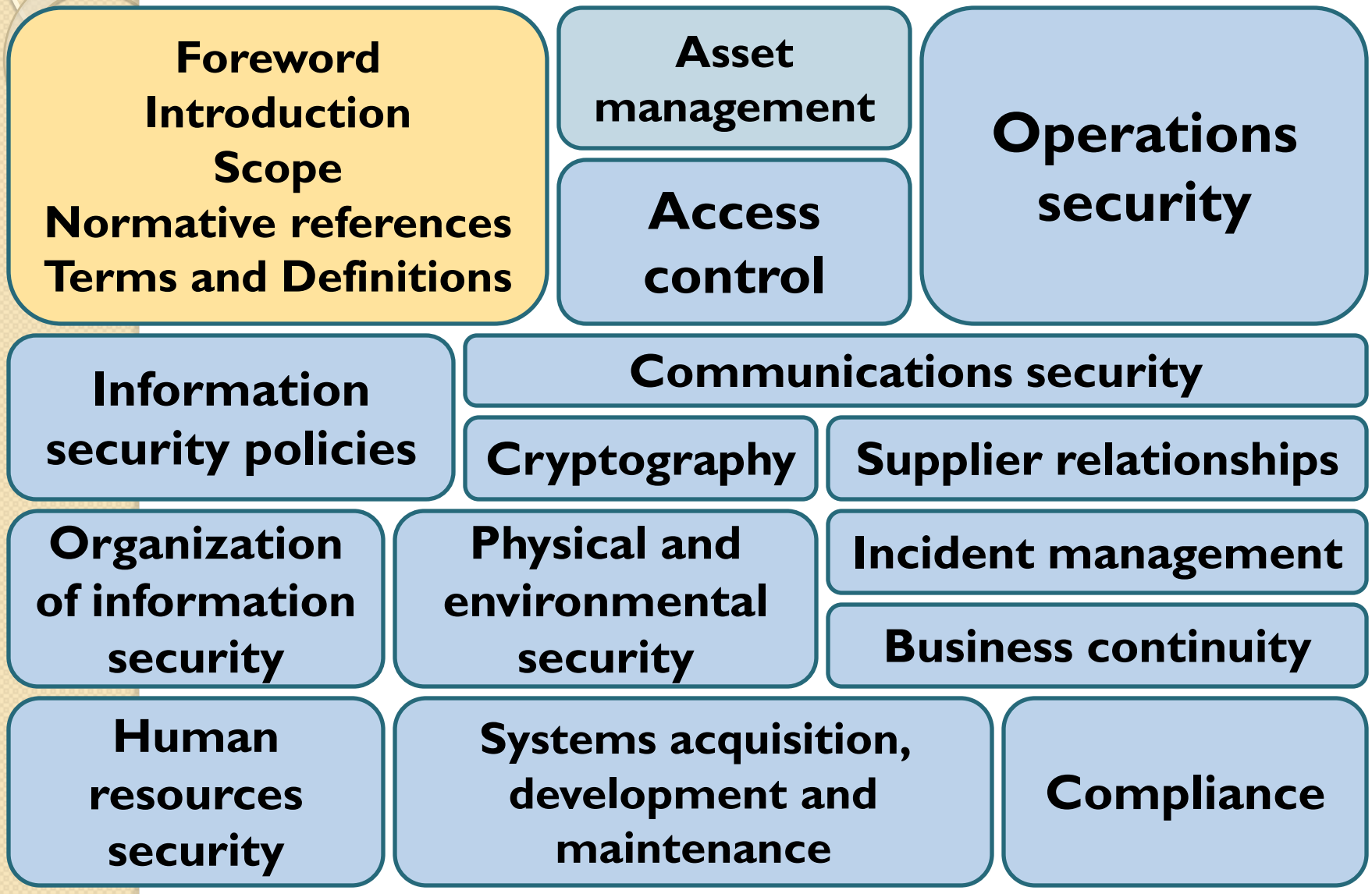
- **Knowledge management.** Knowledge management crosses into the other ITSM processes, and is a way to avoid duplicated work and discovery by organizing and making available information about IT services.
- **Incident management.** When an IT service is disrupted by performance issues or an outage, the IT service desk must address the issue, restore service availability and make improvements and codify procedures to prevent reoccurrence.
- **Problem management.** A problem is the root cause of an incident. An IT organization might remediate an incident but not fix the problem, leading to future incidents. Therefore, problem management is a way to permanently fix issues to improve service delivery and performance.

Source: https://searchitoperations.techtarget.com/definition/ITSM

PCDA MODEL APPLIED TO ISMS



Info security areas (iso 27002)



Quality information standards

ISO/IEC 25010:2011

Systems and software engineering - **S**ystems and software **Qua**lity **R**equirements and **E**valuation (SQuaRE) - System and software quality models

Quality in use

the degree to which a product or system can be used by specific users to meet their needs to achieve specific goals with **effectiveness**, **efficiency**, **freedom from risk** and **satisfaction** in specific **context**s of use.

ISO/IEC 25010:2011

SW&IS Quality in Use characteristics

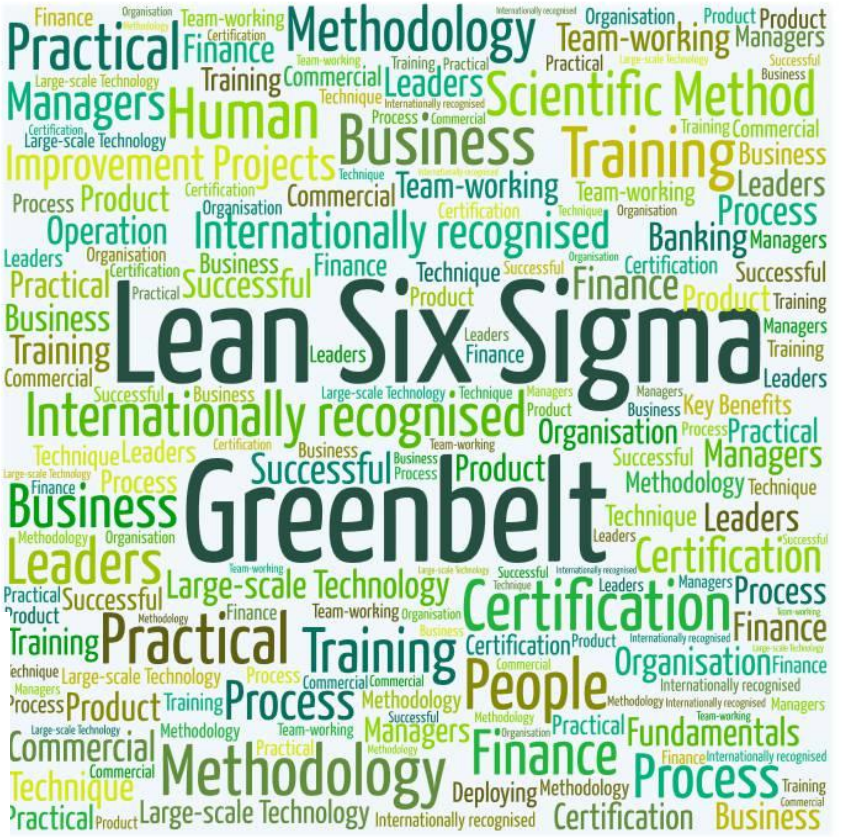
Effectiveness	Accuracy and completeness with which users achieve specified goals
Efficiency	Resources expended in relation to the accuracy and completeness with which users achieve goals
Satisfaction	
Usefulness	Satisfied with perceived achievement of pragmatic goals
Trust	Confidence product behaves as intended
Pleasure	Fulfilling personal needs
Comfort	Physical comfort
Freedom from risk	
Economic risk mitigation	financial status, efficient operation, commercial property, reputation or other resources
Health and safety risk mitigation	to people
Environmental risk mitigation	to property or the environment
Context coverage	
Context completeness	Can be used in all the specified contexts of use
Flexibility	Can be used in contexts beyond those initially & explicitly specified in the requirements

SW product quality

- Characterics & Subcaracteristics

certifications

- Quality
- Six Sigma (± 3σ)
- Lean management



ITIL (IT Infrastructure Library)

Information technology & service management standards

Traceability

Traceability - Definition

- The ability to retrace the history, use or location of a product or component by means of recorded identification.

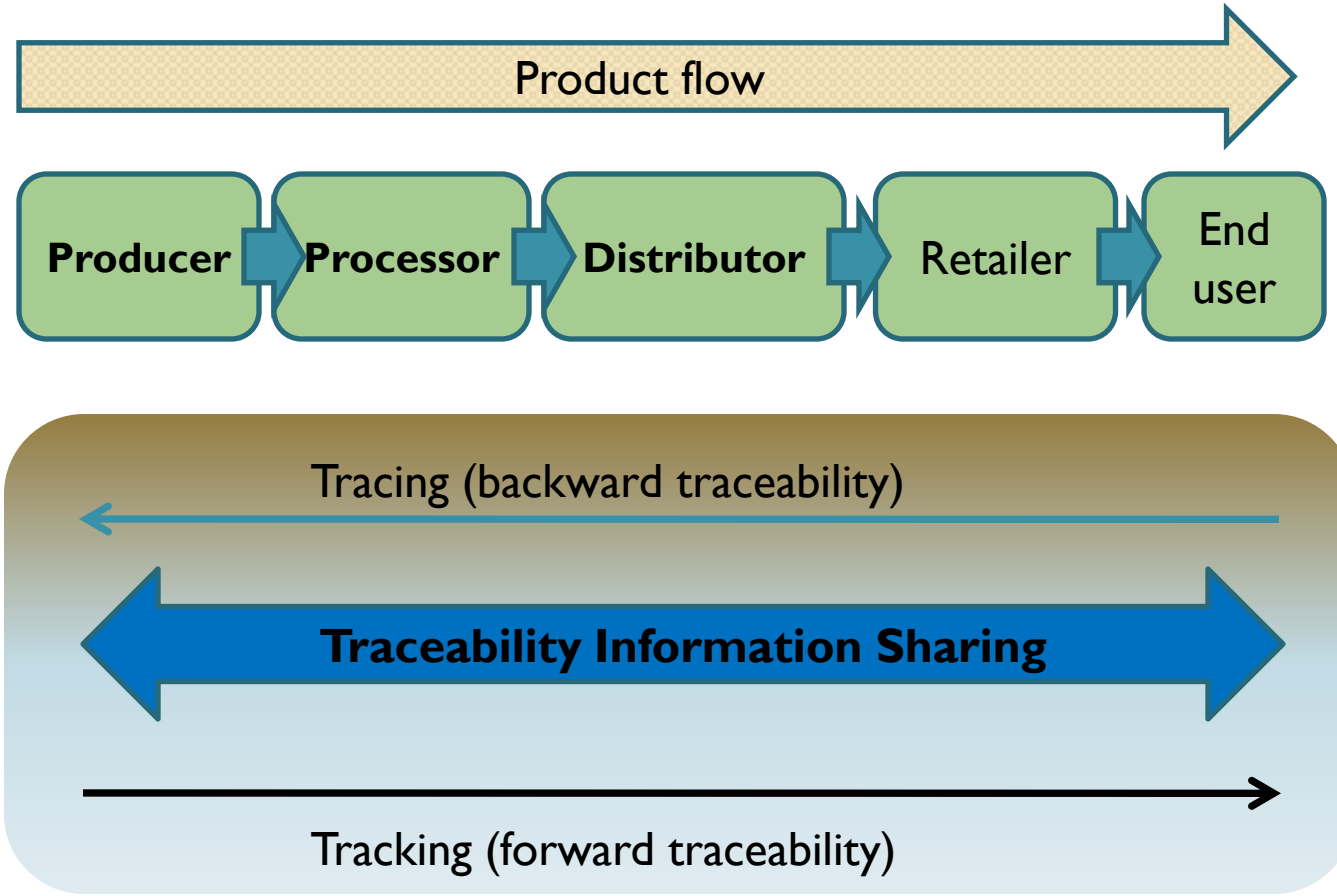
- **ISO 9001 standard – subsection 8.6.2 Identification and traceability:**

Where appropriate, the organization shall identify process outputs by suitable means.

The organization shall identify the status of process outputs with respect to monitoring and measurement requirements throughout realization of goods and services.

Where traceability is a requirement, the organization shall control the unique identification of the process outputs, and maintain it as documented information.

Supply chain view

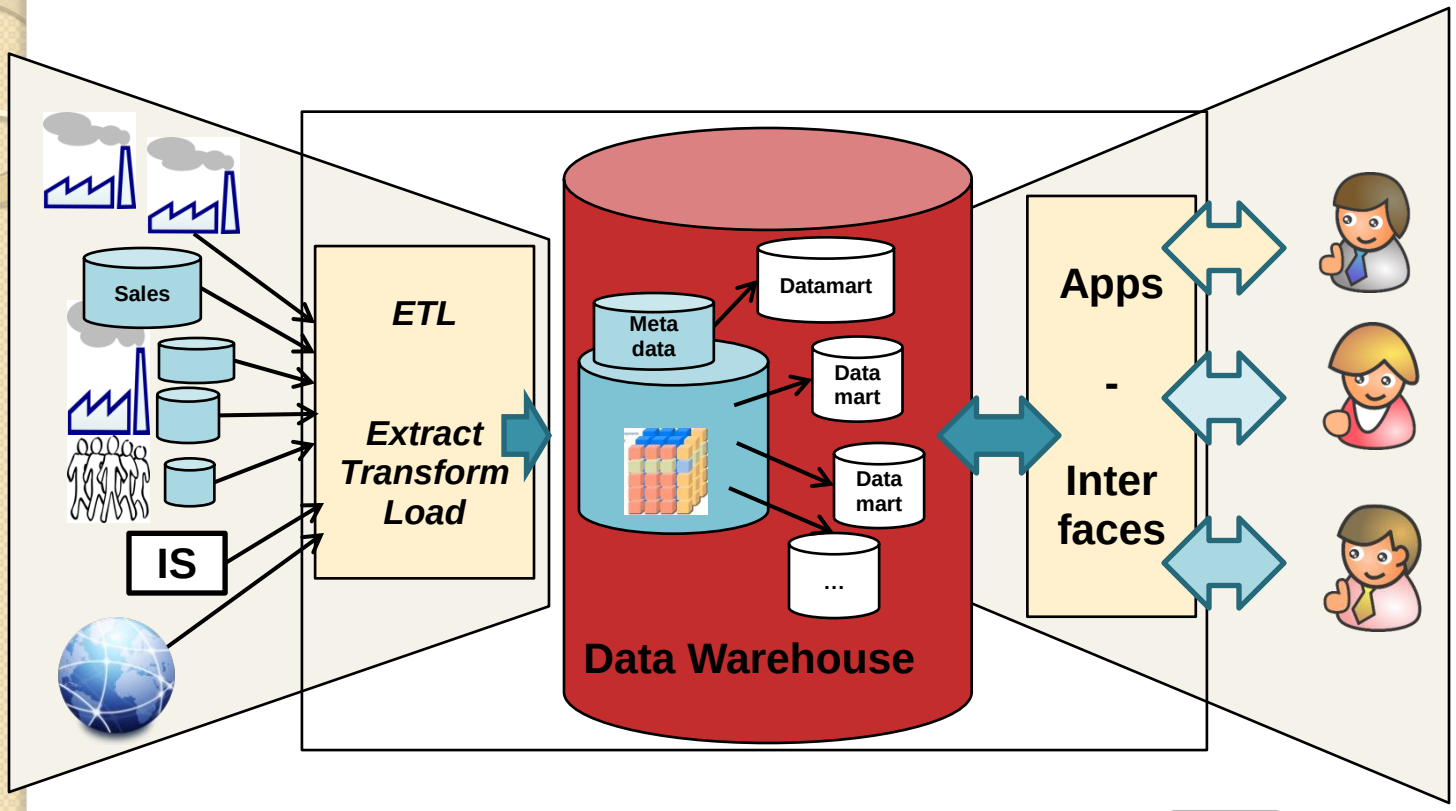


Source: Bosona T. and Gebresenbet G. (2013), "Food traceability as an integral part of logistics management in food and agricultural supply chain", Food Control, Vol. 33 No. 1, pp. 32-48.

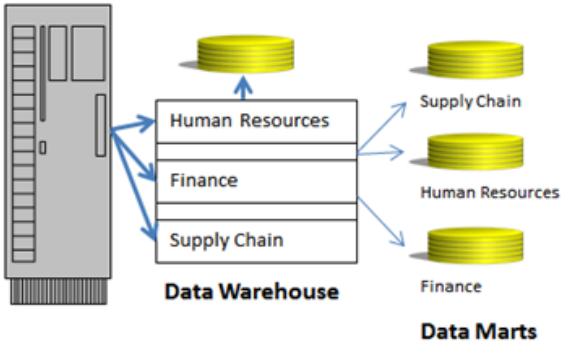
Business Intelligence

- Provides a centralised view on multiple distributed data sources
- Offers many analytical capabilities on these data in order to turn them into information and knowledge
- Aims to support managers in their decision making process.

BI architecture



- Key technical issues:
  - Users' needs identification
  - Data integration



Food traceability: Interdependent standards and disciplines

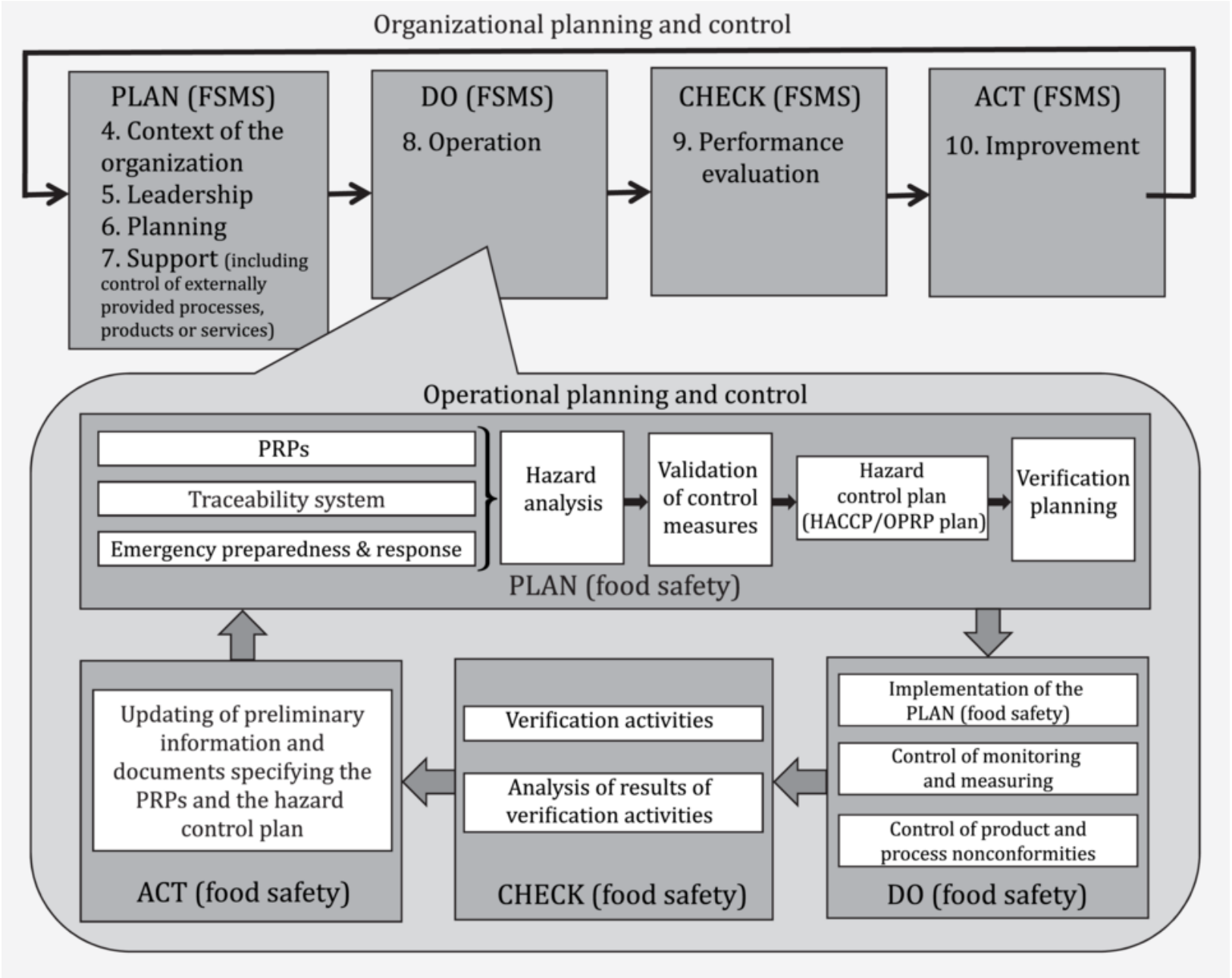
ISO 22005

Traceability in the feed and food chain - General principles and basic requirements for system design and implementation

It supports the ISO 22000 standard:

Food safety management systems - Requirements for any organization in the food chain

PDCA at two levels



Food Traceability

- refers to "all stages in the food supply chain so that the product can be checked for safety and quality control, traced upward, and tracked downward at any time required"
- legislative frameworks (e.g. Codex Alimentarius) enforce nation-, Europe- and world-wide traceability measures
- voluntary schemes, such as
  - the Hazard Analysis of Critical Control Points (HACCP)
  - the ISO 22000:2018
- food scandals in Europe: mad cows in GB & dioxin contaminated chicken and eggs in Belgium

Food Traceability needs

- to provide fast answer to questions like:
  - *Who supplied the fertilizers?*
  - *Which medication did the cows receive?*

Key challenges:

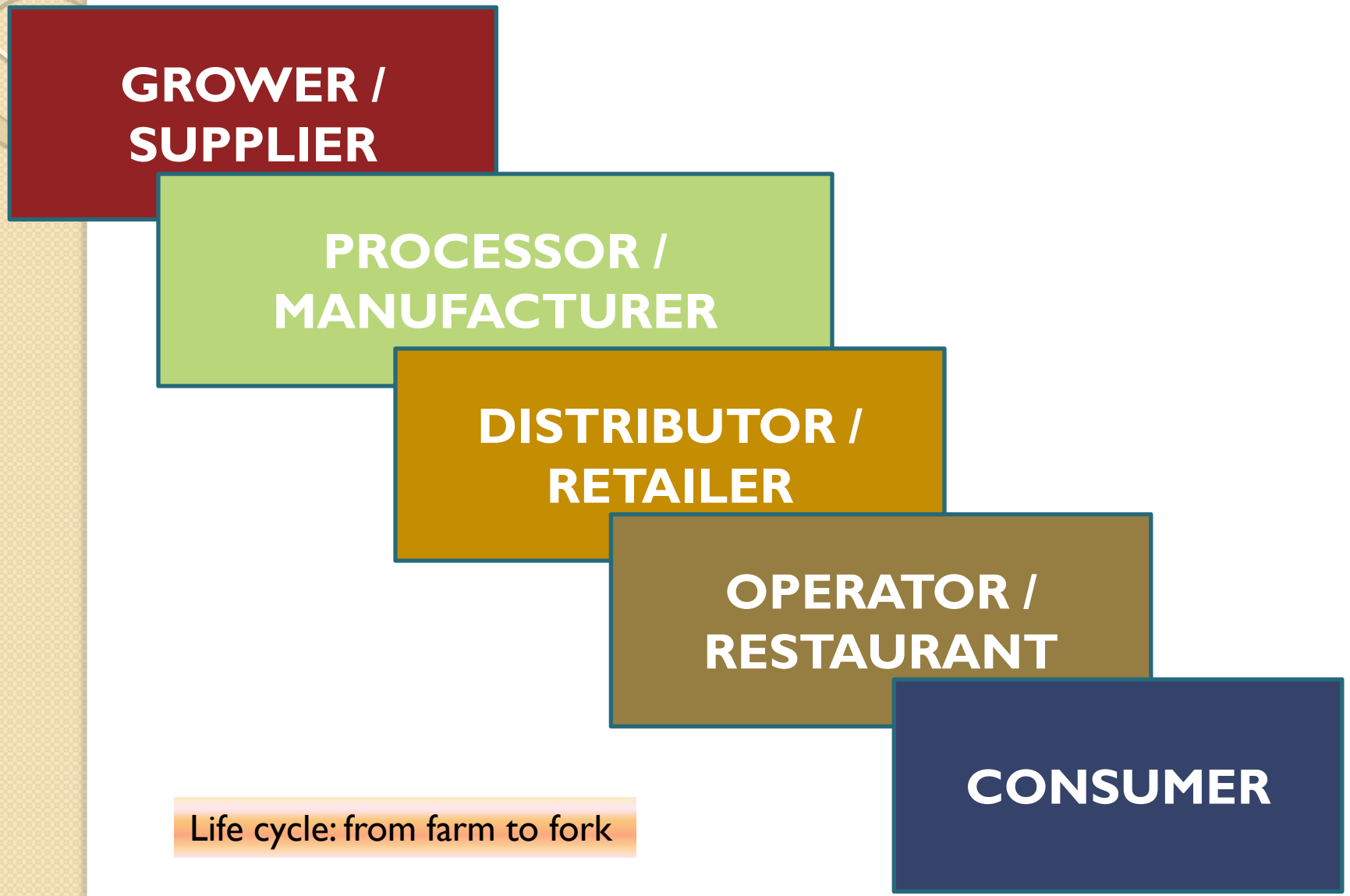
(i) the availability of the information

(ii) the content uniformity and sufficiency of information

(iii) the speed of access to information

(iv) the strategic perspective of information use

FOOD SUPPLY CHAIN



Life cycle: from farm to fork

Food traceability

Information flow

Information management

Requirements: standards legislation

Resources/ capabilities

Key Performance Indicators

Stakeholders

Supply chain

Measurement

Food safety requirements

- Traceability
- Visibility
- Interoperability
- Compatibility
- Readiness

communicating

tracking and tracing

respond

Software & equipment for food traceability

Commercial Software Applications:

- FoodTrack
- Enterprise Quality management – EQM
- QualTrace

Tools for data capturing:

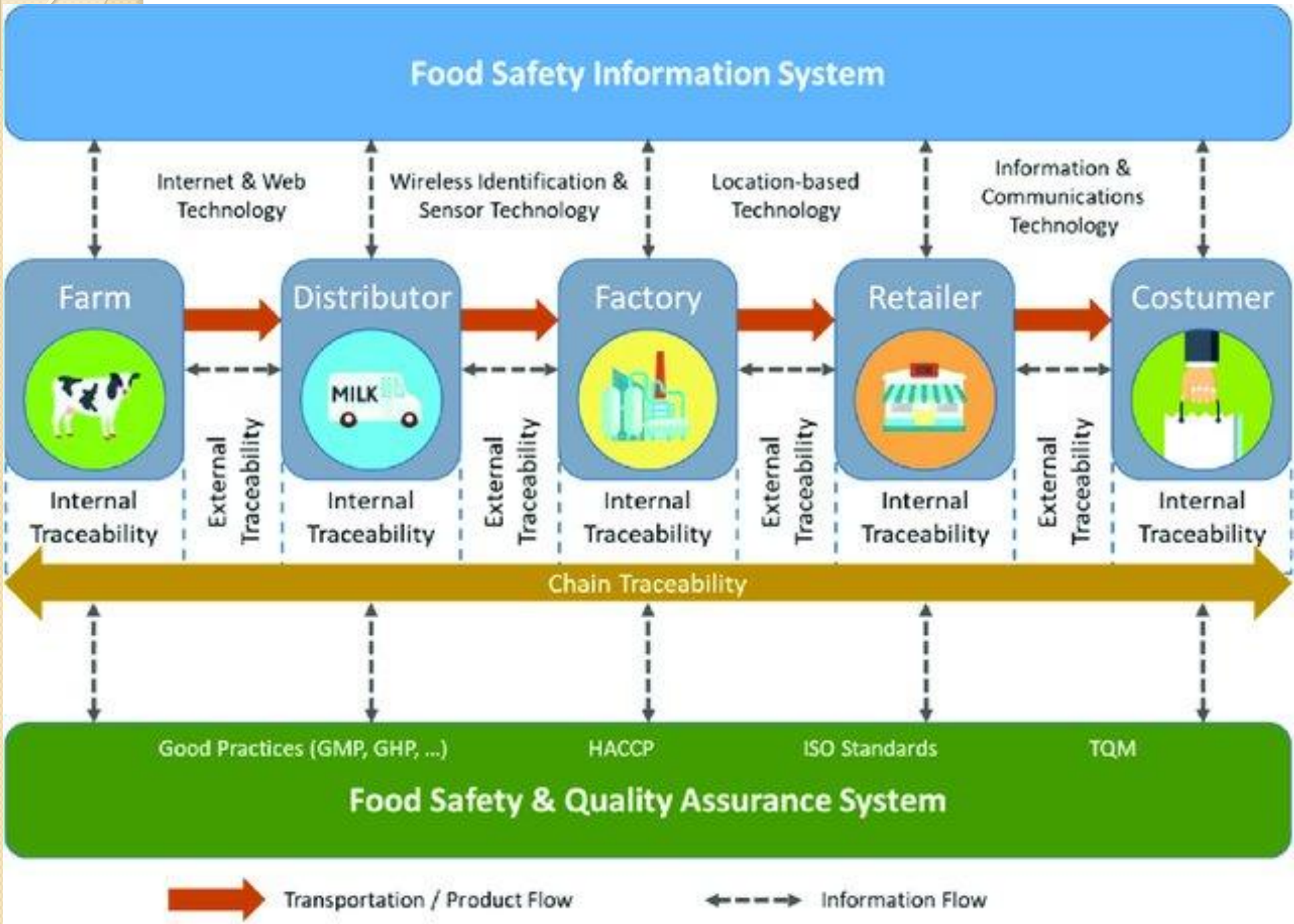
- alphanumerical code
- bar code
- RFID

Traceability innovations

Potential future innovations for improved speed and precision:

- DNA fingerprinting
- nanotechnology
- retina imaging
- edible tags
- e-paper tags

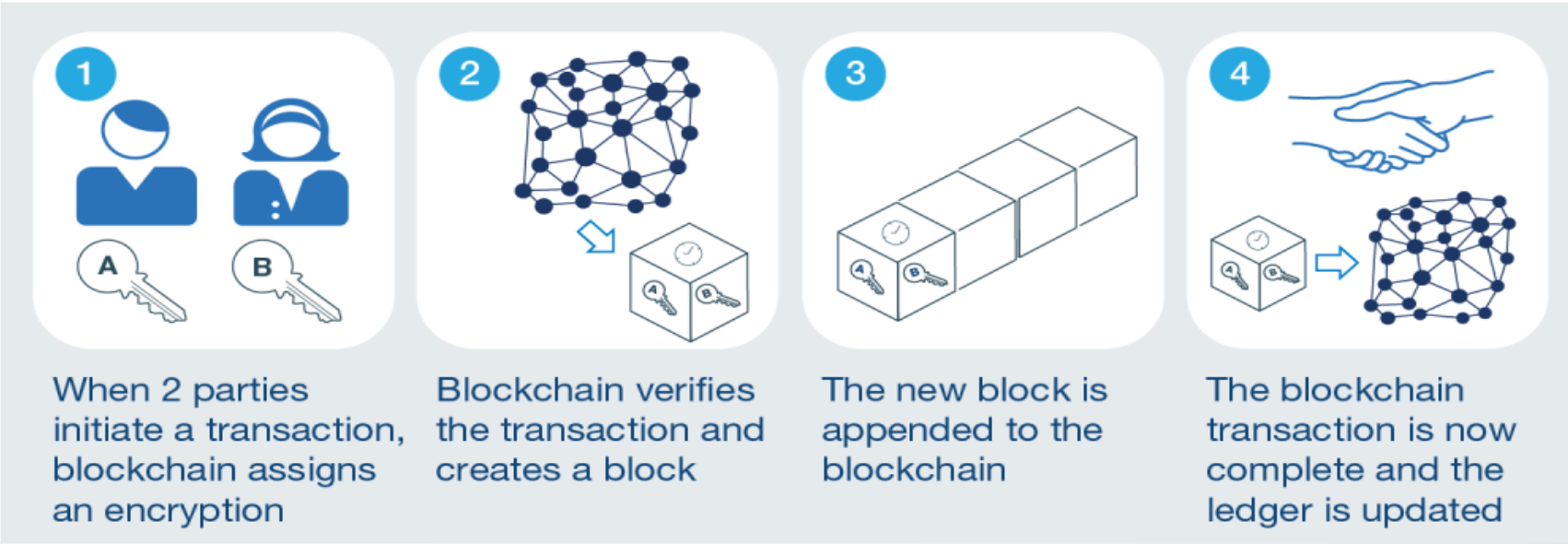
  (electronic paper that displays the appearance of regular ink on paper) into crop and food-animal production industries


Food Safety Information System
Internet & Web Technology
Wireless Identification & Sensor Technology
Location-based Technology
Information & Communications Technology
Farm
Distributor
Factory
Retailer
Costumer
MILK
Internal Traceability
External Traceability
Internal Traceability
External Traceability
Internal Traceability
External Traceability
Internal Traceability
External Traceability
Internal Traceability
Chain Traceability
Good Practices (GMP, GHP, ...)
HACCP
ISO Standards
TQM
Food Safety & Quality Assurance System
Transportation / Product Flow
Information Flow

Technologies

Barcode **linear/2-dim** **Data matrix**	
RFID	
Blockchain	

How to create a blockchain transaction



Blockchain is an expandable list of records or blocks, each containing data representing an individual transaction by members of a network.

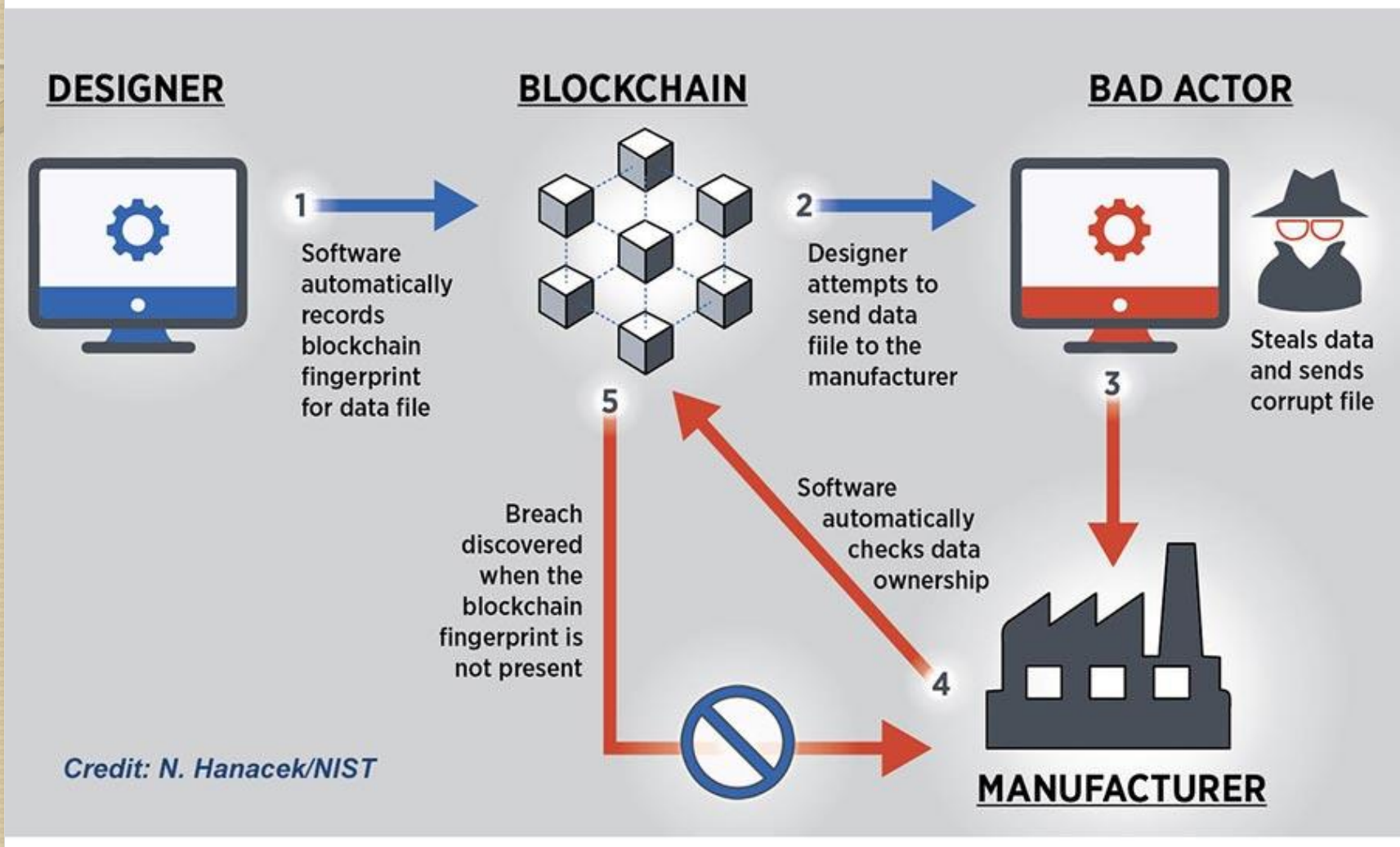
Each block consists of a data set, a time stamp, a cryptographic hash (a cybersecurity fingerprint) and the hash of the previous block linking them together.

Information in any block cannot be altered without changing all subsequent blocks and **alerting record-keepers in the network that possible foul play has occurred**.

Blockchain in new food product design

- a processor's master chef will collaborate with clients' chefs about new product recipes, processing, packaging, etc.
- product design teams need to produce new graphics and packaging—all of which need to be protected from prying eyes while each team member gets accur and timely information.
- **how does blockchain work?**

Anti-theft system



Blockchain: Smart manufacturing

Smart manufacturing requires that product data be shared and exchanged among numerous engineering applications and information systems, but all the information generated and shared in a product's lifecycle needs to be **protected from tampering, corruption and theft**.

It must also be totally traceable and time-stamped, and always up to date.

Blockchain pros

- promising ledger and data sharing application
- connecting disparate supply chain partners through decentralization
- immutable/unchangeable and time stamped
- using smart contracts to automate data relationships

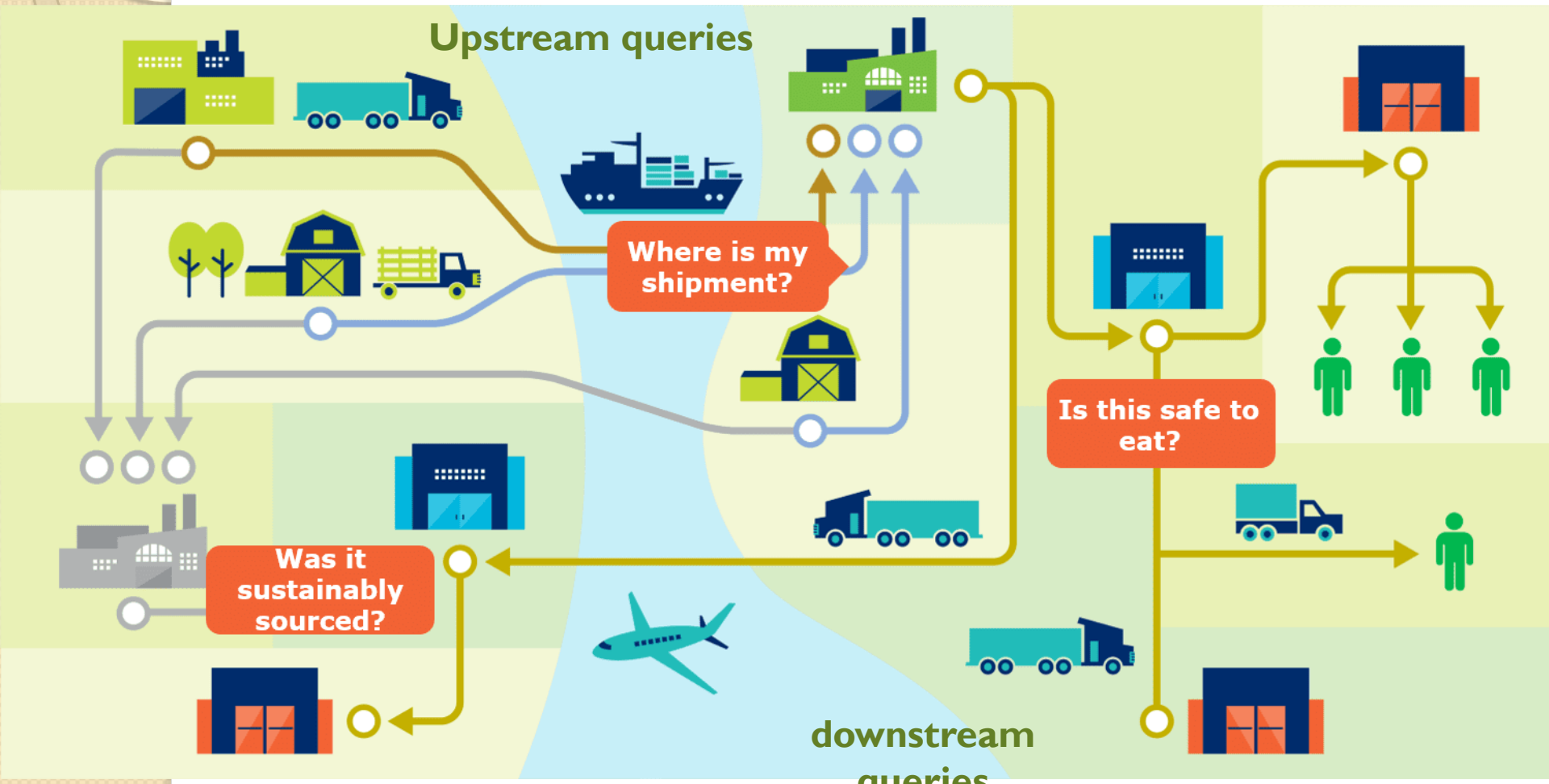
Standardized exchange of data

To capture **the business value of data sharing, transparency, and trust**

Traceability requirements may extend from all the way upstream (suppliers of raw materials, ingredients and components) to all the way downstream (customers of finished goods including end-consumers).

The GS1 and ISO **open standards** of Electronic Product Code Information Services (EPCIS) and Core Business Vocabulary (CBV) enable standardized exchange of data and item-level tracking.

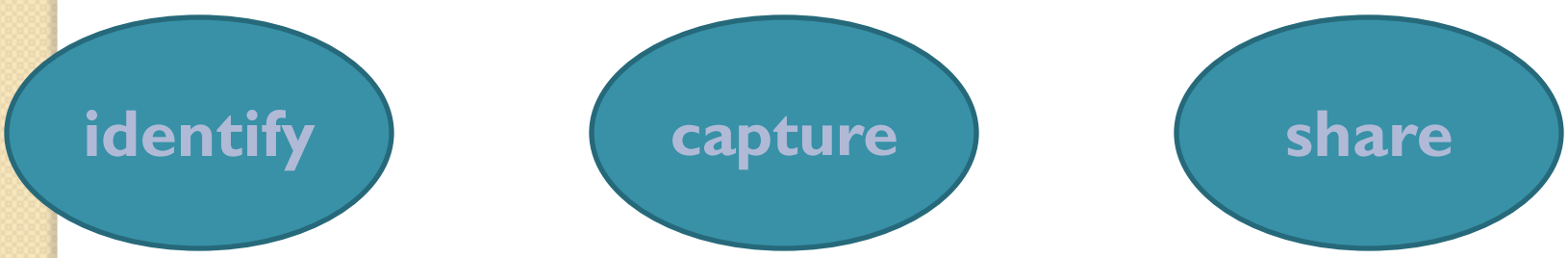
Who-What-Where-When-Why?



https://www.gs1.org/docs/traceability/elearn/index.html
(7:00)

Key Data Elements (KDE)

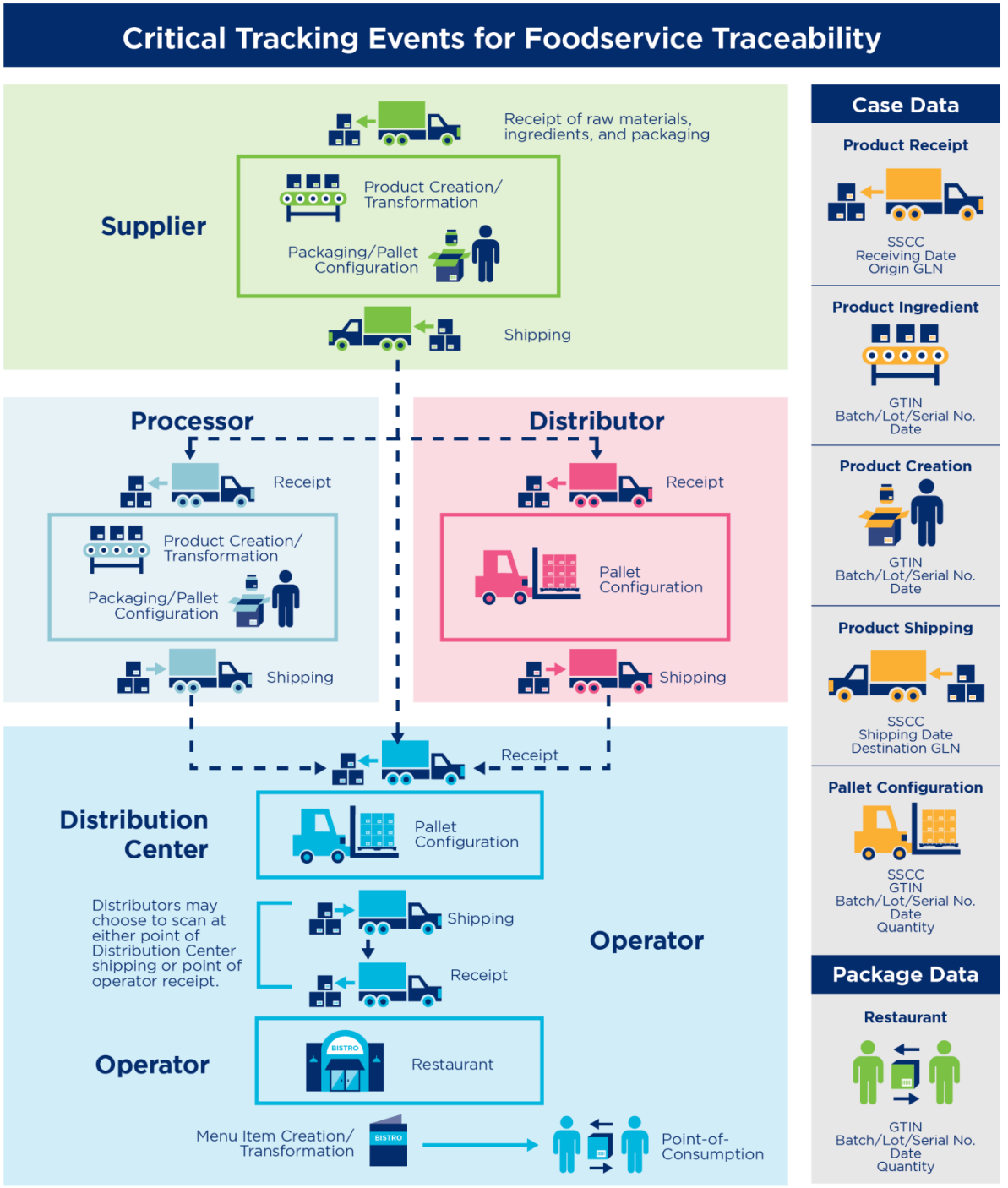
- data elements that comprise all of the information collected at each **Critical Tracking Event**.
- universally agreed upon and followed by all supply chain companies.
- grower ID, harvest date, ship date, destination ID, case or pallet ID, receipt date etc.



- Global Location Number (GLN)

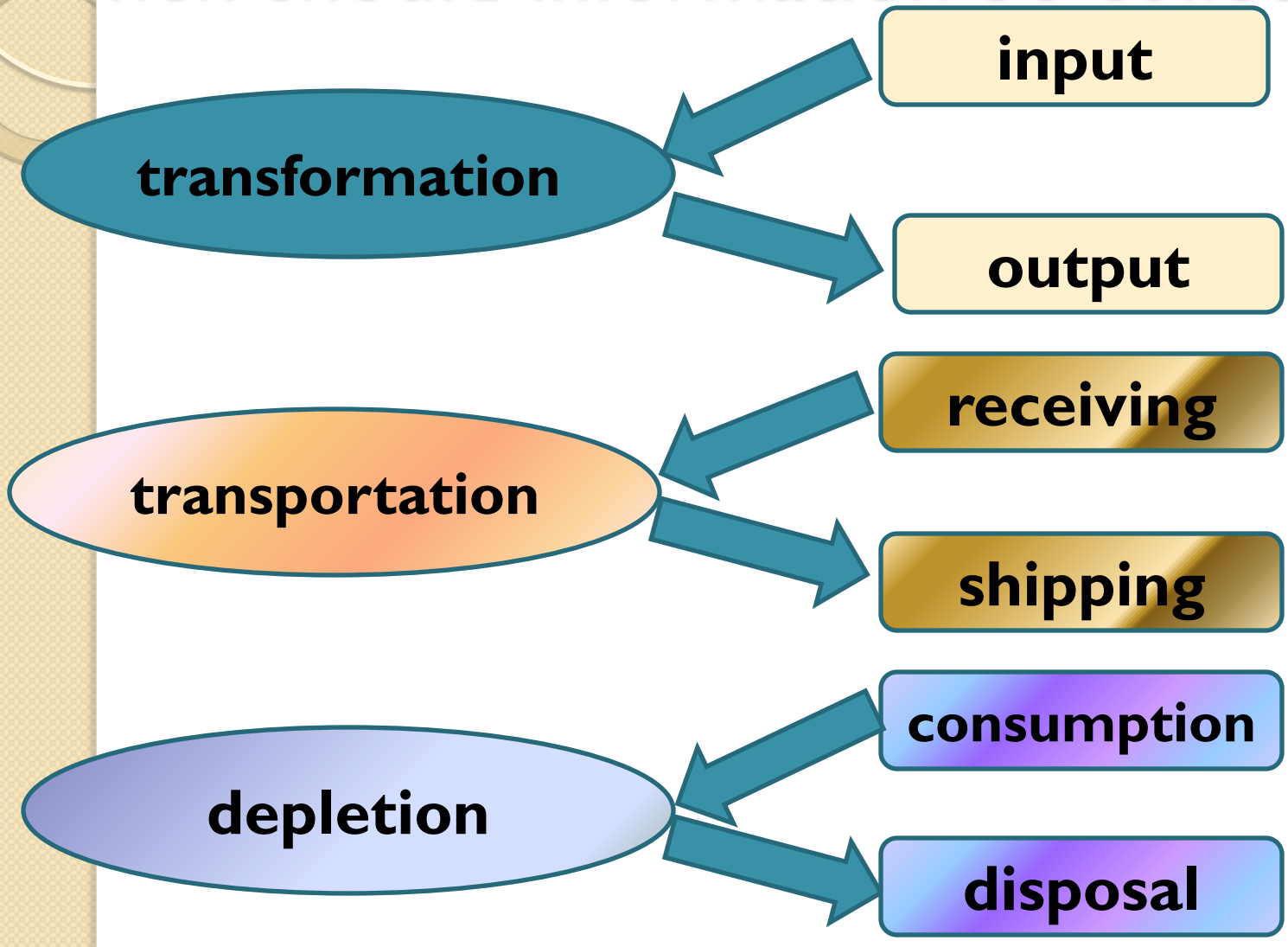
- Global Trade Item Number (GTIN)

Serial Shipping Container Code (SSCC)



Critical Tracking Events

When should information be collected?

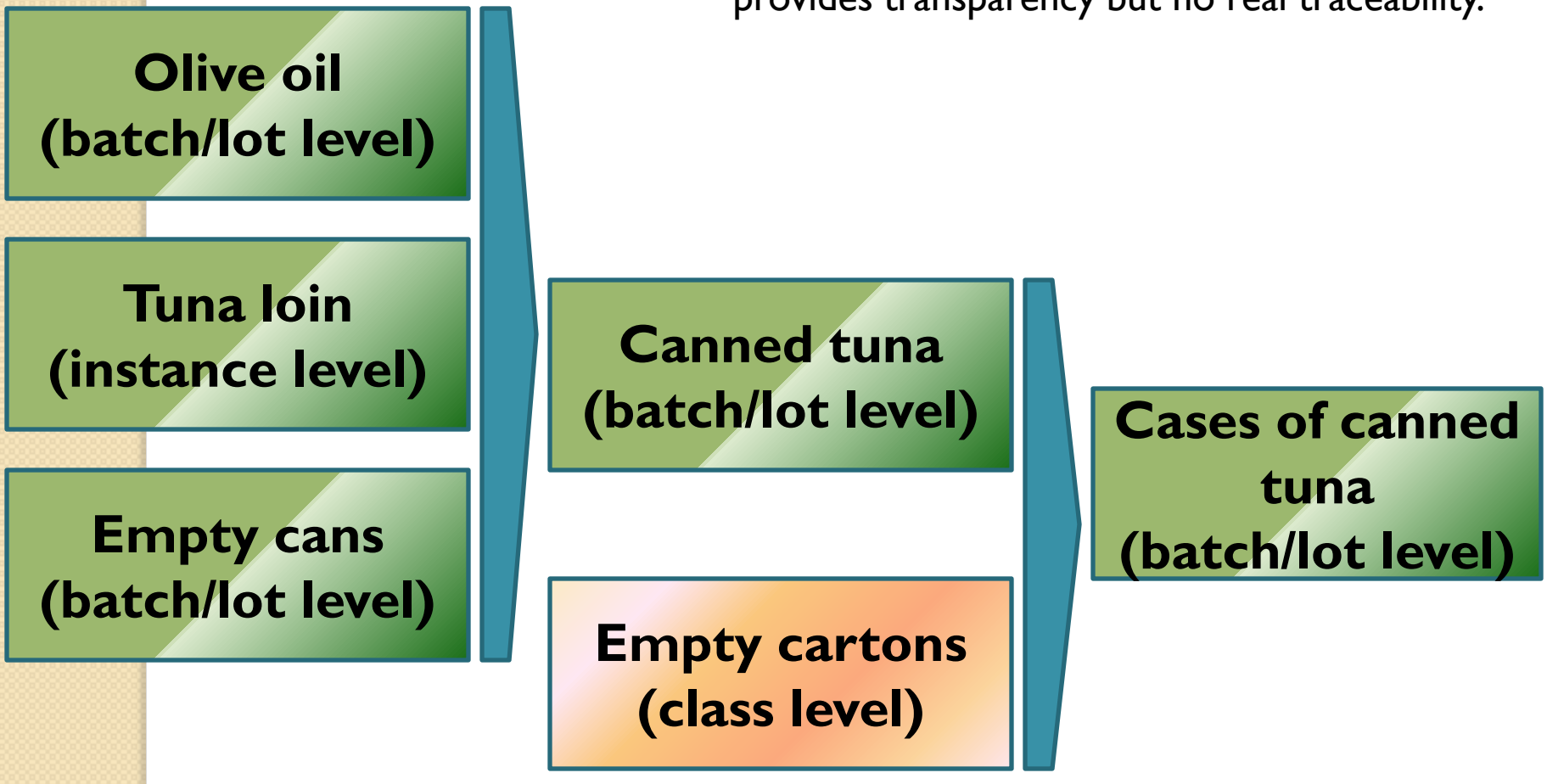


Trade item identification levels (granularity/precision)

- **Class** : all products of a given type are marked identically (e.g. 10 count cases of jars of jam)
- **Batch/lot** : the object has the same product / part ID as other objects belonging to a group of instances (e.g. 10 ct. cases of jars of jam within a given batch/lot are marked identically)
- **Instance (full serialization)** : the object is identified with a unique serial number. The combination of GTIN +Ser. No. denotes an individual instance (single product occurrence)

GS1 Standard - Example of identification levels

The empty cartons are shown in a different colour, since they are identified on class level. This provides transparency but no real traceability.

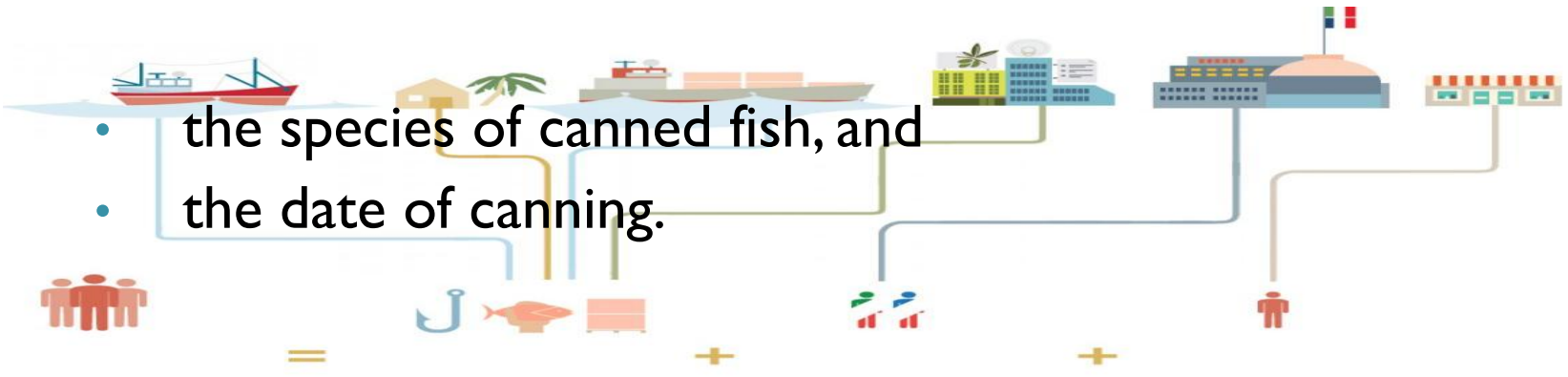


Tuna supply chain traceability

A tuna maker was **ISO 22005** certified.

Via digital mapping and real-time data, consumers can access online information for each product, such as

- the origin of the raw material,
- the type of fishing vessel,
- its country of origin,
- the geographical area,
- the date on which fishing took place,
- the fishing technique,
- the species of canned fish, and
- the date of canning.



Olive oil traceability system

Extra Virgin Olive Oil (EVOO)

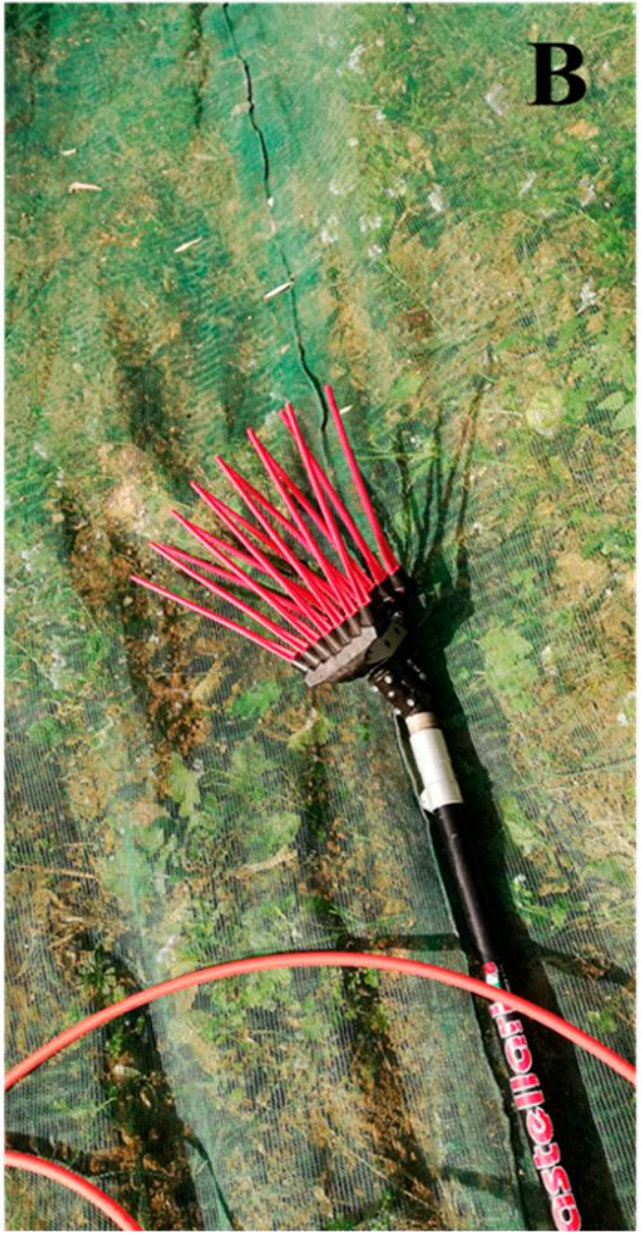
	Standing olive tree	Olive harvest	Olive pressing	Nutritional information of the oil	Final product	Final consumer
PHASES	$RFID_1$ application, georeferentiation and cultivar identification of the olive tree standing	$RFID_2$ application on the crate and add other information related to each single log	Information on the yield and the kind of olive press and processing information	Nutritional information such as fats, carbohydrates, proteins, salt and E vitamin	QR code tag printed on the external label and protected by a «scratch and win» system	QR code once scratched was scanned by the final consumer and the infotracing information were read on a web link
MULTI-ACTORS						
MULTI-TAGS						
MULTI-DEVICES						

EVOO TRACEABILITY

Radio Frequency Identification (RFID) technology

(A) The RFID1 standard used is UHF at 860 MHz, Class 1 Gen 2, waterproof coin shaped with central hole;

(B) The RFID2 is UHF at 860 MHz, waterproof flexible band with two holes at the extremities fixed with a small cord on the crate.



(A) air compressor with 5.5 kW diesel engine

(B) pneumatic combs for olive harvesting

(C) laying nets for the interception of olives on the ground

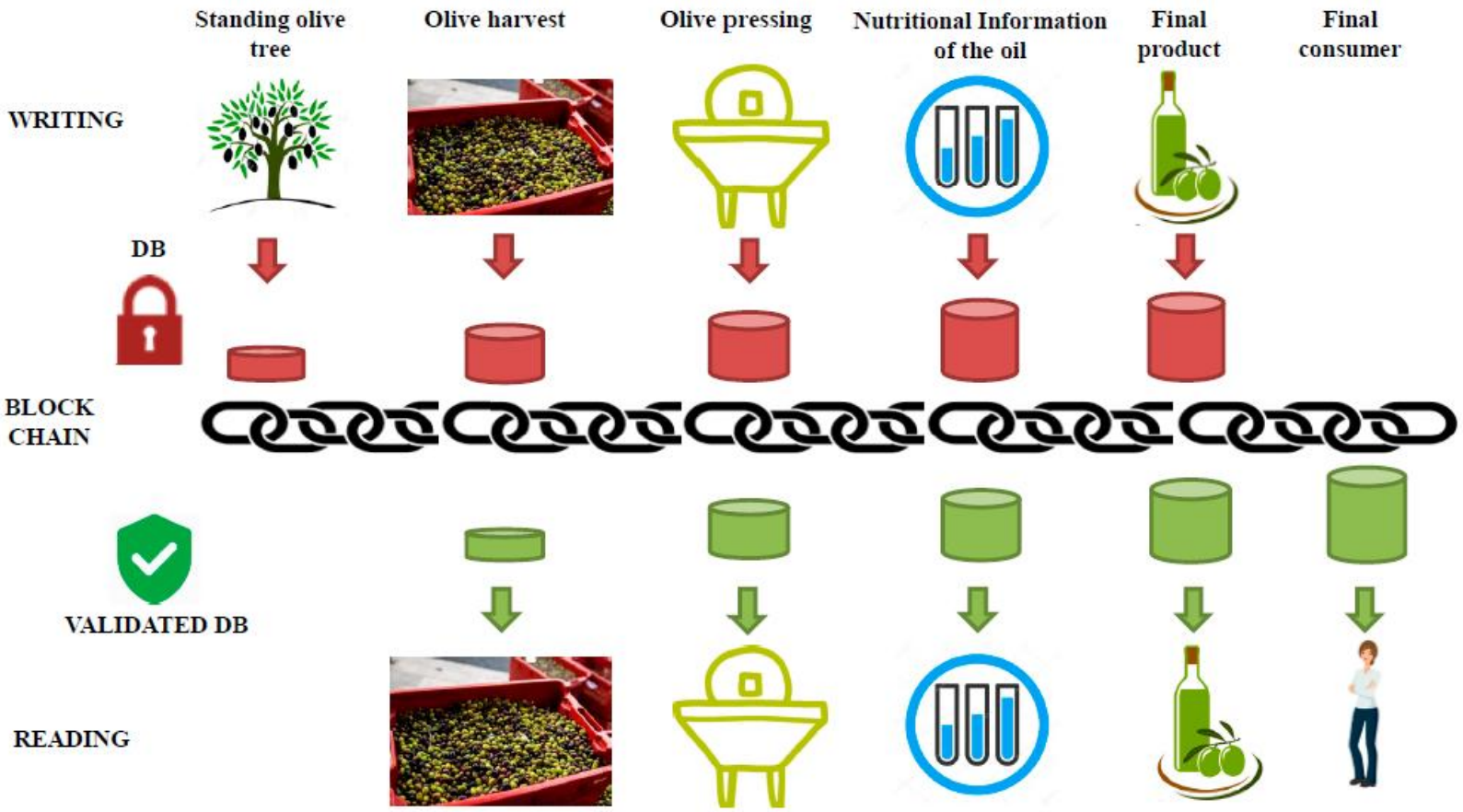
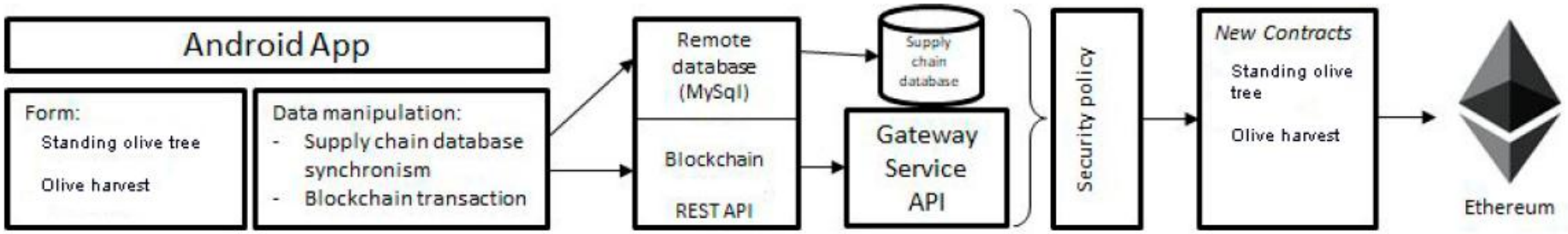


Figure 4. A schematic description EVOO traceability with implemented the blockchain data flow.



Traceability System Activities

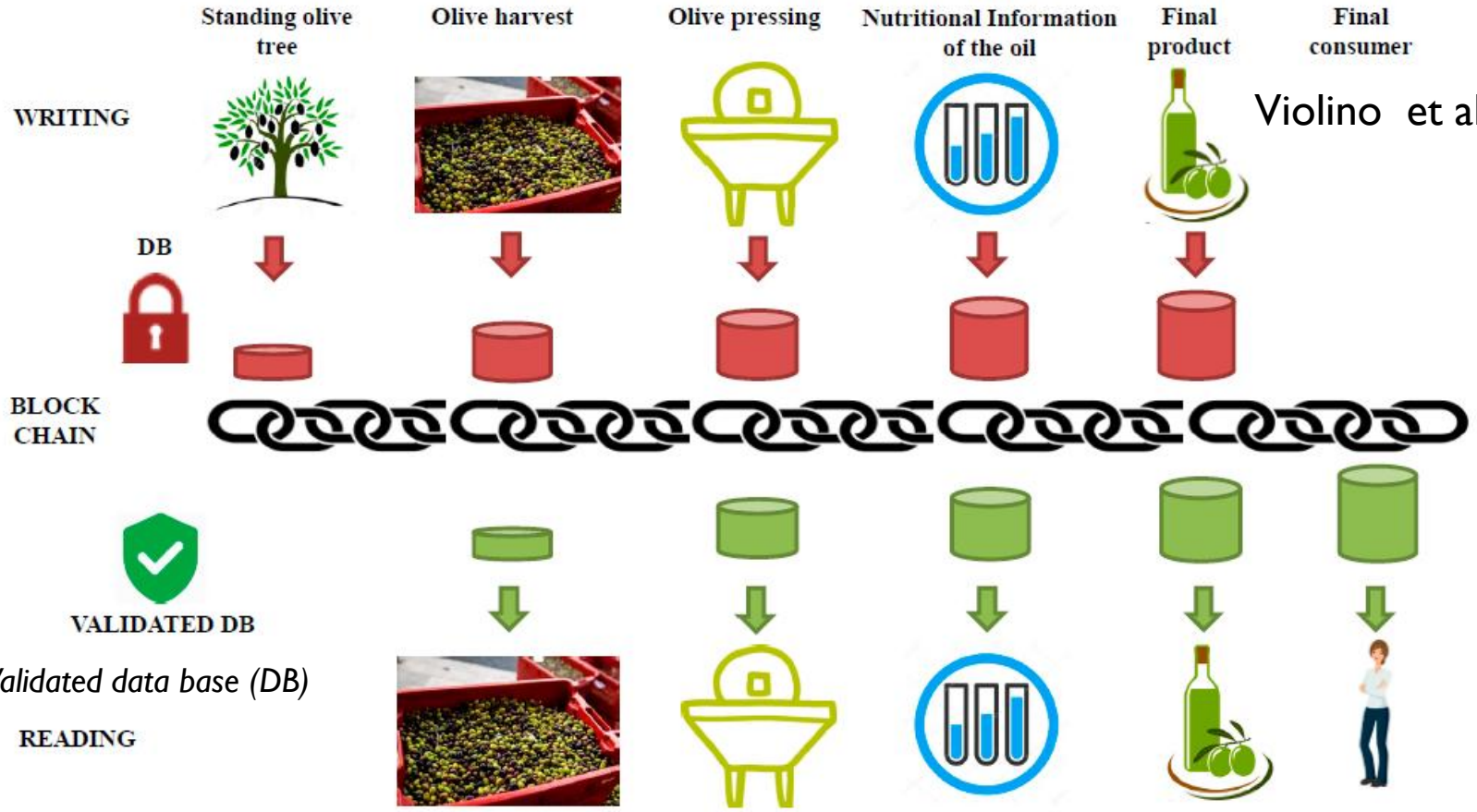
(A) Main activity of the Infoliva app (written in Italian to be used by local operators);

(B) Activity regarding the standing olive tree cultivar (Carboncella, Frantoio, Leccino), GPS (automated inserted and unmodifiable), date (data; automated inserted and unmodifiable) and notes;

(C) Activity regarding the olive harvest phase crate weight, olive maturation (high, medium, low), olive defects (high, medium, low), date (data; automated inserted and unmodifiable) and notes;

(D) Activity regarding the synchronization phase with the remote server and blockchain.

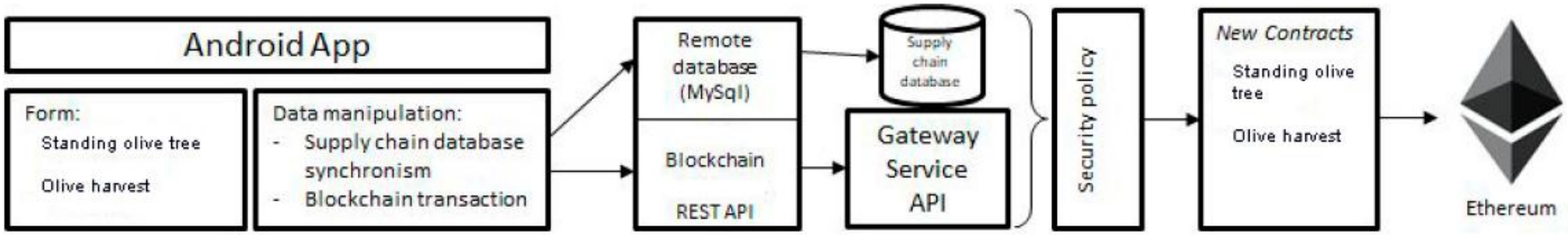
Interconnection diagram between the INFOLIVA app and the blockchain



Violino et al., 2020

Validated data base (DB)

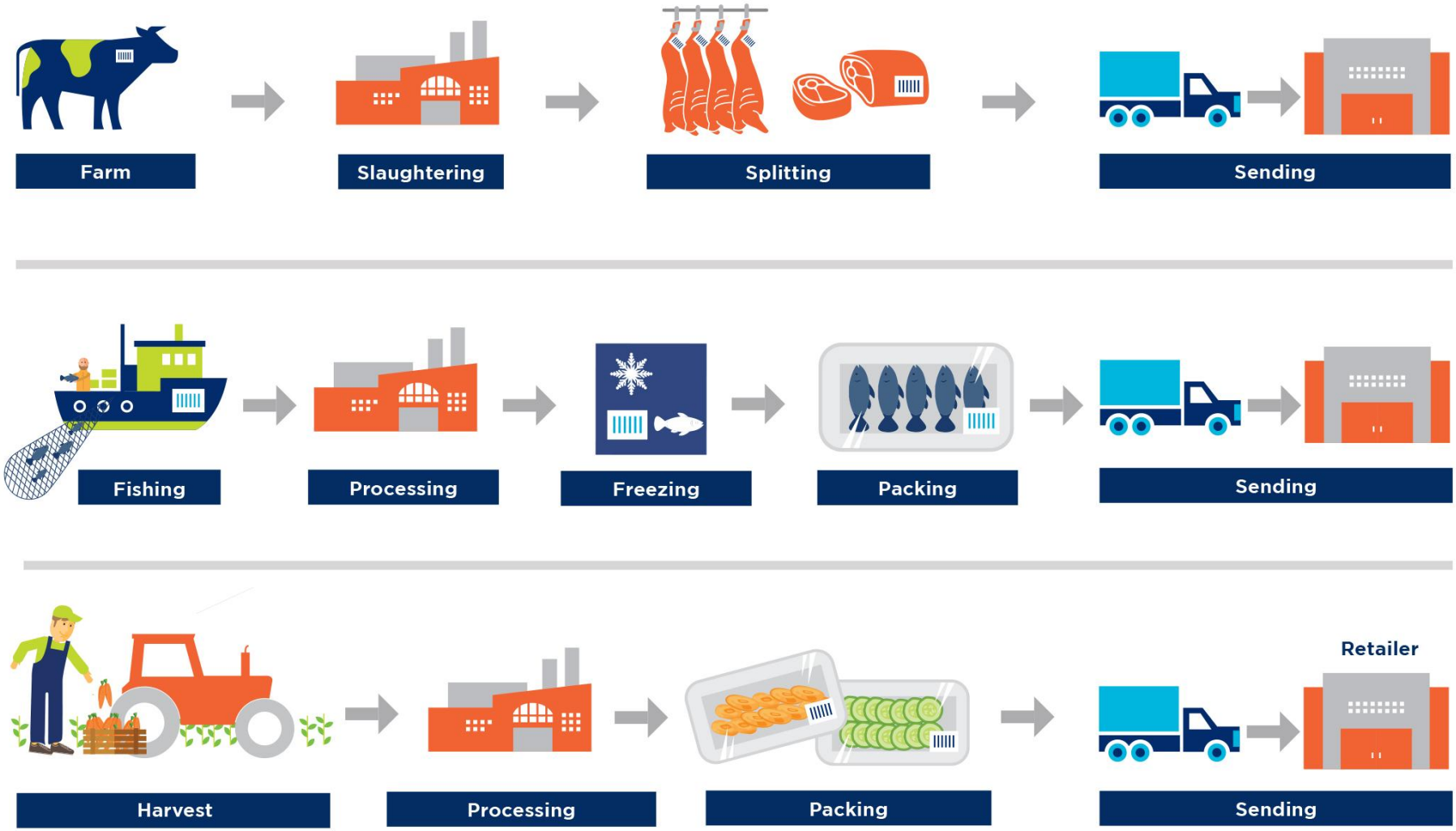
Figure 4. A schematic description EVOO traceability with implemented the blockchain data flow.



Ftrace solution

- A cross-sector traceability solution fully based on GS1 standards. fTRACE is a end-to-end traceability community solution provided by the fTRACE GmbH, a 100% subsidiary of GS1 Germany.
- fTRACE improves efficiency and trust of the entire supply chain by standardizing industries and enabling companies to share transparency information on batch level: The core of the fTRACE approach is to capture and share **event based traceability data**.
- Based on this, a variety of value adding applications, such as fresh counter traceability, end consumer information and BI dashboards are provided for retailers, brand owners and manufacturer.

EU project - Ftrace : Event-based traceability



https://web.ftrace.com/en/research

HOW TO FIND THE CORRECT FTRACE CODE

The codes on the packaging pictured here show you which products you can trace with fTRACE. On this page, we will help you to find your product's fTRACE code quickly and easily.

fTRACE - insert code | TRACE IT!

» Try service with this test code!

GTIN (01) | LOT (10) | TRACE IT!

ABOUT THE FTRACE CODE

On every product that you can trace with fTRACE, the fTRACE code is shown in two forms. One is the fTRACE barcode, which you can scan easily with the fTRACE app and any other free barcode reader.

There is also a number code, which you can type directly into the dialogue box on the website. The position of the code varies slightly from brand to brand. Here you can see where to find the code.

FTRACE ON A SMARTPHONE

Download the fTRACE app.

» Get the **fTRACE GS1** iPhone-app

» Get the **fTRACE GS1** Android-app

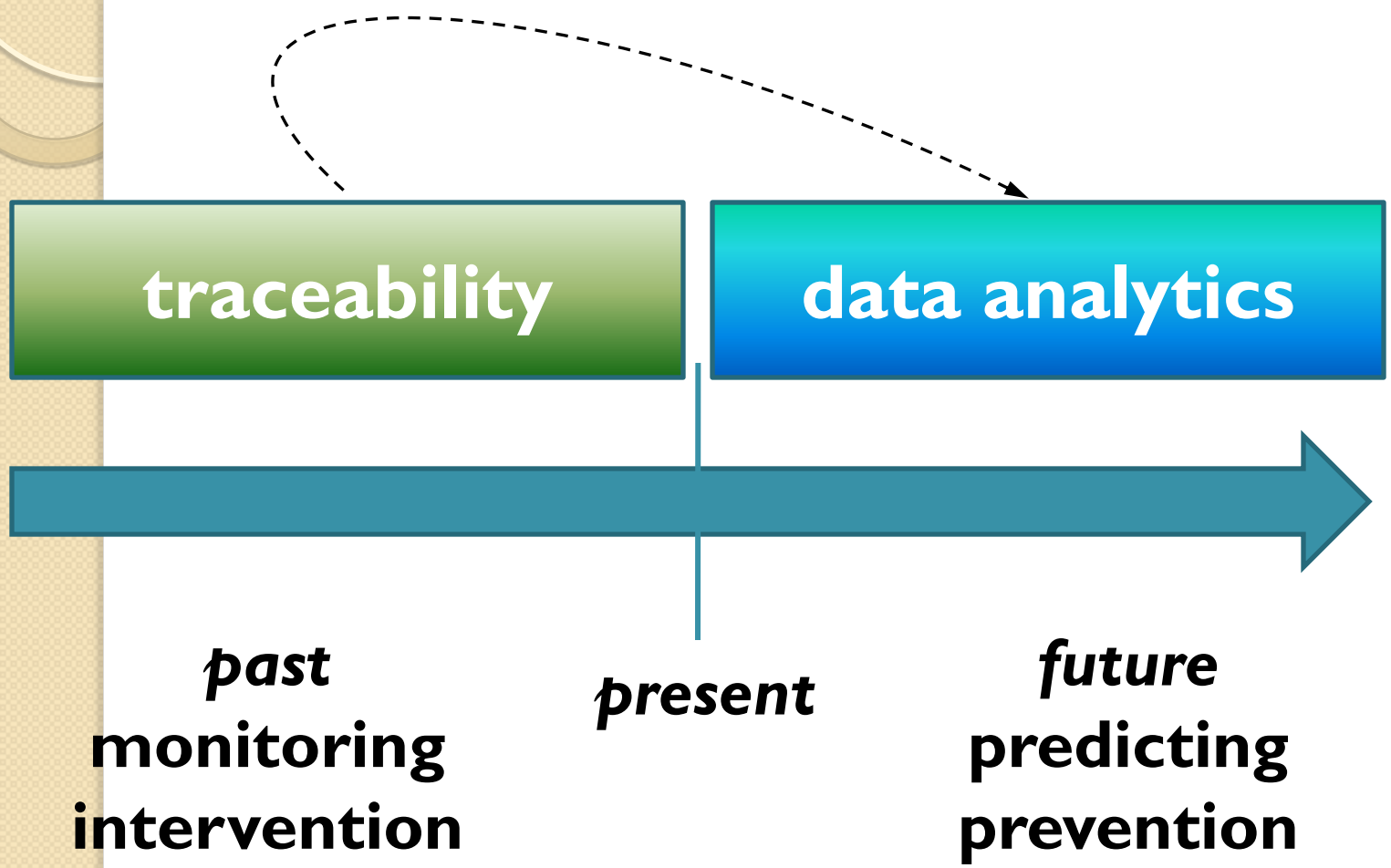
If you don't have an iPhone or Android device, you can also use any other free barcode reader. Or go to the mobile site m.ftrace.com.

» Download barcode reader

FIND THE CODE VIA THE BRAND OF THE PRODUCT

Click on the product's brand logo, compare the position on the label shown and enter the code directly.

decision making enabler



Source: GS1 Global Traceability Standard (GS1 AISBL, 2017)

Food for thought

Traceability is about:

- Safety and recall management
- Sustainability
- Fighting fraud
- Assuring transparency and trust
- Chain of custody

Lean management

- The Toyota Production System (Ohno, 1956)
- In 1990, three senior managers of MIT's International Motor Vehicle Program (IMVP), Jim Womack, Dan Jones, and Dan Roos, published a book that has had a great influence on the way industries around the world make things. That book, entitled
- *The Machine That Changed the World: The Story of Lean Production, was the result of a five-year, in-depth scholarly study of the* Toyota Production System.

The machine that changed the world (Womack, Jones & Roos, 1990)

- Teamwork
- Communication
- Efficient use of resources and elimination of waste
- Continuous improvement

1. Specify **value** from the **standpoint** of the end customer.
2. Identify the value stream and **eliminate** all steps that do not add value.
3. Make the remaining value-creating steps **flow**, so that the product flows smoothly towards the customer.
4. When the flow is established, let the customer **pull** value upstream from the next upstream activity.
5. When steps 1 through 4 are complete, the process starts **all over** again and continues until a state of perfection is reached in which perfect value is created with no waste.

Lean - TQM

Lean was conceived as a total management system, not just for the manufacturing floor.

Isolating Lean from the rest of the management system will not allow it to fully develop and mature.

Lean needs to be a part of a total quality management system.

(Goetsch & Davis, 2016)

7 types of waste - muda

- **T**ransport
- **I**nventory
- **M**otion
- **W**aiting
- **O**ver-processing
- **O**verproduction
- **D**efects

TIM WOOD

Lean in three words

Muri = overburdened

Mura = unevenness, fluctuation, variation

Muda = waste

No Muri, Mura, or Muda

- Muda waste
- Mura lack of balance
- Muri overload

5S

- **S**eiri — **Sort** : sort needed and unneeded items
- **S**eiton — **Set-in-order**: set in order, arrange things in their proper place
- **S**eiso — **Shine**: clean up the workplace
- **S**eiketsu — **Standardize**: standardize the first three S's method
- **S**hitsuke — **Sustain**: make 5S a part of your duty

Single Minute Exchange of Dies (SMED)

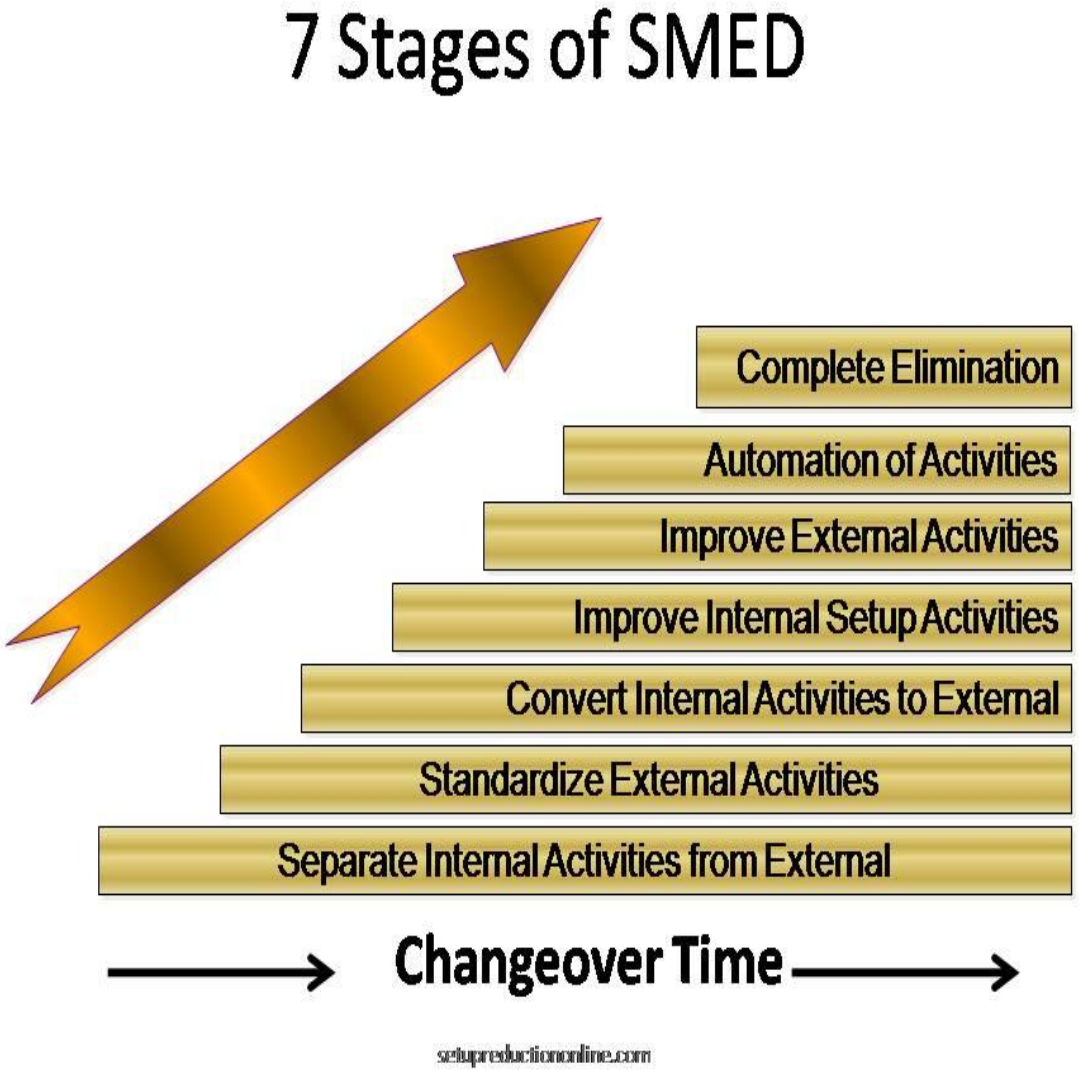
- Also known as a Quick Changeover.
- Used to reduce the amount of time it takes to change from running one process in an operation to running another.
- In addition to improving cycle time in a process, SMED can help reduce costs and increase flexibility within a process.
- The "single minute" title refers to the goal of reducing the changeover time to single-digit minutes, from a maximum of nine minutes down to one (if possible).

Single Minute Exchange of Die (SMED)

- Developed by Shigeo Shingo to reduce the set-up time (change of dies) of pressing machines.
- Set-up times per each exchange of dies shortened from 1 to 2 hours (or even half a day) to only a few minutes each, allowing an organization to run smaller batches and align more closely to customer demand.

Example: the setup reduction progress over the years in car racing pit stops

The essence of the SMED system is to convert as many changeover steps as possible to "external" (performed while the equipment is running) and to simplify and streamline the remaining steps.



Tools of Lean Production

- The 5S's: seiri (sort), seiton (set in order), seiso (shine), seiketsu (standardize), and shitsuke (sustain)
- Visual controls
- Efficient layout and standardized work
- Pull production
- Single minute exchange of dies (SMED)
- Total productive maintenance
- Source inspection
- Continuous improvement

Lean in practice

The lean system is a set of practices that include standardizing procedures, team based problem-solving and quality control, continuous improvement to eliminate waste, and production planning to minimize peaks and troughs in the use of labor and equipment.

Two studies of Nike suppliers found that lean management improved compliance with labor standards relating to wages and hours. (Compliance with health and safety standards was unaffected.)
In addition, lean management requires training *workers* to identify quality problems and *managers* to schedule workloads more efficiently to avoid excessive overtime.

The studies found that after a factory adopted the lean system, managers became more reluctant to mistreat workers and exhibited greater concern that people might defect to a competitor.
Results suggest that applying lean management can increase workers' skills and boost management's efforts to motivate and retain workers through better employment terms.

Lean: Toyota Production System (TPS: Thinking People System)

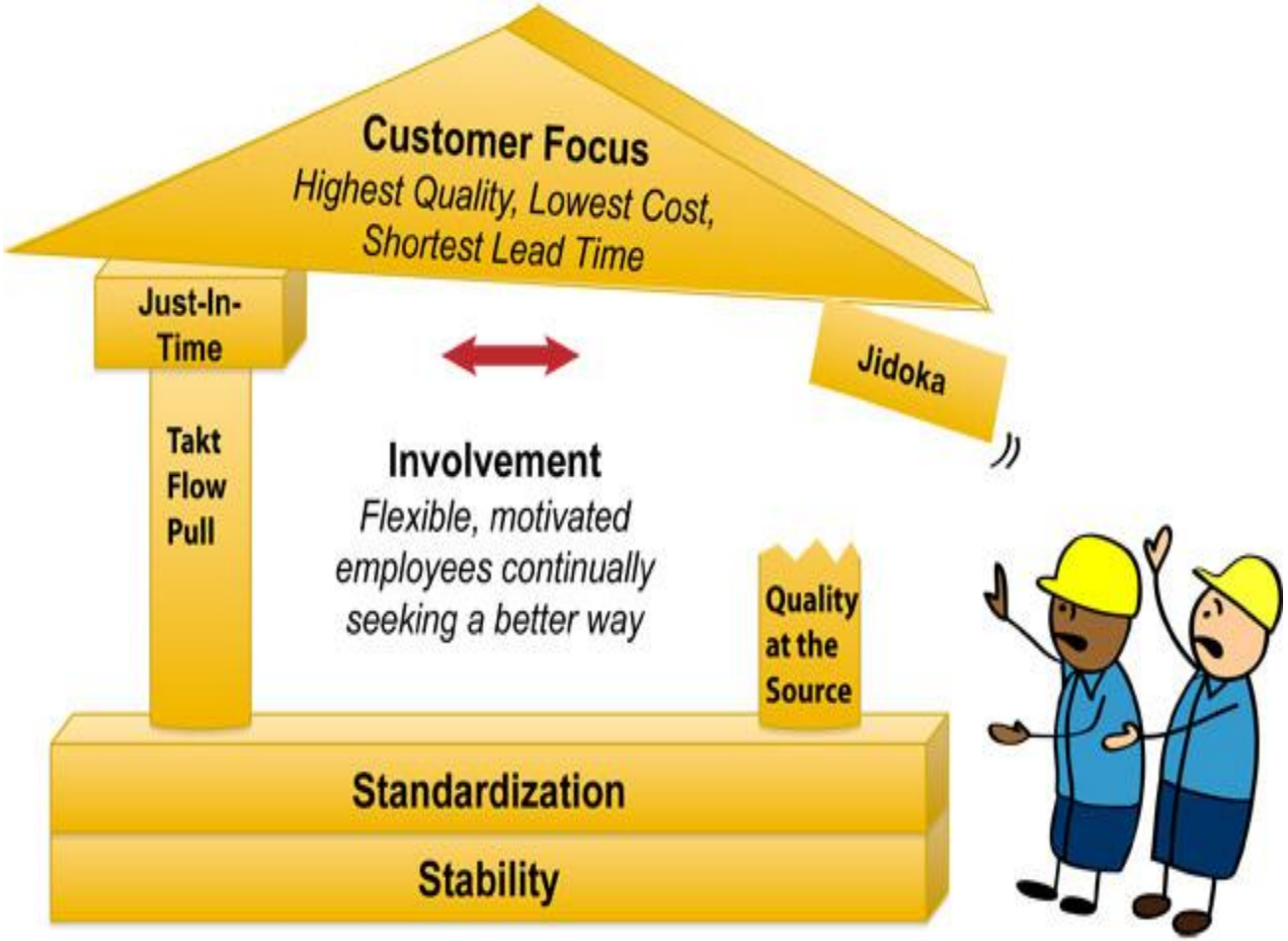
Increase in teamwork is produced by better matching takt time, getting closer to continuous one-piece-flow and pulling more flexibly and rigorously in smaller batches.

https://www.lean.org/the-lean-post/articles/tps-the-thinking-people-system

Spear, S., Bowen, H.K. (1999) Decoding the DNA of the Toyota Production System, Harvard Business Review. Sep/Oct, Vol. 77 No 5, pp. 96-106

The two pillars of lean

- Just-in-time
- Jidoka



https://insights.btoes.com/lean-resources/what-is-jidoka-toyota-

Jidoka

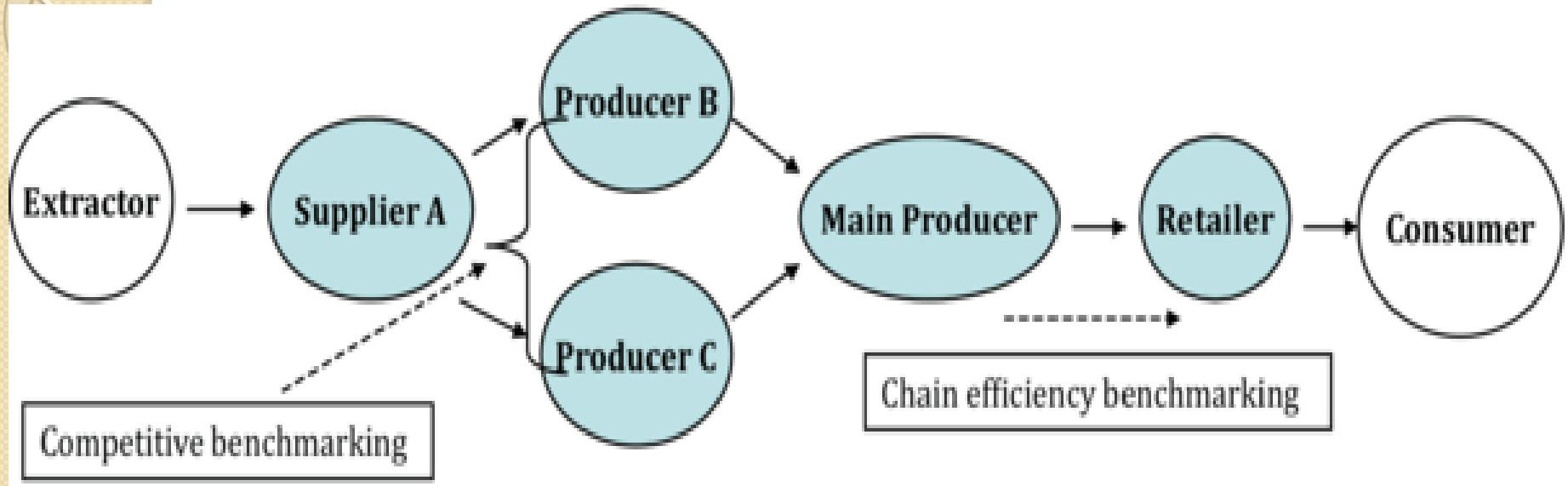
Jidoka means halting an entire process when a defect is discovered so that it won't cause additional problems further down the line.

Jidoka can be accomplished manually, or the line can be programmed to stop automatically, or both.

ISO standards Lean - Six Sigma

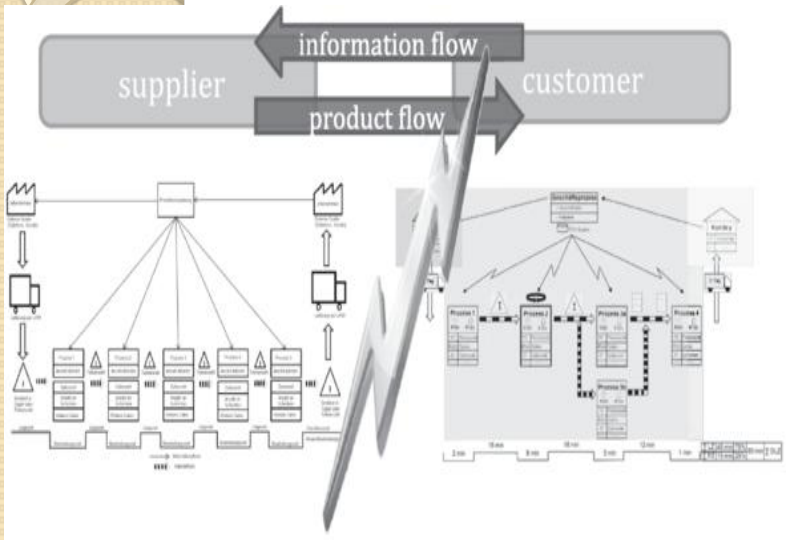
- **ISO 18404:2015** Quantitative methods in process improvement — Six Sigma — Competencies for key personnel and their organizations in relation to Six Sigma and Lean implementation

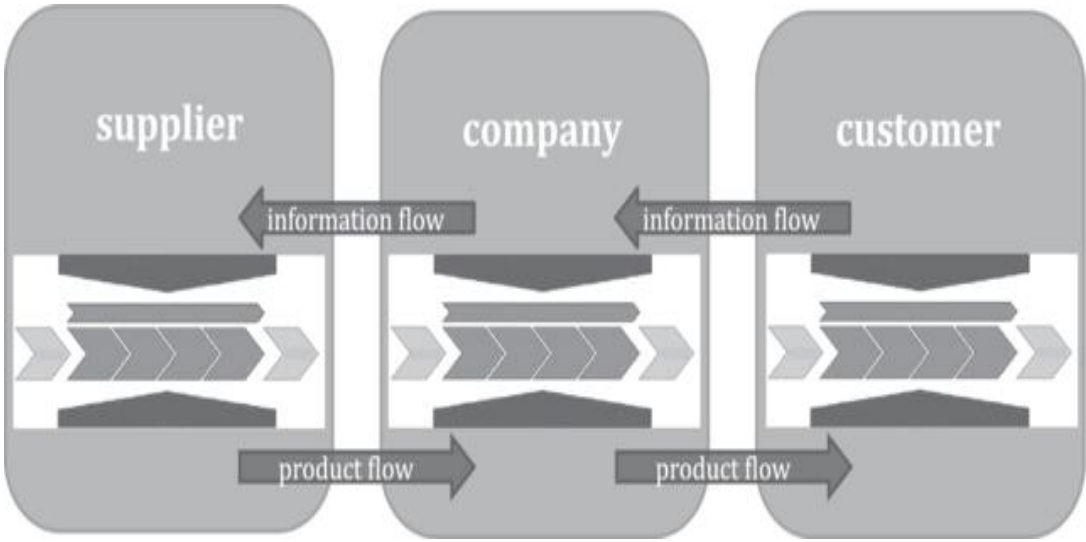
ISO 17258:2015 - Supply chain

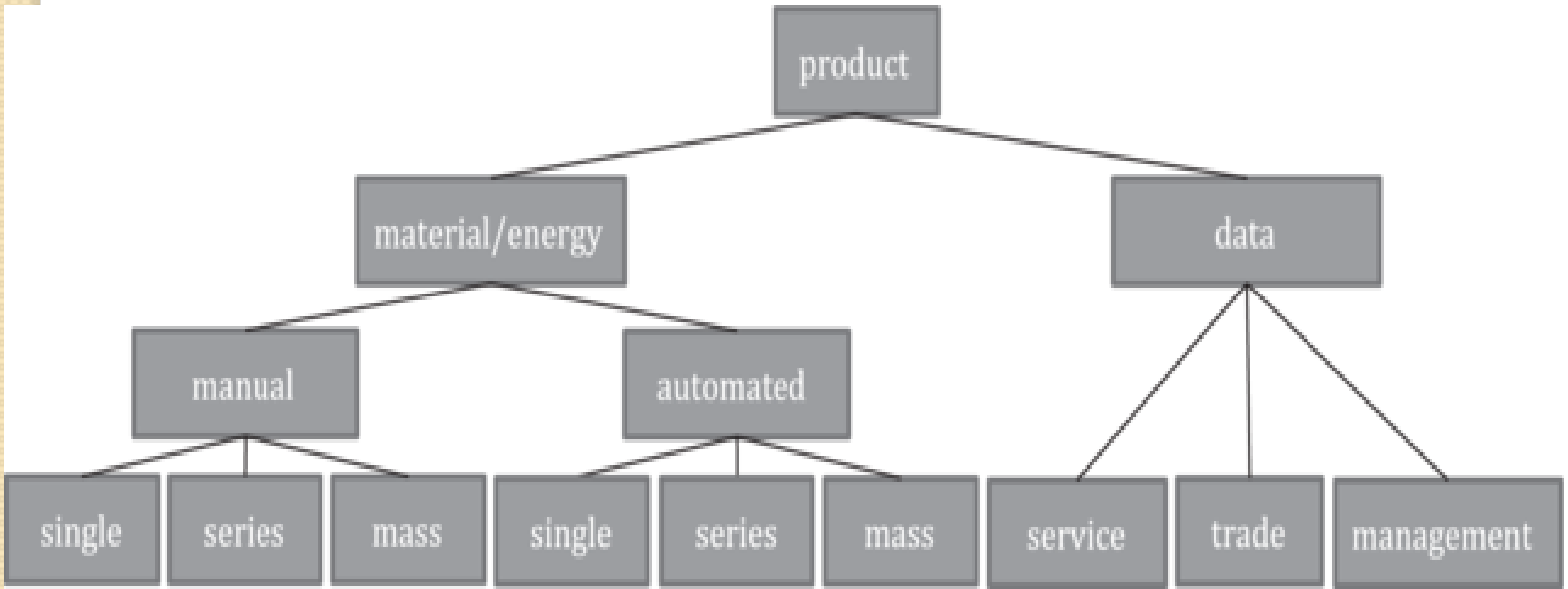


The level of quality and performance delivered to the consumer is the "total" of all quality and performance levels of the different transformers along the supply chain.

ISO 22468:2020 – Value Stream Management







Lean thinking

In services

- Satisfy the needs of the customer by performing only those activities that add value in the eyes of the customer.
- Define the "value stream" by flowcharting the process to identify both value-added and non-value-added activities.
- Eliminate waste. Waste in the value stream is any activity for which the customer is not willing to pay.

In the supply chain

Value-stream mapping leads to a reduction or elimination of waste, e.g. unnecessary discussions or the multiple and thus redundant preparation of value stream data targeted to each contact person or auditor are omitted (ISO 22468:2020 - Value stream management).

Bordoloi, Fitzsimmons & Fitzsimmons (2018)

Lean 4.0

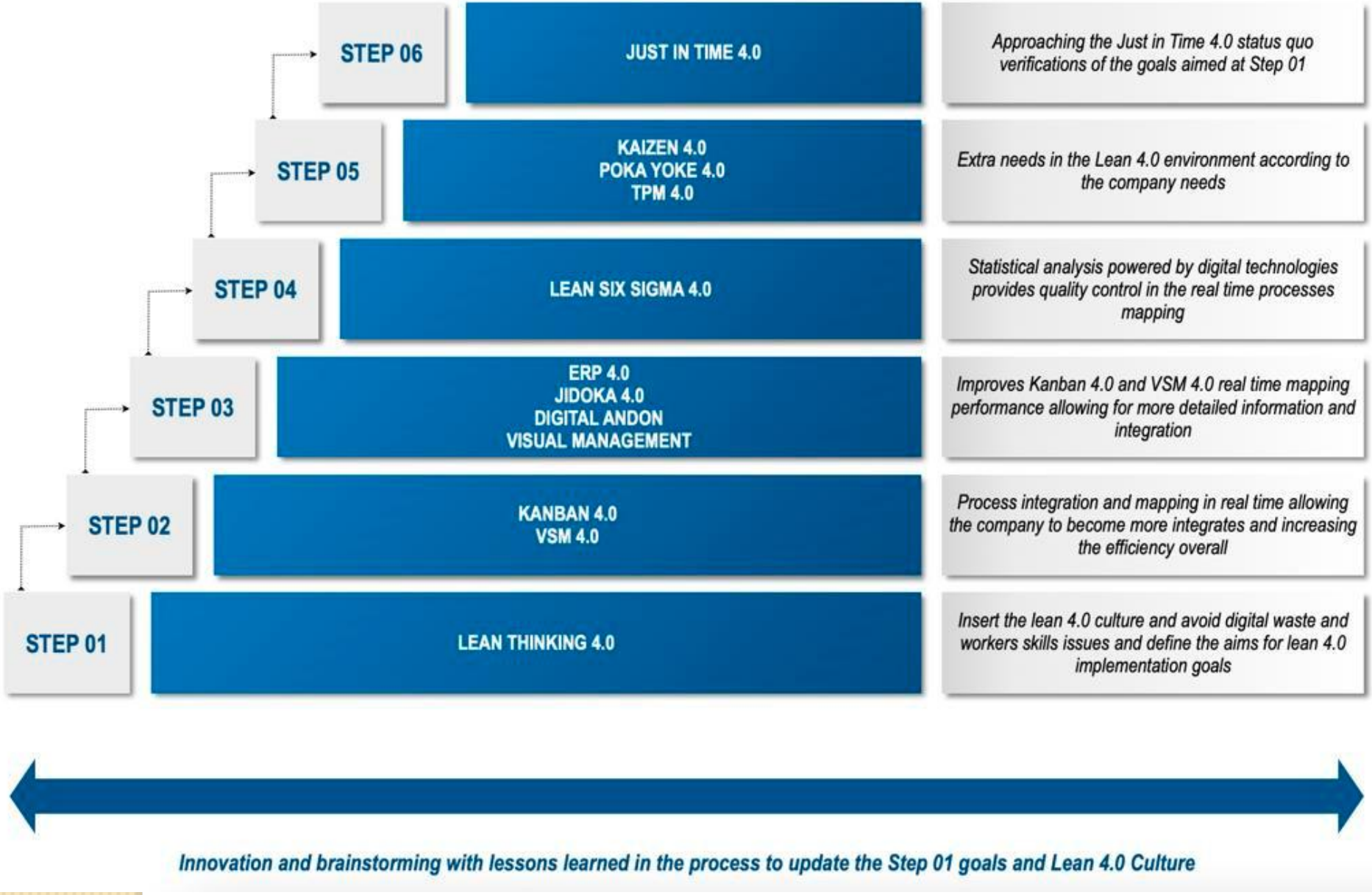
A perspective of Lean that can implement the new digital technologies in its main tools to improve waste detection and reduction in both digital and real processes.

Lean thinking to tackle the waste of employee training, focusing on solving problems, and facilitating the flow or information.

Lean thinking 4.0

Value Stream mapping 4.0

Lean Tools in the Context of Industry 4.0



Rossi et al., 2022

The Meaning of Digital Waste

- any non-value adding activity

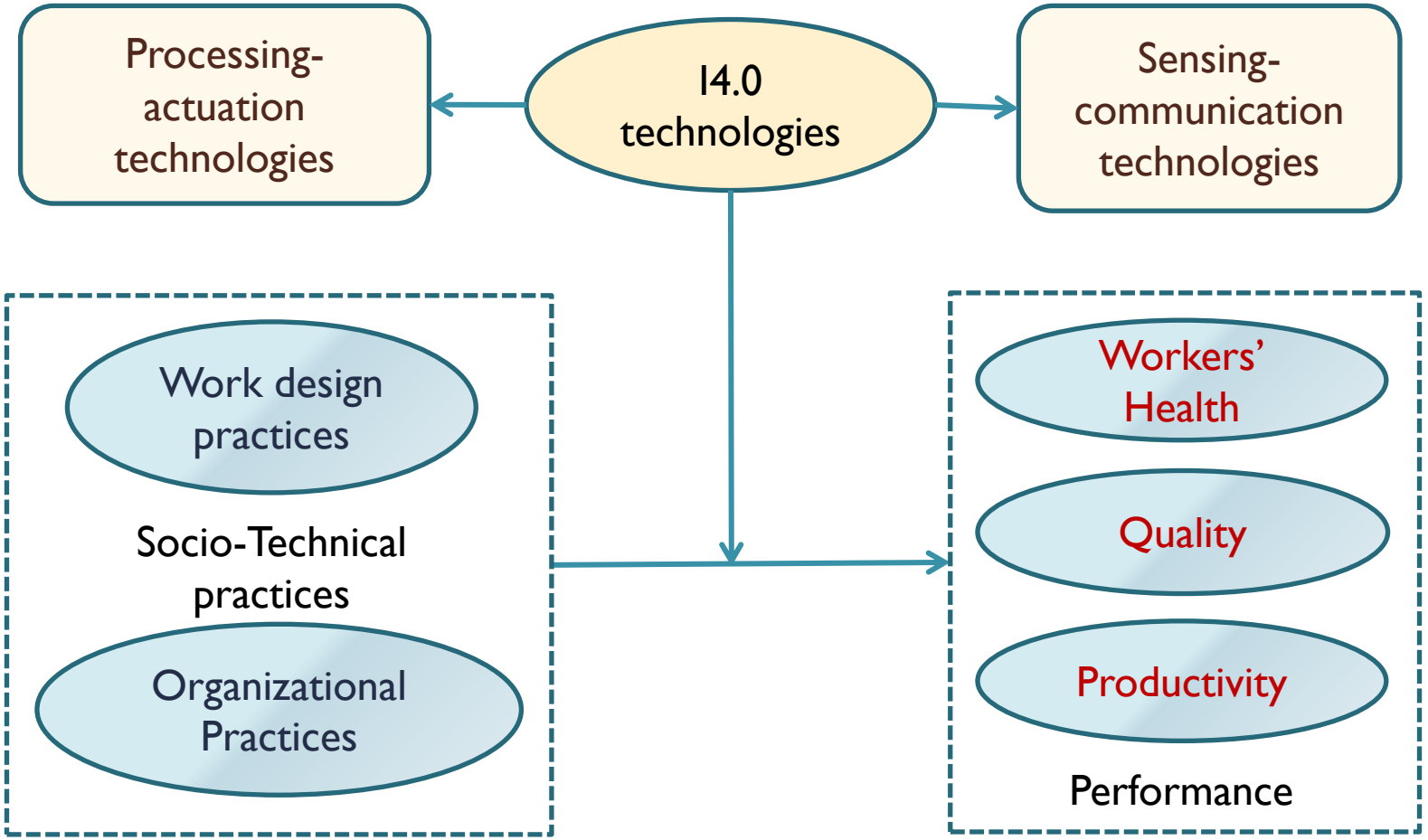
Two types of digital waste:

- (i) passive digital waste due to missing digital opportunities to unlock the power of (existing) data, and
- (ii) active digital waste as a result of a data rich manufacturing environment that lacks from the proper information management approaches to derive the right amount of information to be provided at the right time to the right person, machine or information system for decision-making (knowledge).

Lean 4.0 to combat Digital Waste

- synchronized production environment between virtual models and simulations representing the virtual factory that will help to design, engineer, verify and validate waste-free production operations in the cyber world before their release in the real factory, i.e. **Digital Twins**
- data visibility (e.g. new generation Andon systems and digital dashboards)
- information transparency (e.g. real-time production monitoring and communication systems), and
- critical events forecasting (e.g. predictability charts for continuous improvement) of production operations conducted by humans, machines and computer systems on the shopfloor
- **Digital Quality Management**

I4.0 moderates the relationship between ST practices and performance, to an extent and direction that varied according to the focus of the technologies and practices adopted



Tortorella, G., Fogliatto, F.S., Kumar, M., Gonzalez, V. and Pepper, M. (2022), "Effect of Industry 4.0 on the relationship between socio-technical practices and workers' performance", Journal of Manufacturing Technology Management, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/JMTM-04-2022-0173

Sociotechnical practices	
Communication and information system	Clarity in defining the role of workers
Problem-solving indicators exposure	Risk alerts utilization
Overload for the achievement of goals	Search for good organizational climate
Management of staff turnover	Search for the health and safety of workers
Ergonomics criteria for workstation design	Balancing among quality, scope, time, and cost
Workstations appropriated to workers	Anticipating and reducing the risk of incidents
Workers' recognition and reward	Appreciation for workers training
Teamwork and coaching	Ergonomics recommendations as regulations
Clarity in targets definition	Regulation of technical, organizational, and human aspects

(Tortorella et al., 2019; 2022)

Lean Sustainability

- Two sides of the same coin
- Maximize resource use and economic efficiency
- Focus on issues outside the immediate firm
- Driving out waste is the common ground

sustainable mobility

https://www.bmwusa.com/vehicles/bmwi.html

UN SDG 9

https://www.un.org/sustainabledevelopment/infrastructure-industrialization/

http://www.unsdsn.gr/

Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation

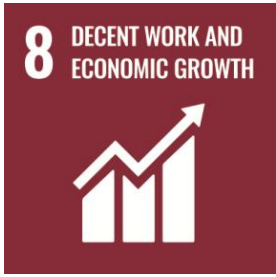
Sustainable Development Goals - SDGs

Is digital only good?

- No Poverty
- Zero Hunger
- Does digital cause unemployment ?
- Does digital enhance economic growth ?

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation



Digital readiness

- **access** to broadband internet service
- **inclusivity** (the affordability of broadband, the degree to which it is equitably accessed, and the degree to which it's used)
- **institutions** (political prioritization of broadband strategies, technology for public services, and local broadband solutions such as municipal networks)
- **digital proficiency** (users' ability to navigate the digital world)

lean-green: A decomposed framework for sustainability improvement

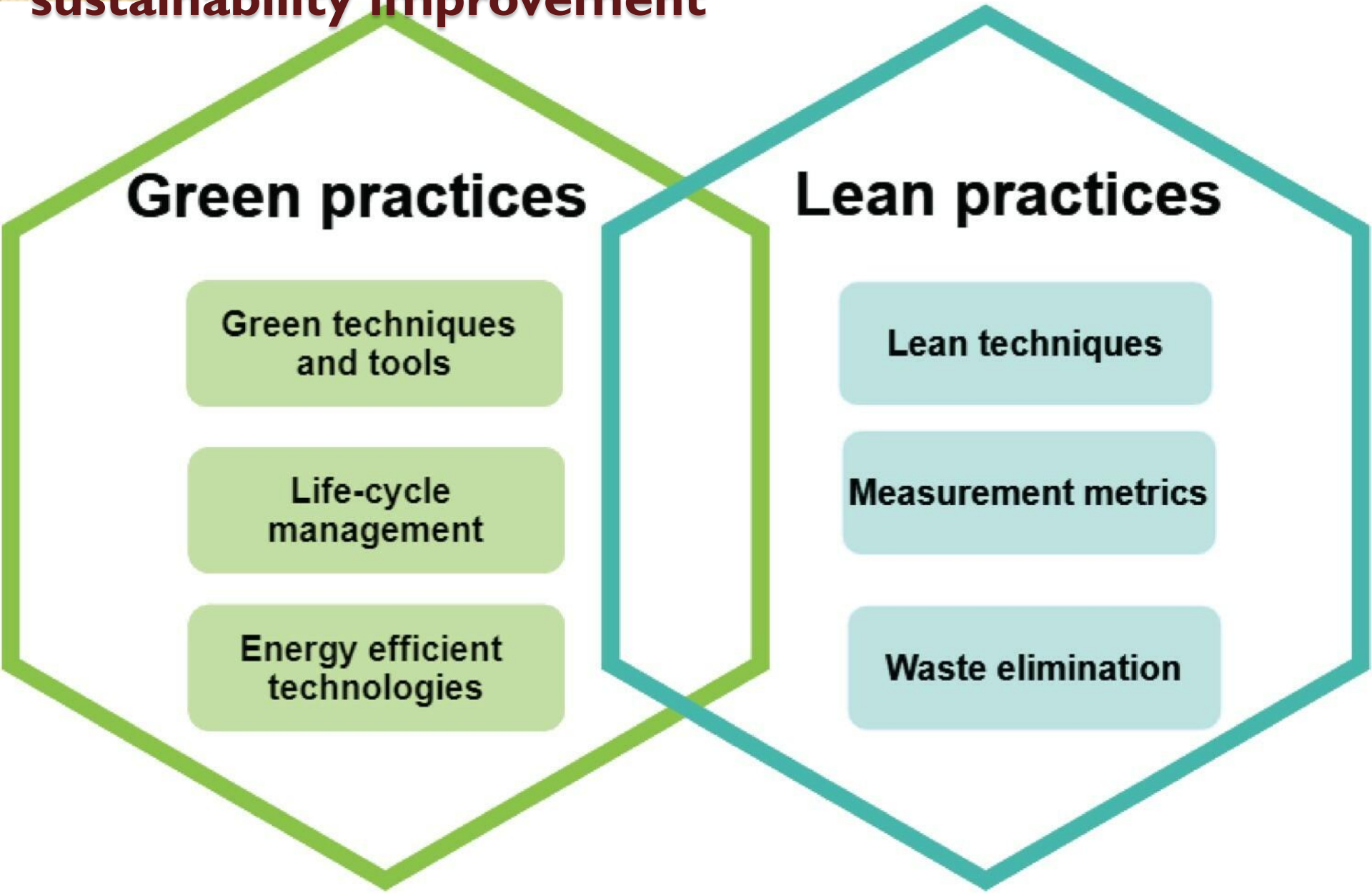
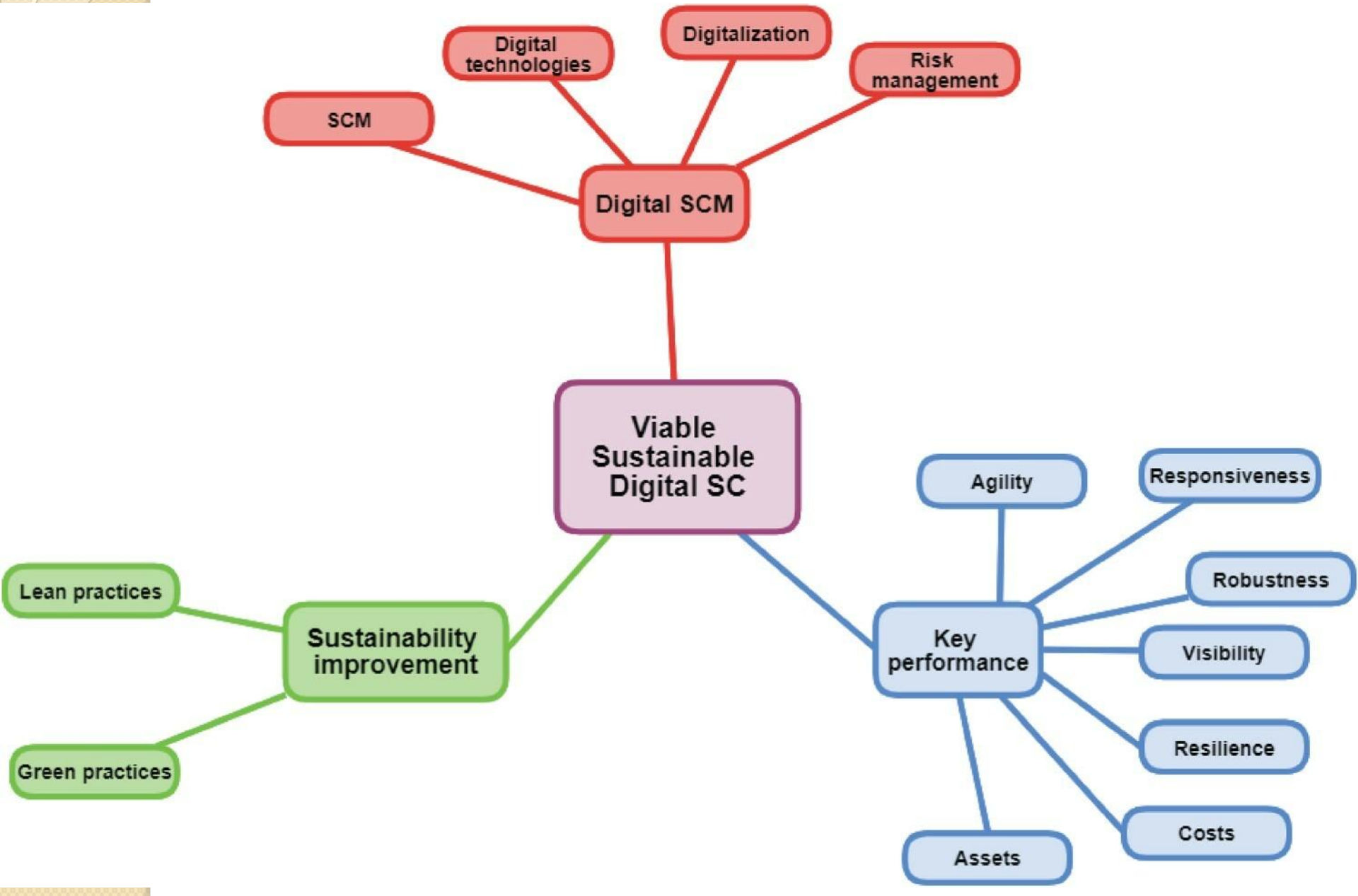


Figure 8. in *Zekhnini et al., 2022*

Integrating L&G practices for the VSDSC



Zekhnini et al., 2022

Tools and strategies for DSC viability

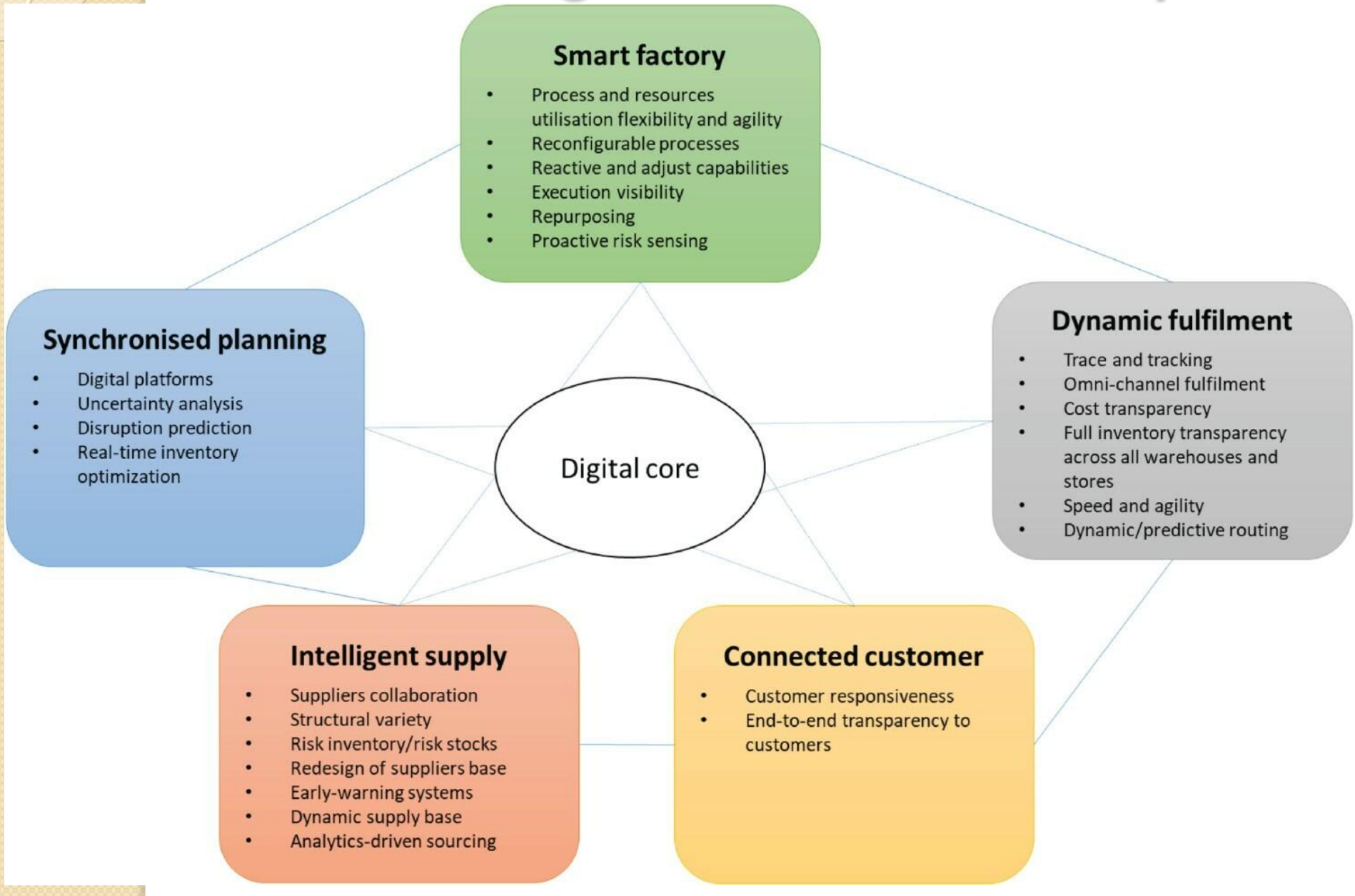


Figure 9. in *Zekhnini et al., 2022*

Lessons Learned

- Digital Transformation is not about Technology
- Figure out your business strategy before you invest in anything
- Leverage insiders
- Design customer experience from the outside in
- Recognize employees' fear of being replaced
- Bring Silicon Valley start-up **culture** inside

Behnam Tabrizi, Ed Lam, Kirk Girard, and Vernon Irvin (Harvard Business Review, 2019)

- Thank you for your attention!
- Do you have any questions?