Delphi Study - Additive Manufacturing on Supply Chain Resilience: Round 1

Delphi Study on Capabilities and Vulnerabilities concerning the use of Additive Manufacturing related to Supply Chain Resilience

The survey will take about 15 minutes to complete. Each page is made of one or two questions.

\* Mandatory

# Research and Round Description

This study is focused on the use of Additive Manufacturing (also known as 3D printing) related to Supply Chain Resilience. Additive Manufacturing (AM) is a production method where parts are produced layer-by-layer starting from a CAD file.

The goal of the research is to evaluate the Supply Chain capabilities and vulnerabilities connected with the use of AM.

This round requires to evaluate the relevance of proposed **Capabilities and Vulnerabilities** concerning the use of Additive Manufacturing (AM) related to Supply Chain Resilience on a scale from ***1 – strongly disagree*** to ***5 – strongly agree***. Capabilities and Vulnerabilities are proposed as affirmative sentences about which the participant should express his/her opinion. **The evaluations of single participants will not be shared with others**, in order to assure anonymity.

Anagraphical Informations

1. Name:
2. Surname:

Evaluation of Capabilities

Capability 1

3. Evaluate the relevance of AM in support to the Capability **“Adaptability”** as described below:

" AM strengthens the capability “Adaptability” by supporting short lead times in production "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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4. Evaluate the relevance of AM in support to the Capability **“Adaptability”** as described below:

" AM strengthens the capability “Adaptability” by supporting the possibility to reallocate production"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 2

5. Evaluate the relevance of AM in support to the Capability **“Capacity”** as described below:

"AM strengthens the capability “Capacity” by facilitating redundancy in production"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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6. Evaluate the relevance of AM in support to the Capability **“Capacity”** as described below:

"AM strengthens the capability “Capacity” by increasing production scalability"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 3

7. Evaluate the relevance of AM in support to the Capability **“Collaboration”** as described below:

" AM strengthens the capability “Collaboration” by promoting an increase in collaborative information sharing between supply chain partners"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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8. Evaluate the relevance of AM in support to the Capability **“Collaboration”** as described below:

" AM strengthens the capability “Collaboration” by enhancing the increase in collaborative demand forecasting between partners in the supply chain"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 4

9. Evaluate the relevance of AM in support to the Capability **“**Dispersion**”** as described below:

" AM strengthens the capability “Dispersion” by enhancing the ability to distribute capacity in multiple locations "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 5

10. Evaluate the relevance of AM in support to the Capability **“Efficiency”** as described below:

" AM strengthens the capability “Efficiency” because there is minimum raw material consumption during production "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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11. Evaluate the relevance of AM in support to the Capability **“Efficiency”** as described below:

" AM strengthens the capability “Efficiency” because there is increased capacity sharing"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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12. Evaluate the relevance of AM in support to the Capability **“Efficiency”** as described below:

“AM strengthens the capability “Efficiency” by allowing complex products to be produced in an easy way"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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13. Evaluate the relevance of AM in support to the Capability **“Efficiency”** as described below:

" AM strengthens the capability “Efficiency” because AM promotes a tool-less manufacturing approach"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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14. Evaluate the relevance of AM in support to the Capability **“Efficiency”** as described below:

" AM strengthens the capability “Efficiency” because there is an extension of the product's life cycle"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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15. Evaluate the relevance of AM in support to the Capability **“Efficiency”** as described below:

“AM strengthens the capability “Efficiency” because there is a reduced need for labor"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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16. Evaluate the relevance of AM in support to the Capability **“Efficiency”** as described below:

“AM strengthens the capability “Efficiency” because production is on-demand according to customer orders"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 6

17. Evaluate the relevance of AM in support to the Capability **“**Flexibility in order fulfillment**”** as described below:

" AM strengthens the capability “Flexibility in order fulfillment” by allowing possibility to postpone production until a customer order is received "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 7

18. Evaluate the relevance of AM in support to the Capability **“**Flexibility in sourcing**”** as described below:

" AM weakens the capability “Flexibility in sourcing” because there is a limited availability of substitute suppliers "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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19. Evaluate the relevance of AM in support to the Capability **“**Flexibility in sourcing**”** as described below:

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" AM weakens the capability “Flexibility in sourcing” because there is a limited availability of raw materials required for production"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 8

20. Evaluate the relevance of AM in support to the Capability **“**Market position**”** as described below:

"AM strengthens the capability “Market position” because it provides room for co-design of products with customers"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 9

21. Evaluate the relevance of AM in support to the Capability **“**Recovery**”** as described below:

" AM strengthens the capability “Recovery” by enhancing the ability to outsource production in the event of capacity/distribution shortages "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Capabilities

Capability 10

22. Evaluate the relevance of AM in support to the Capability **“**Visibility**”** as described below:

“AM strengthens the capability “Visibility” because the reliance on ICT systems for information sharing helps in anticipating customer demands "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Vulnerabilities

Vulnerability 1

23. Evaluate the relevance of AM in support to the Vulnerability **“Connectivity”** as described below:

" AM mitigates the vulnerability “Connectivity” issues as there is an increase in the degree of outsourcing of production to external entities due to the digital nature of AM technology "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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24. Evaluate the relevance of AM in support to the Vulnerability **“Connectivity”** as described below:

" AM increases the vulnerability “Connectivity” issues limiting information flows when adequate ICT infrastructures are missing "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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25. Evaluate the relevance of AM in support to the Vulnerability **“Connectivity”** as described below:

" AM increases the vulnerability “Connectivity” issues as the limited number of suppliers of raw materials increases the reliance upon specialty sources "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Vulnerabilities

Vulnerability 2

26. Evaluate the relevance of AM in support to the Vulnerability **“Deliberate threats”** as described below:

" AM increases the vulnerability “Deliberate threats” as the high level of information exchange between partners in the supply chain exposes the supply chain to industrial espionage "

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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27. Evaluate the relevance of AM in support to the Vulnerability **“Deliberate threats”** as described below:

"AM mitigates the vulnerability “Deliberate threats” as the ability to disperse capacity to multiple production facilities increases resilience against threats; threats meaning theft, sabotage, product liability"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Vulnerabilities

Vulnerability 3

28. Evaluate the relevance of AM in support to the Vulnerability **“Resource limits”** as described below:

"AM increases the vulnerability “Resource limits” as the reliance on very few suppliers in the supply chain causes an exposure to raw material and supplier unavailability"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Vulnerabilities

Vulnerability 4

29. Evaluate the relevance of AM in support to the Vulnerability **“Sensitivity”** as described below:

" AM increases the vulnerability “Sensitivity” due to the lack of standardization"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Vulnerabilities

Vulnerability 5

30. Evaluate the relevance of AM in support to the Vulnerability **“**Supplier-Costumer disruption**”** as described below:

" AM mitigates the vulnerability “Supplier-Costumer disruption” thanks to the possibility to reallocate production and distribute capacity to alternate production facilities"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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Evaluation of Vulnerabilities

Vulnerability 6

31. Evaluate the relevance of AM in support to the Vulnerability **“Turbulence”** as described below:

“AM mitigates the vulnerability “Turbulence” thanks to the possibility to reallocate production and distribute capacity to alternate production facilities"

*(1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)*

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