# SERVITIZATION REVOLUTION

L'impatto positivo della servitizzazione

**14.11.2022 - Galleria Campari - Sesto San Giovanni, Milano.**

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# Circolarità, demanifattura e sostenibilità nell’erogazione di prodotti e servizi

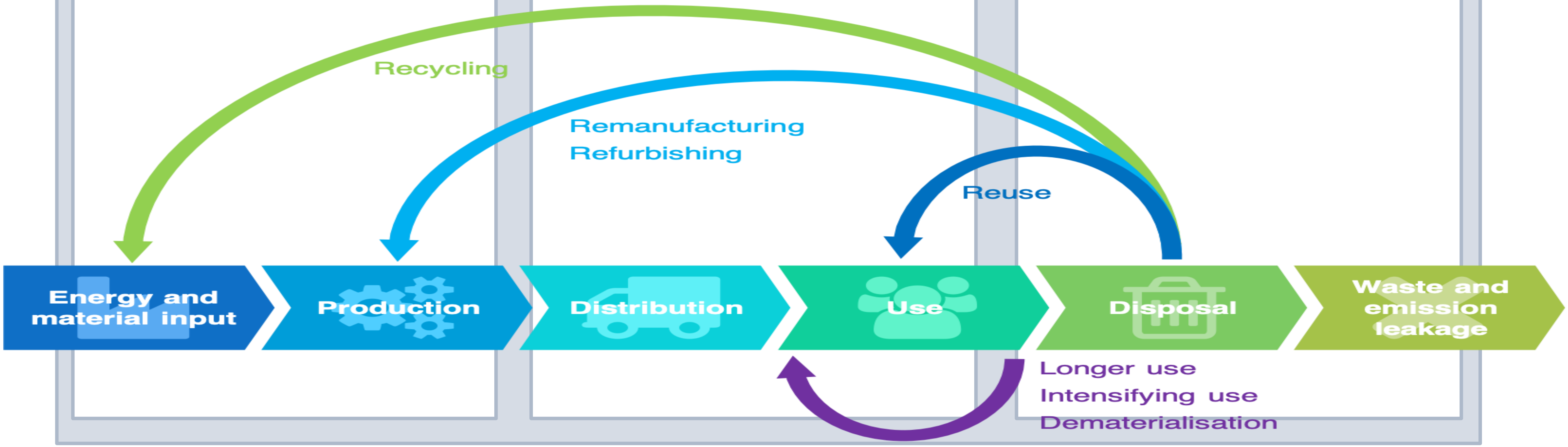
*Ripensare i livelli decisionali strategici, tattici e operativi per affrontare le nuove sfide di eterogeneità e di sincronizzazione degli attori delle Supply-Chain globali*

# Contents

**'Industrial' circular economy**

is a process of maximizing and recapturing the value added to the material when a product was first manufactured, operated up to end-of-life

| Circularity | Servitization | Remanufacturing |
| --- | --- | --- |



# Differences between Remanufacturing and Repairing

| Remanufacture | Repair |
|---|---|
| **Applicability** | |
| Used product | Defective Product |
| **Process** | |
| Complete disassembly | Failure Detection |
| Cleaning of all parts | Disassembly of some parts |
| Remediation/ replenishment/upgrading | Restoration and replacement of defective part |
| Product assembly | Reassembly of parts |
| **Characteristics** | |
| Industrialized process | Mechanics work |
| Overall restoration to like new condition | Individual repair of defect |
| Customer receive anonymous product | Customer keep his/her own product |
| Upgrading / upcycling to state of technology | Product retains earlier standards |

# Industrial ‘circularity’ opportunities

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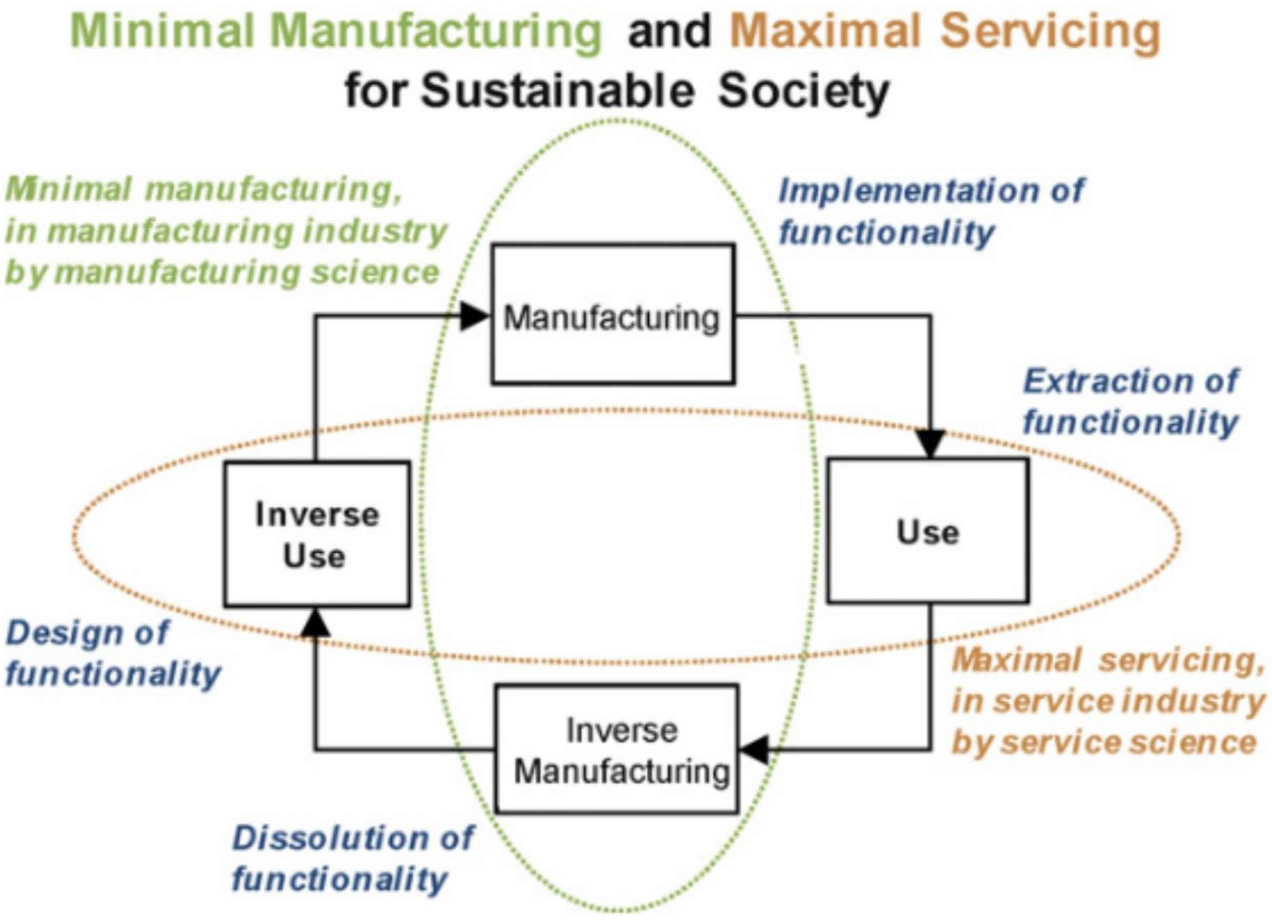
**Financial Opportunities**

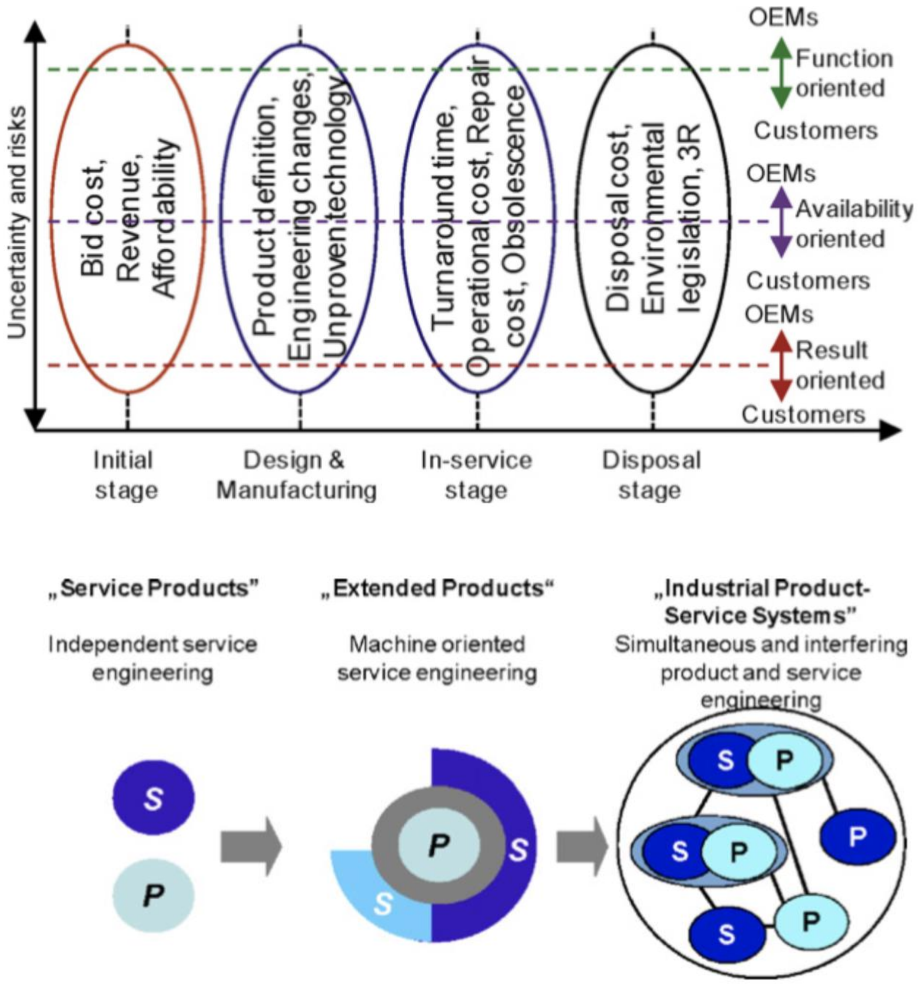
- Employment
- Enterprise
- Innovation and Creativity
- Skills

**Sustainability Opportunities**

- Sustainable Consumption and Production
- Climate Change and Energy
- Natural Resource Protection and Environmental Enhancement
  - Landfill Reduction
  - Pollution Reduction
  - Raw Materials Savings
  - Quality of Life
- Society

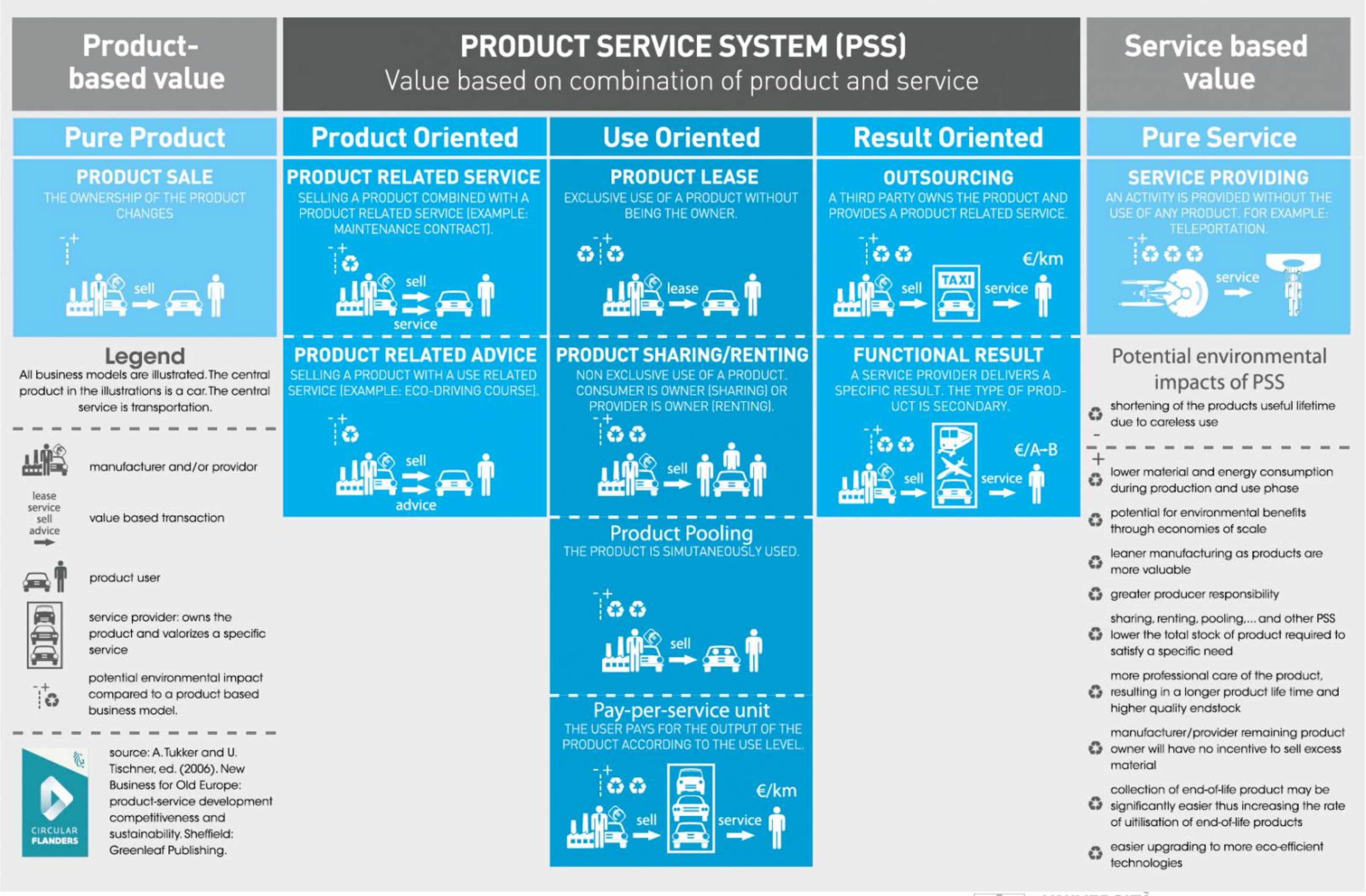
# Industrial ‘circularity’ treaths



# The PSS concept

## PRODUCT SERVICE SYSTEMS: MAIN AND SUB-CATEGORIES




# A Seminal paper (2009) on Transition

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*International Journal of Mathematics and Computers in Simulation* • Volume 3, Issue 1, Pages 30 - 43 • 2009

**Document type**
Article

**Source type**
Journal

**ISSN**
19980159

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## Influencing factors of successful transitions towards product-service systems: A simulation approach

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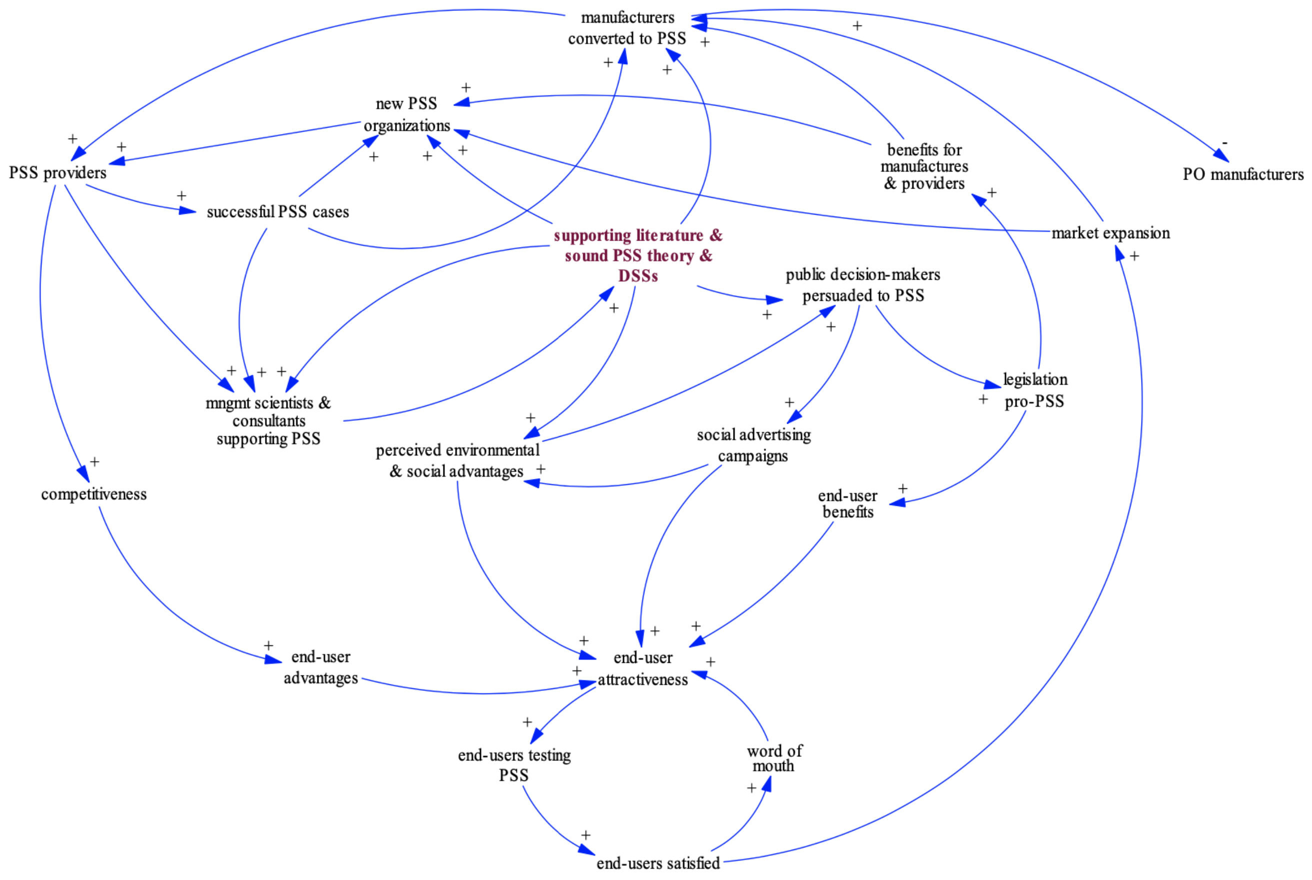
### Abstract
Product-Service Systems (PSS) are new business strategies moving and extending the product value towards its functional usage and related required services. From a theoretical point of view the PSS concept is known since a decade and many Authors reported reasonable possible success factors: higher profits over the entire life-cycle, diminished environmental burden, and localization of required services. Nevertheless the PSS promises remain quantitatively unproven relaying on a simple theory that involves a few constructs with some empirical grounding, but that is limited by weak conceptualization, few propositions, and/or rough underlying theoretical logic. A plausible interpretation to analyze the possible evolution of a PSS strategy could be considering it as a new business proposition competing on a traditional Product-Oriented (PO)



# Parameters for Product-Service System Approach

**Product Parameters**

The criteria required for a product to be successfully sold or servitized can be summarized in

The product has to be easy in repairing and in remanufacturing

Product is made up of standard interchangeable parts

Sufficient market demand to sustain enterprise

Product technology is stable over more than one life cycle

Technology exists to maintain (better if remotely) and restore product

An evaluation of disposal options and environmental impact of legislation is also necessary to determine a product’s suitability for full servitization

# A crucial paper (2010)

Genoa

CIRP Annals - Manufacturing Technology 59 (2010) 607–627

Contents lists available at ScienceDirect

CIRP Annals - Manufacturing Technology

journal homepage: http://ees.elsevier.com/cirp/default.asp

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## Industrial Product-Service Systems—IPS[2]

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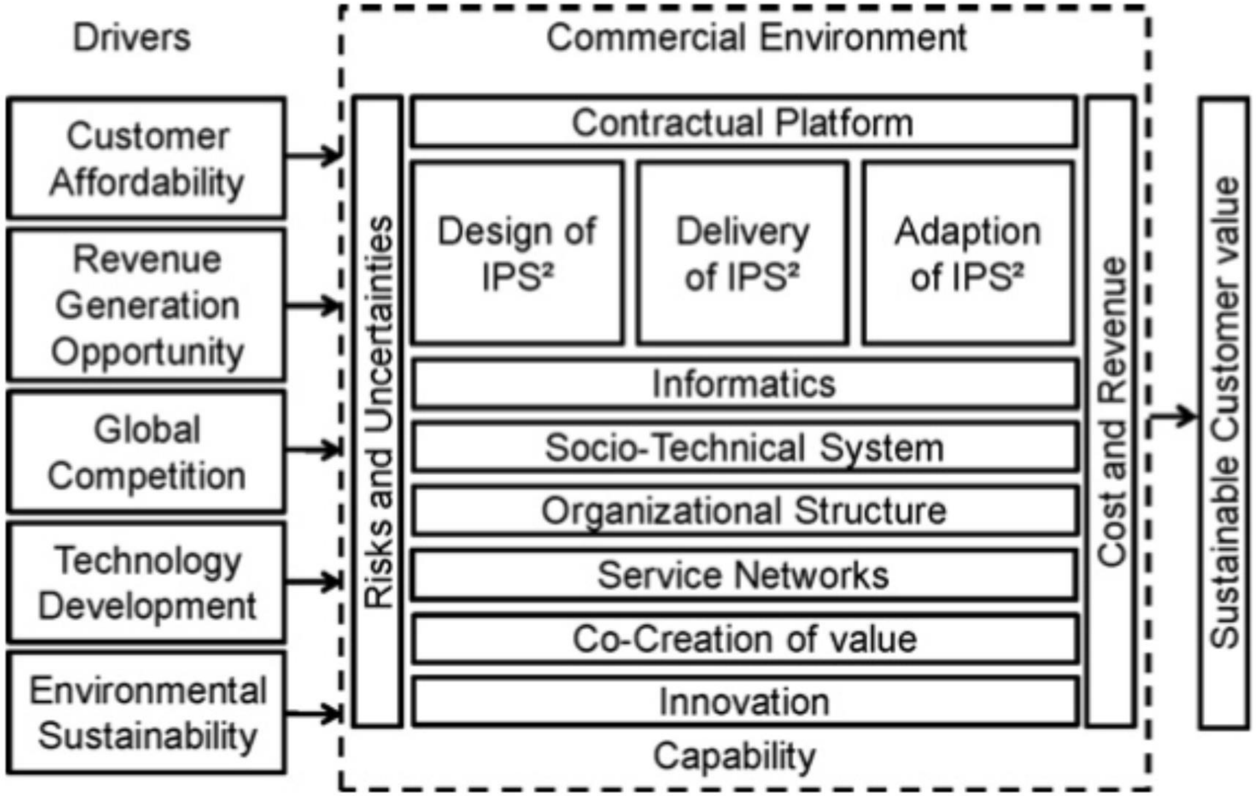
ARTICLE INFO

Keywords:
Service
Lifecycle
Industrial Product-Service Systems

ABSTRACT

In mechanical engineering and plant design, product-related services are usually cor add-on to the actual product. Industrial Product-Service Systems deal with dynami dencies of products and services in production. Research areas cover new concepts which enable the machine producers to design the potential services in an optimal during the development of the machine. This paradigm shift from the separated co products and services to a new product understanding consisting of integrated product creates innovation potential to increase the sustainable competitiveness of mechanic and plant design. The latter allows business models which do not focus on the machin the use for the customer e.g. in form of continuously available machines. The bu determines the complexity of delivery processes. Characteristics of Industrial Pr Systems allow covering all market demands.



What is the main reason for producer to set foundation for PSS ?

The economic benefits come from the cost savings

up to 50%

The reduction in energy

up to 60%

The reduction in material cost

up to 70%

This cost advantage enables companies to offer remanufactured products at **up to 40%** lower prices than the new ones with nearly **20% profit margins**

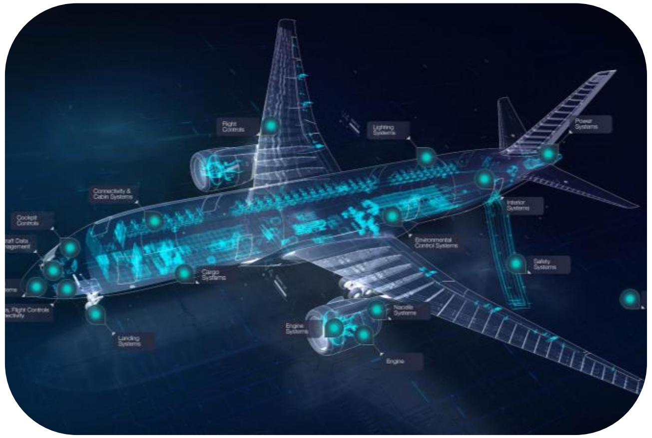
# Successful Remanufacture Example

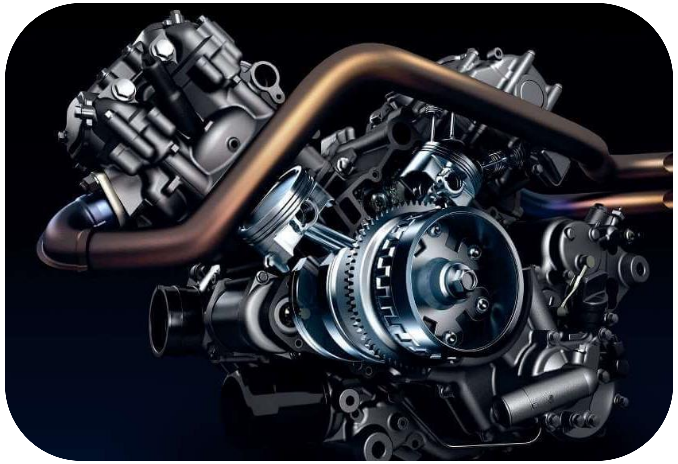
**Samples of PSS**

Airplane engines

Compressors

Motor Vehicle Parts





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# Successful Remanufacture Example

**Sample of PSS**

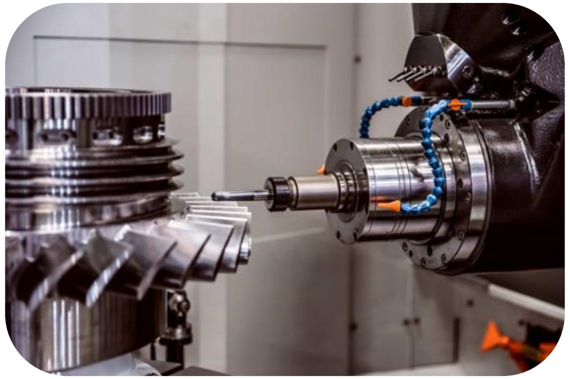
- Notebooks
- Photocopiers
- Laser Toner Cartridges

**Sample of PSS**

- Industrial Robots

- Bakery Equipment

- Industrial machinery



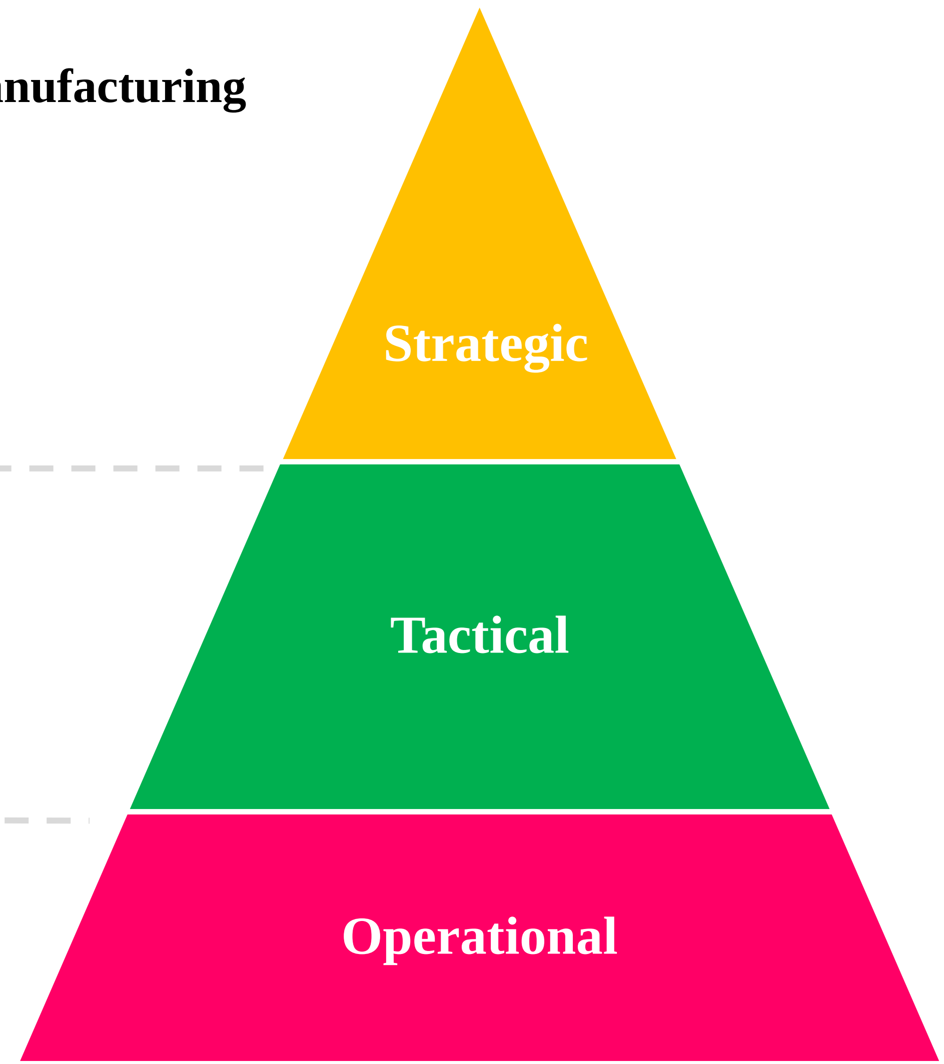
# Decision making in PSS

Classification of decision-making

- ✓ **Engagement in servitization/remanufacturing**
- ✓ **Product design**
- ✓ **Network design**
- ✓ **Supply chain coordination**
- ✓ **Service & Collection strategy**

- ✓ MRO / Returns disposition
- ✓ Product acquisition management
- ✓ Inventory management
- ✓ Production planning

- ✓ Maintenance planning
- ✓ Disassembly planning
- ✓ Scheduling
- ✓ Process planning



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## Engagement in PSS

Increasing environmental awareness

+

The benefits of remanufacturing

Companies must consider their degree of involvement in PSS practices

Research on engagement decision introduce key drivers

- Critical drivers of original equipment manufacturers' (OEMs') decisions towards in-house PSS
- Barriers towards serviticization/ remanufacturing in developing countries
- Economic viability and technical feasibility
- Optimal timing of implementing in-house practices

# Product design

Original equipment manufacturers' product design decisions must consider both

- The pre-life stage
- End-of-life stage

→ Maximize Overall profit / the whole product life-cycle

→ Enhance the product servitization/remanufacturability

Product design decisions are classified into four focuses :

- Sustainable product design
- Product life-cycle approach of optimizing product designs
- Component recovery options
- Design for Serviceability and Disassembly

In product design , from a methodological standpoint, three model types are noted

- Conceptual and descriptive models mainly in the form of guidelines and roadmaps for sustainable product design studies
- Mathematical and analytical models for component and disassembly-based studies
- systematic models for studies with life-cycle perspective -cycle perspective

# Strategic decisions

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**Network design**

Designing an efficient SC network is crucial to meet demand considering the reciprocal flows between customers and manufacturers

- Locations of Facilities
- Capacities of facilities
- Optimal transportation mode
- Distribution channel
- Location-inventory
- Planning problems

**Network design models can be divided into two groups:**

- Deterministic models neglecting uncertainties
- Stochastic models addressing different types of real-world uncertainties

Uncertainty

- Demand
- Returns quality

Ignoring uncertainties when designing network

May be

- Impractical
- Risky

As it can endanger the business survival

# Strategic decisions

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## Supply chain coordination

Coordination is essential for resolving conflicts and disagreements between SC members. Researchers have proposed various mechanisms such as information sharing, contracts and other initiatives to improve SC coordination

SC coordination studies are divided into four focuses

- The first group investigates the impact of demand information sharing on the pricing and SC profit
- The second group examines the use of contracts through correlating service level with pricing to increase SC profit
- The third group addresses the trade-offs between pricing, servicitization, and remanufacturing effort when maximizing SC profit
- The fourth group examines the impact of different channel power structures (e.g., centralized; manufacturer-, retailer-, third-party-led decentralized; and Vertical Nash)

The popular methods to resolve conflicts in SC coordination

- Game theory
- Equilibrium models
- Benchmark models

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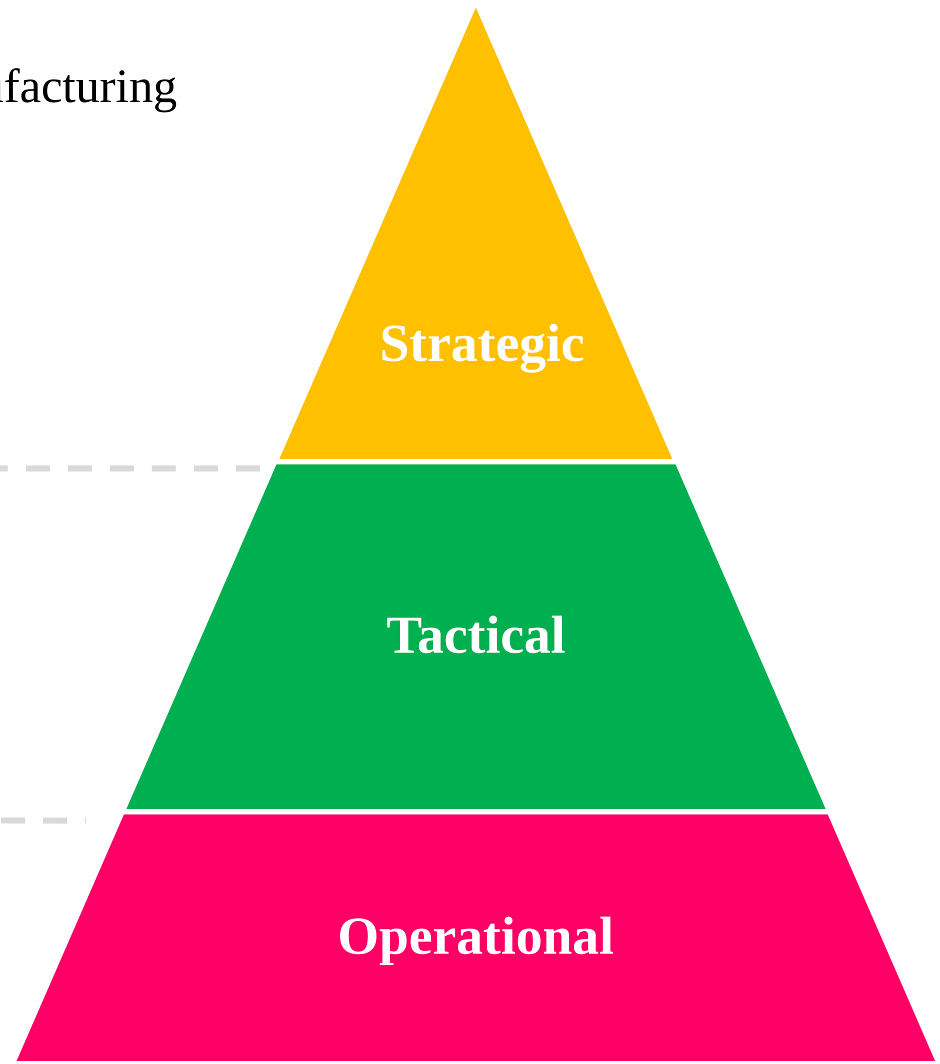

# Tactical decisions

**MRO / Returns disposition**

MRO / Returns disposition (or EOL option) refers to the selection of spare parts, repairing, recovery option for returned products reaching their EOL to maximize the service and recovery value

This decision is more crucial for time-sensitive products

like high-tech products

As any problem in maintenance or delays in remanufacturing

May reduce the product value

Due to obsolescence

Uncertain core condition also complicates the disposition decisions

Because

It affects

The recovery cost

It affects

The quality of recovered products or harvested components

There are three streams for decision making model for returns disposition

One stream promotes joint investigation over inventory control, production control and disposition since inventory level dictates both production and disposition

One stream integrates returns disposition with disassembly planning where trade-offs between value recovery and cost of disassembly are noted

One stream emphasizes returns disposition

Recovery option

Recovery option

Product-level

Component-level

# Tactical decisions

**Production planning**

Production planning in remanufacturing refers to determining the quantity of products to be disassembled, remanufactured, manufactured and/or ordered to achieve some specific goals under constraints at certain time.

Remanufacturing relies on used products with uncertain characteristics

Re-Manufacturing

Manufacturing

Manufacturing takes raw materials as high quality inputs

MRO

Production planning models have been developed to address these complexities in remanufacturing

- The first stream develops mathematical models to determine the number of cores to be disassembled, disposed and remanufactured within a predefined period
- The second stream investigates optimal production policies and develops mathematical models to minimize the total system cost
- The third stream examines the impact of various regulations such as cap-and-trade mechanism, mandatory carbon emissions capacity, and carbon tax on remanufacturing production planning and optimize the profit

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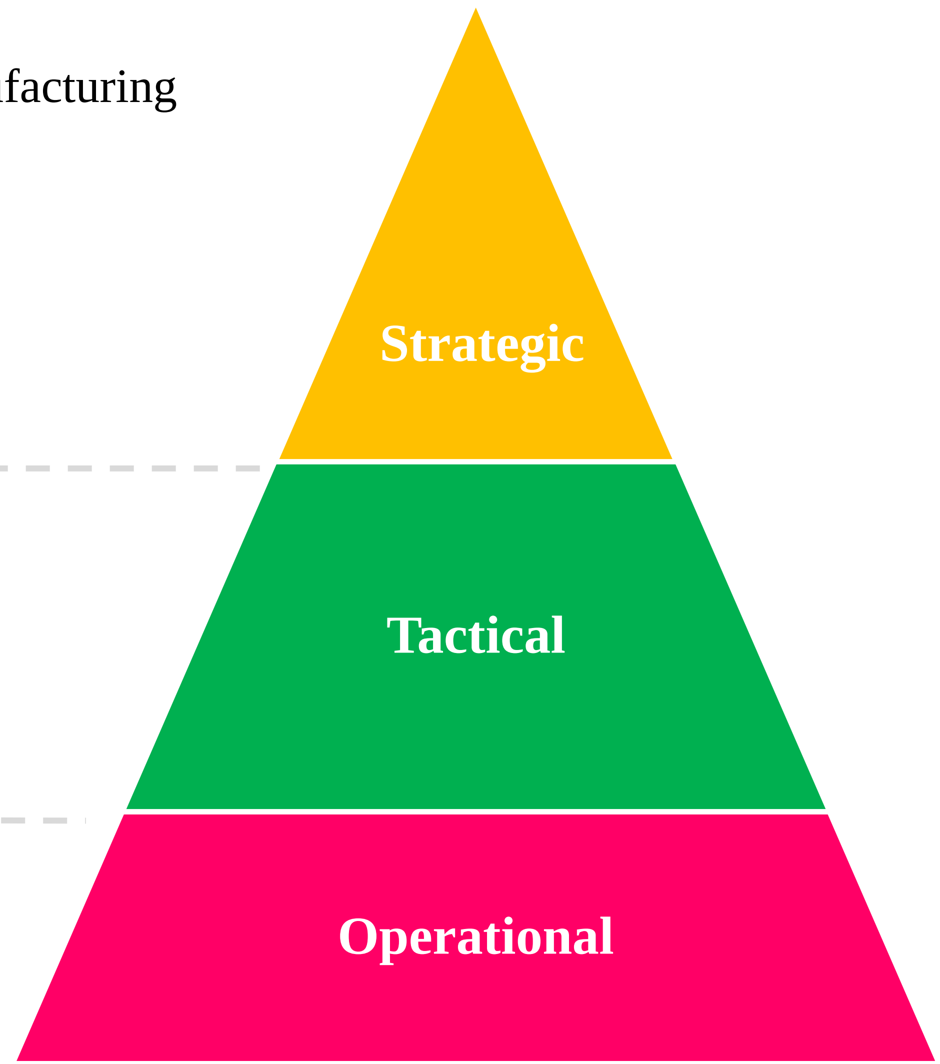
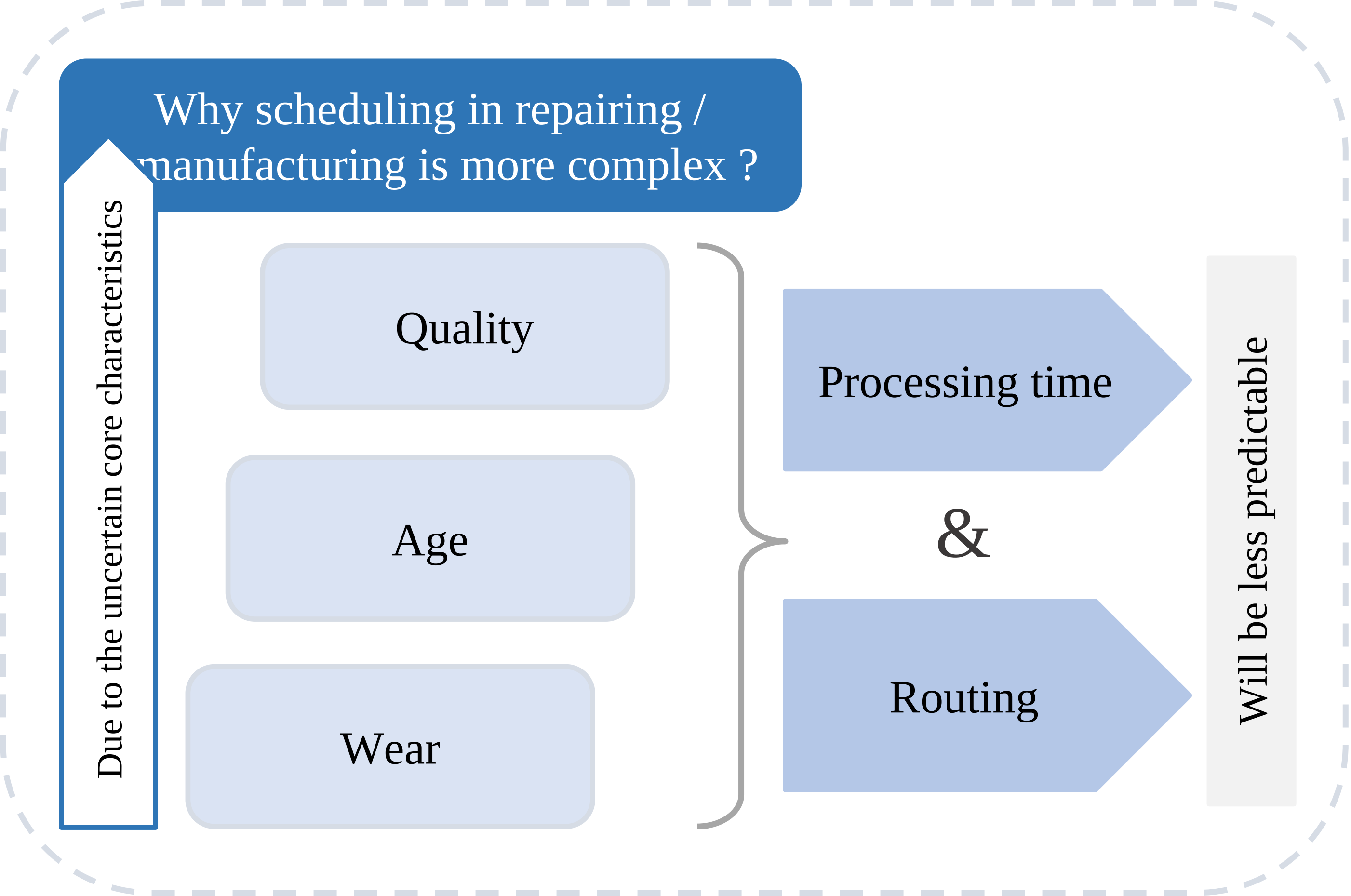


# Operational decisions

**Scheduling** → Scheduling is a process of mapping limited resources with tasks and determining their sequences to optimize multiple objectives




| Various approaches for scheduling | Uncertainties |
| --- | --- |
| Release mechanisms | Demand |
| Dispatching rules | Lead time |
| Production line scheduling | Process yield |
| Flexible job shop scheduling | Returns timing |
| Economic lot sizing | Returns quality |
| | Routing |

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# Some updated paper (2023)

*Lecture Notes in Networks and Systems* • Volume 546 LNNS, Pages 318 - 327 • 2023 • 6th International Conference on System-Integrated Intelligence, SysInt 2022 • Genova • 7 September 2022through 9 September 2022 • Code 282799

**Document type**
Conference Paper

**Source type**
Book Series

**ISSN**
23673370

**ISBN**
978-303116280-0

**DOI**
10.1007/978-3-031-16281-7_31

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## Cyber-Physical Equipment as a Service

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Abstract
Author keywords
SciVal Topics

### Abstract

To transition from a traditional product-based to a service-based busin
companies need a reliable, efficient, and affordable technological infra
paper we hypothesize that companies going through this transition, sh
not only as original equipment manufacturers (OEMs), but as providers
Equipment as a Service (CPE-aaS), following the same digital transform
experienced in other markets, from services to media. First, to clarify o
basic concepts and terminology. Then, general aspects related to the ro
blending new generation IoT and AI advancements (AIOT), considered
technology in this context, are discussed. Finally, to illustrate our appro
practical implementations are briefly presented: projects RAISE and PR
addressing Robotic and Medical Equipment servitization for two world
namely Mitsubishi Electrics™ and ESAOTE™. © 2023, The Author(s), un
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