

Euromaintenance 2016
Athens, Greece – 31st May 2016



POLITECNICO DI MILANO



Sustainable value creation in manufacturing through maintenance services

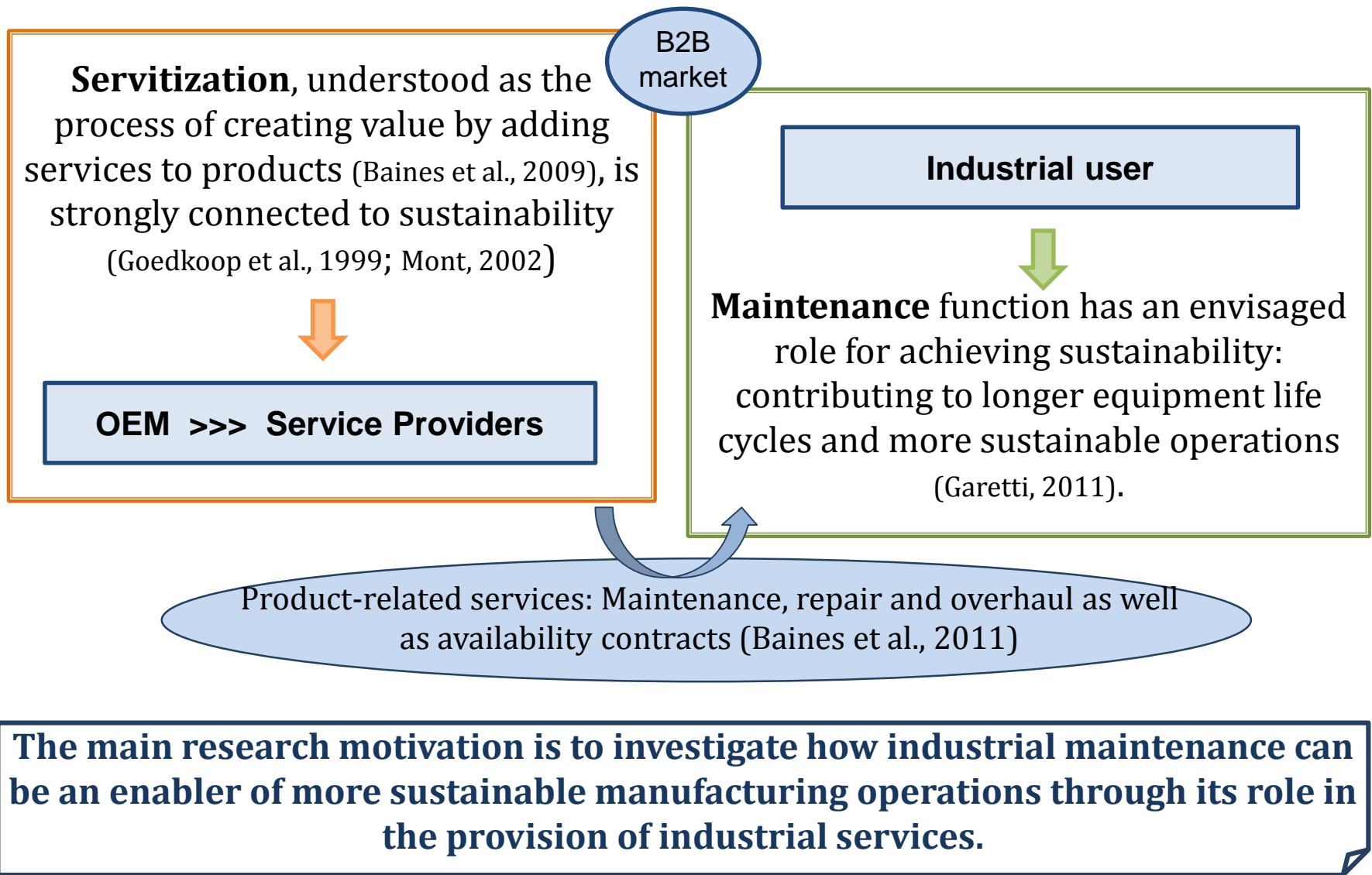
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Introduction





Research Questions

Main Research Question (RQ):

How can maintenance services contribute to sustainable value creation in manufacturing?

Research Sub-Questions (SQ):

SQ1

What is the current approach regarding the acquisition of different maintenance services in manufacturing companies?

SQ2

How does maintenance function in manufacturing companies contribute to more sustainable manufacturing operations?

SQ3

How can technological innovations contribute to enhance sustainable value in maintenance service provision?



Findings & Contribution

Sub-
Question 3

Sub-Question
2

Sub-Question
1

Main
Research
Question

Value analysis of innovative tools and applications categories

Value Analysis Method

1. Definition
of value
dimensions

2. Definition
of rating scale

1.
Visualisation
of results

Overall scores integrating
all value dimensions



■ Diagnosis tools (5,56)

■ Prognosis tools (5,55)

■ Smart sensors (5,34)

■ Inspection tools (5,33)

■ Smart devices (5,25)

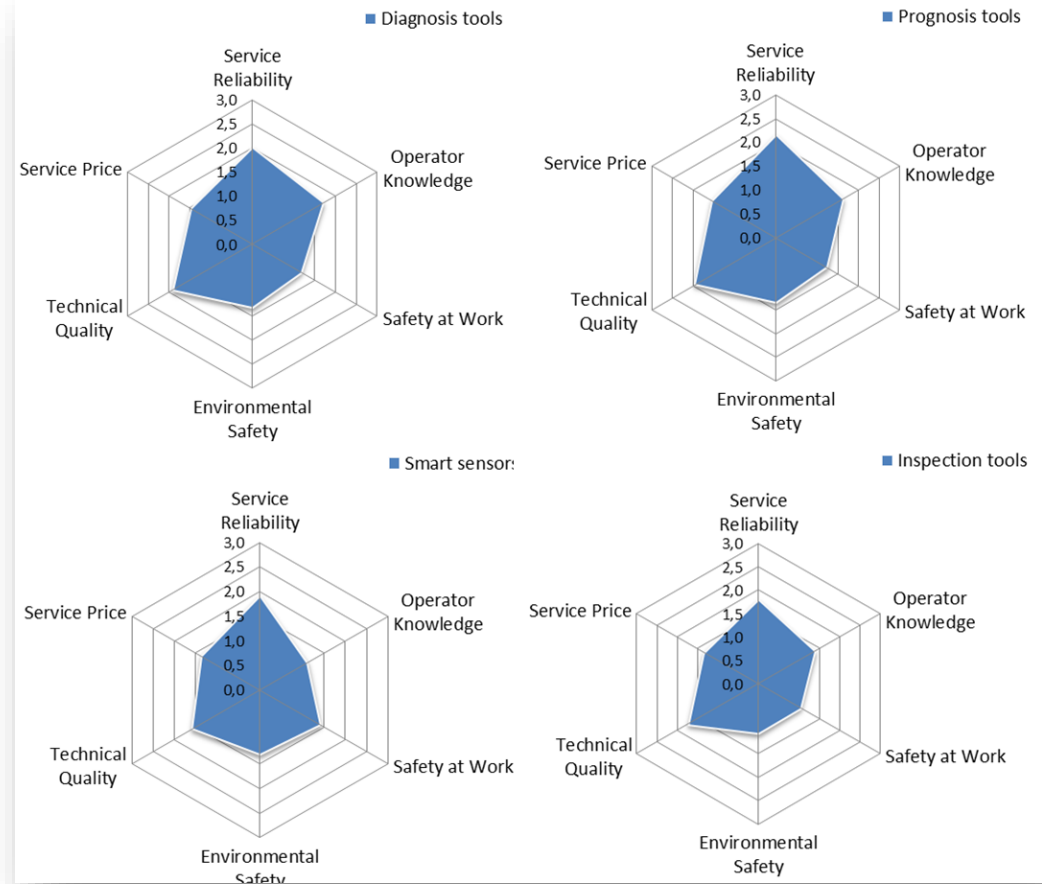
■ AR tools (5,11)

■ E-CMMS (5,05)

■ Location & tracking tools
(5,02)

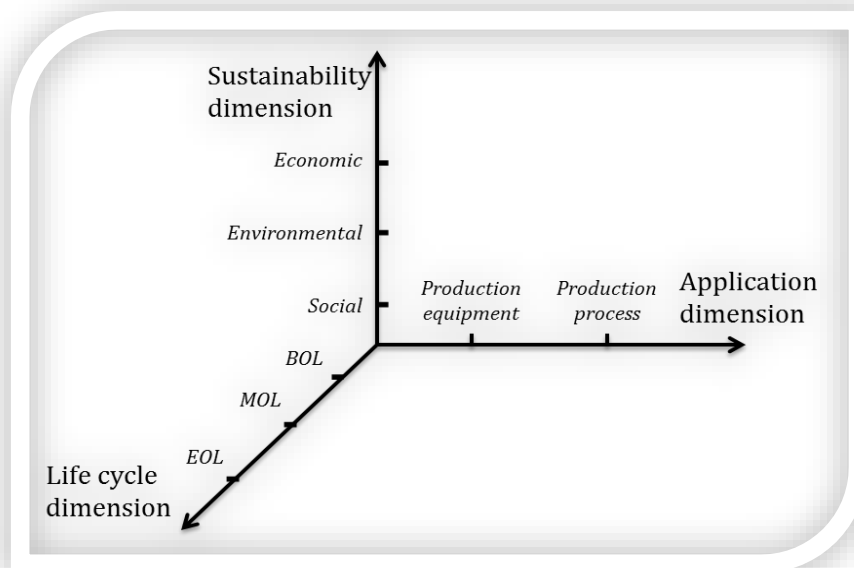
■ Simulation tools (4,83)

■ Cloud-based tools (4,70)





Proposal of a framework for maintenance value within sustainable manufacturing



- ❑ It represents the *three-dimensional space* of maintenance contribution to sustainable manufacturing.
- ❑ Specific contributions in a concrete case would address some part of the framework, as being *context-dependent*.

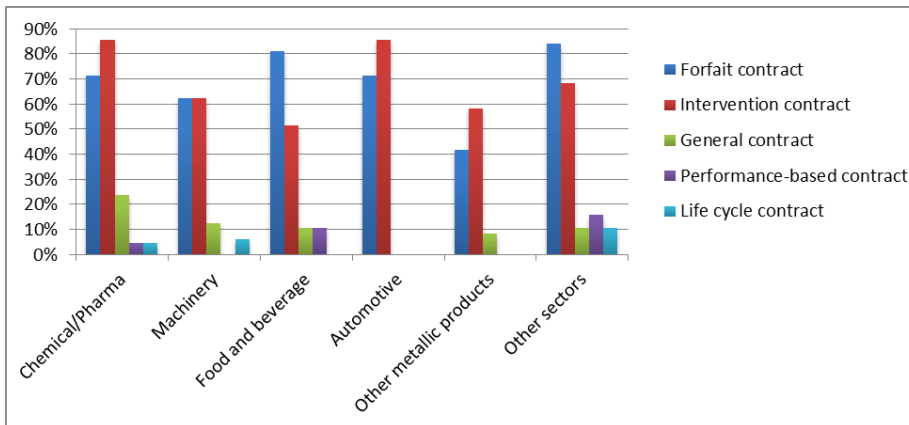
Production equipment	Economic	Environmental	Social
BOL	Equipment acquisition (provision of data related to expected useful life, failure rate, historical reliability)	Environmental standards required (procedure development)	Maintenance personnel required training Safety standards required (procedure development)
MOL	Equipment reliability Equipment availability Maintenance costs Maintenance policies	Equipment integrity Environmental safety (prevention of environmental damage)	Human safety (prevention of human damage) Working conditions improvement (less pressure or extra hours) Adequate tools for interventions Team work (synergies and collaboration between different maintenance teams)
EOL	Equipment components reuse as spare parts	Equipment components reuse as spare parts	

Production process	Economic	Environmental	Social
BOL	New process design (related to new product industrialization)	New process design (compliance with environmental standards)	New process design (compliance with safety standards)
MOL	Process efficiency Output quality (final / intermediate products or processed materials)	Water and air efficiency Air emissions reduction Energy efficiency Land conservation Materials efficiency Environmental safety	Human safety Team work (synergies and collaboration with other business functions) Output safety (final / intermediate products or processed materials)
EOL	Equipment and/or equipment components reuse	Equipment and/or equipment components reuse	



Main finding of the exploratory survey

A. Distribution of maintenance contracts



Potential benefits of performance-based services:

- reduction of material intensity (Roy, 2000),
- control process quality and higher potential for environmental sustainability (Tukker, 2004),
- reduction of cost of ownership and higher levels of availability and reliability performance (Jin et al., 2011).

RESEARCH-PRACTICE GAP:

Performance-based contracts (7%) are among the less extended forms of maintenance service contracts, although according to literature are those providing higher value.



Findings & Contribution

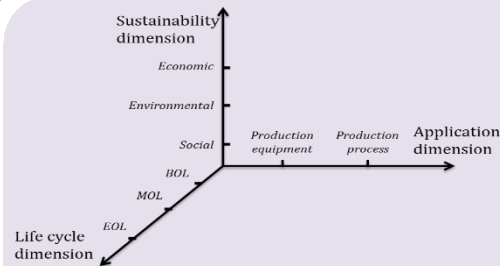
Sub-Question
3

Sub-Question
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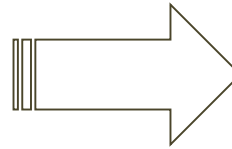
Sub-Question
1

Main
Research
Question

RESEARCH-PRACTICE GAP:
Performance-based contracts (7%) are among the less extended forms of maintenance service contracts, although according to literature are those providing higher value.



Framework for maintenance value within sustainable manufacturing



Focus on performance-based services

Integration of maintenance value as driver for service offerings design



Findings & Contribution

Sub-Question
3

Sub-Question
2

Sub-Question
1

Main
Research
Question

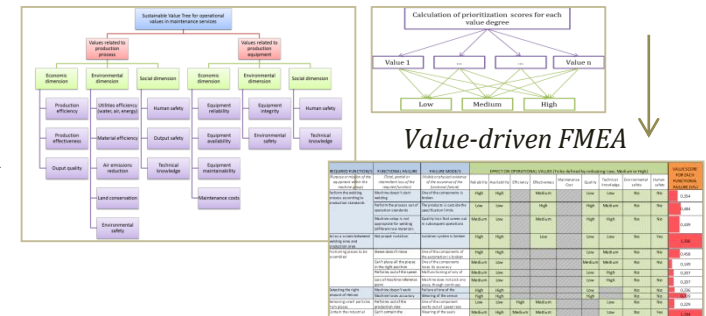
Proposal of value-driven design methodology for performance-based maintenance services

		Industrial user involvement
STEP I - Equipment & process analysis	I.1. Strategic & operational context analysis	X
	I.2. Identification & description of target entity	X
STEP II - Value analysis	II.1. Selection of a set of operational values	X X
	II.2. Rating of selected set of operational values	X X
	II.3. Value-driven FMEA	X X
STEP III - Service solution definition	III.1. Portfolio analysis	
	III.2. Alternatives definition & evaluation	X
	III.3. Performance measures selection	X

Based on a set of guiding questions

Description of business & strategic context of the industrial user	Which is the industrial user's sector? Which is the company/plant size? Which is its main target market? What are its main products? How is their demand (constant, variable, seasonal...)? Which are the main strategic priorities and goals?
Description of production process in the plant under concern	How is the functional chart of plant departments/functions? Which is the concrete position of maintenance function in the functional chart? Which type of production process is there in the plant? Which is the plant layout and the main processes in each plant area? Which are the environmental and safety standards implemented in the plant?

Sustainable Value Tree → Rating AHP



Analysis of provider's portfolio and service alternatives, according to scores obtained above.

	Service offering 1 (S1)	Service offering 2 (S2)	Service offering 3 (S3)
Direct maintenance activities	95.00	95.00	95.00
Indirect maintenance activities	95.00	95.00	95.00
Overall performance	95.00	95.00	95.00
Service offering 4 (S4)	95.00	95.00	95.00
Service offering 5 (S5)	95.00	95.00	95.00
Service offering 6 (S6)	95.00	95.00	95.00
Service offering 7 (S7)	95.00	95.00	95.00
Service offering 8 (S8)	95.00	95.00	95.00
Service offering 9 (S9)	95.00	95.00	95.00
Service offering 10 (S10)	95.00	95.00	95.00

Service offering selection

	Measure 1 (M1)	Measure 2 (M2)	Measure 3 (M3)
Measure 4 (M4)	95.00	95.00	95.00
Measure 5 (M5)	95.00	95.00	95.00
Measure 6 (M6)	95.00	95.00	95.00
Measure 7 (M7)	95.00	95.00	95.00
Measure 8 (M8)	95.00	95.00	95.00
Measure 9 (M9)	95.00	95.00	95.00
Measure 10 (M10)	95.00	95.00	95.00
Measure 11 (M11)	95.00	95.00	95.00
Measure 12 (M12)	95.00	95.00	95.00
Measure 13 (M13)	95.00	95.00	95.00
Measure 14 (M14)	95.00	95.00	95.00
Measure 15 (M15)	95.00	95.00	95.00

Measures selection



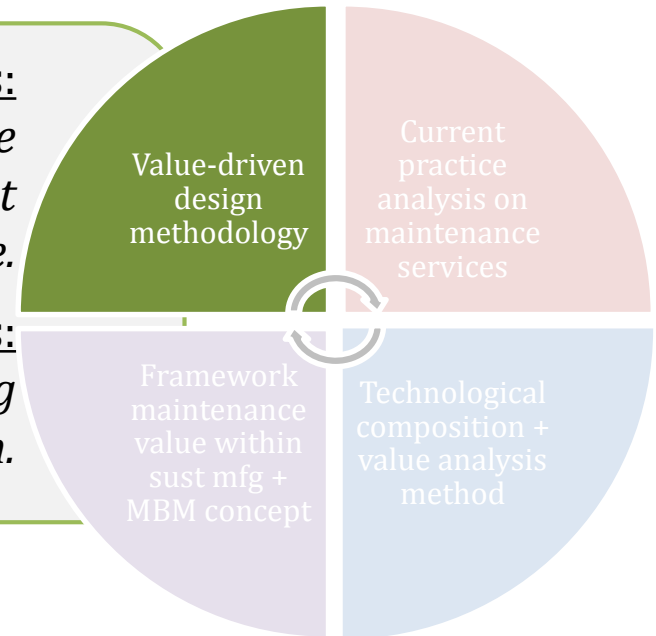
Conclusions & Further Research

Implications for servitized manufacturers:

The methodology can be used as a means to engage with the customer, which could be keener to contract further services once a small collaboration is done.

Implications for industrial users:

They could benefit of the method as being a means to support service selection.



Further Research:

Further testing of the proposed methodology in different contexts:
OEMs + different users' operations.

Enlargement of methodology scope by addressing also the service delivery planning.



Questions & Comments ?

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