Analysis of the adaptability potential of networked production systems in an uncertain environment

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Marseille, the 7th of June 2023
AGENDA

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- Problem statement
- Research questions
- Research framework
- Illustrative case
- Conclusion / perspectives
How did manufacturing and production systems evolve during the time and what are their current needs?

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Production systems are increasingly facing the challenges of dealing with uncertainties and unforeseen disruptive events, which can significantly affect their overall performance.

Production system’s capability to master their business in a turbulent world is critical to ensure its sustainable competitiveness and efficiently react to these unexpected events.

In order to prepare for this new challenge, companies and networks of companies must exploit the transformative capabilities of Digitalization and Automatization.
Research context

Production systems are key part of the value chain. They have to cope with risks and opportunities as uncertainty is the new normal. Among those events, management of new product opportunities is crucial.

**New product:** The manufacturing process of the product is unknown by the concerned production system but known by the market.
Collaborative Networked Organizations (CNOs)
- Long term strategic network
- Goal oriented network

Production system
- Reconfigurable Manufacturing systems (RMS)
- Flexible Manufacturing systems (FMS)
- Adaptive manufacturing systems

Uncertainty
- Demand fluctuation
- Emergent technologies
- New product requirement

Adaptability
- Reconfiguration planning management
- Seizing opportunity


Research context – Literature review

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Adaptability
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What is the adaptability potential of a production system in relation to the manufacture of a new product?

Problem statement
Research questions

**RQ1:** What concepts and characteristics should be considered to automatically analyze the adaptability potential of a production system to support a new product opportunity?

**RQ2:** How can we automatically assess the adaptability within the manufacturing system itself (intra-adaptation)?

**RQ3:** How to identify on-the-fly complementary capabilities in a network of partners to complete the unfulfilled requirements within the manufacturing system (inter-adaptation)?
Research framework

1. **New product description**
   - Requirements
   - Feedback

2. **Intra-system adaptability analysis (Matchmaking)**

3. **Inter-system adaptability analysis (Matchmaking)**

4. **Inter-system adaptability assessment (Selection)**

**External resource capability pool**

**External input pool**

*Client* — *Targeted manufacturing system* — *Manufacturing partner* — *Supplier*
Manufacturing Resource Capability Ontology (MaRCO) model

Selection algorithms that include:

- Multi Criteria Decision Making (e.g., production cost, transport cost and production sequence)
- Optimization: Trajectory metaheuristics (VNS)
Use case: An intra-analysis of the adaptation of a shampoo production system to manufacture a hydroalcoholic gel requirement due to a pandemic disruption.

**Intra-system adaptability analysis (Matchmaking)**

1. **New product description**
   - Matching between resource capability and operation requirement: If the operation and the capability has the same name and the properties of the inputs corresponding to this operation are included in the corresponding resource → Match between C and O
   - Matching between stock and I/O requirement: If the input and the stock have the same name → Match between S and M
Use case: An inter-analysis of the adaptation of a shampoo production system to manufacture a hydroalcoholic gel requirement due to a pandemic disruption.

Inter-system adaptability analysis (Matchmaking)

Identify all the candidates that have suitable resources within the set of manufacturing partners and suitable inputs within the set of suppliers.
Use case: An *inter*-analysis of the adaptation of a shampoo production system to manufacture a hydroalcoholic gel requirement due to a pandemic disruption

*Inter*-system adaptability analysis (Matchmaking)

**Identify** all the candidates that have suitable resources within the set of manufacturing partners and suitable inputs within the set of suppliers.
Use case: An inter-analysis of the adaptation of a shampoo production system to manufacture a hydroalcoholic gel requirement due to a pandemic disruption.

Inter-system adaptability assessment (Selection)

Filter all the candidates that have been identified previously within a collaborative network perimeter.
Use case: An inter-analysis of the adaptation of a shampoo production system to manufacture a hydroalcoholic gel requirement due to a pandemic disruption.
Use case: An inter-analysis of the adaptation of a shampoo production system to manufacture a hydroalcoholic gel requirement due to a pandemic disruption.

Inter-system adaptability assessment (Selection)

Criteria specified by the targeted manufacturing system (cost, distance....)
Use case: An inter-analysis of the adaptation of a shampoo production system to manufacture a hydroalcoholic gel requirement due to a pandemic disruption.

Inter-system adaptability assessment (Selection)

Use a multi-criteria selective algorithm that allows consolidation and coordination of the network.
Conclusion

We have provided a framework that analyzes the adaptability potential of a networked targeted manufacturing system for a new product requirement.

**RQ1**: What concepts and characteristics should be considered to automatically analyze the adaptability potential of a production system to support a new product opportunity?

**RQ2**: How can we automatically assess the adaptability within the manufacturing system itself?

**RQ3**: How to identify on-the-fly complementary capabilities in a network of partners to complete the unfulfilled requirements within the manufacturing system?

- Capability based ontology (MaRCO model)
- Matchmaking (intra-system)
- Matchmaking (inter-system)
- Evaluation
Next steps

Find adequate selection algorithms for the evaluation part

Implement ontology and its semantic rules

Use case - Simulation
Thank you for your attention!

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