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About the Paradox of Sustainable Production

Transforming Consumption-Production Systems Toward Just and Sustainable Futures

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The Manufacturing Industry in the Context of Digital and Sustainable Transformation

Results

Discussion

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The Manufacturing Industry in the Context of Digital and Sustainable Transformation

Sustainable and Industrial Transformation



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Current State

Although interdependencies are obvious, the manufacturing industry remains one of the highest emission contributors:

 \rightarrow 9,8% in the EU [1]

 \rightarrow 30% the world [2]





Digital & Sustainable Transformation of the Industry

There are synergetic effects of digitalization and sustainability that are seen as a potential for a more sustainable manufacturing industry



Research shows that Industry 4.0 technologies, such as artificial intelligence, can be used for sustainable purposes

[3, 4, 5, 6, 7, 8, 9, 10]

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However, to leverage the potential of digital transformation for sustainability, the manufacturing industry must, in the first place, succeed in the process of transforming into a (fully) digitalized sector.



Digital & Sustainable Transformation of the Industry



Improvements in ecological and economic terms are possible, e.g., through increased resource efficiency.

Improvements in social terms are possible, e.g., in the form of greener and sustainable value and job creation, or, through smart and autonomous systems that benefit employees' well-being.

[3, 7, 11]

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However, this only applies if the technologies are used as intended and do not lead, e.g., to job loss, information security issues, complexity, wasted quality, and wasted energy.



Digital & Sustainable Transformation of the Industry



Given its nature, the manufacturing industry shows a tendency to remain this focus by understanding and practicing sustainability mostly in terms of resource efficiency and adaption to demand curves



However, digitalization will further lead to a fundamental change in sociocultural and structural terms because it crucially affects how human beings work and relate with and to each other.

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Results – Digital & Sustainable Transformation of the Industry



Out of 31 interview partners, merely 16,1% (5) addressed sustainability in the context of the digital transformation

→ indicating a weak (automated) association







When addressed, it was mostly associated with e.g., CO_2 footprints, energy transition, or energy efficiency

 \rightarrow indicating a strong focus on the ecological and economic dimension

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Results – Digital & Sustainable Transformation of the Industry



 Adressing Social Dimension

Not Adressing Social Dimension Only two addressed the social dimension and reflected people as sustainability-oriented consumers and as current or future employees

→ indicating a weak (automated)
association of social
sustainability



Success Factors in Digital Transformation Processes – An exploratory study in the manufacturing sector in Germany



The digitization of the manufacturing industry is primarily classified by a techno-economic focus



Digitization is hindered by human fears and other issues arising in the social sphere, deriving from seemingly frightening processes of change

[20]

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To succeed in digitization, a human-centered change management strategy is needed to complement the current techno-economic focus by mitigating social barriers

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"And a very important topic, which is also strongly driven by customers, is sustainability. This is also being questioned more and more by customers. How is the process structured, how sustainable is production, what is our CO2 foodprint in the process?"

*Translated: Transkript_200902b_LS50169, Pos. 88, Nr. 12

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"That's, so people, people, people, I think that's the biggest challenge. Or probably almost the only one. Of course, our industry in particular has certain challenges, the energy transition and so on and so forth, but I think everything stands and falls with the people."

*Translated: Transkript_200914_LS50063, Pos. 50, Nr. 14

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Discussion

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The Paradox of Sustainable Production



Participants of the manufacturing industry state a socially oriented and humancentered digital transformation as the most fundamental success factor of digital transformation in the context of the manufacturing industry.

However, at the same time, they miss out on addressing social sustainability when issuing sustainable transformation.

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Pathway – Sustainable Transformation of the Manufacturing Industry

Given its nature, we can see that we could resolve it via the implementation of strong educational efforts trying to help the respective people of the manufacturing industry to understand the holistic and interdependent character of sustainable development. [21, 22, 23]





Consequently, the European Commission has proposed its transformative vision of Industry 5.0 as a resilient and sustainable sector, which:



"...moves past a narrow and traditional focus on technology-or economic enabled growth" [19] while fostering "a multi-valent understanding of capital – human and natural as well as financial" [18].





Thank you for your attention!

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https://www.fhaachen.de/fachbereiche/energietechnik/

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- (1) Panagiotopoulou, Vasiliki Christina/Stavropoulos, Panagiotis/Chryssolouris, George (2022). A critical review on the environmental impact of manufacturing: a holistic perspective. The International Journal of Advanced Manufacturing Technology 118 (1-2), 603– 625. https://doi.org/10.1007/s00170-021-07980-w
- (2) Shukla, P. R./Skea, Jim/Reisinger, Andy (Eds.) (2022). Climate change 2022. Mitigation of climate change. Geneva, IPCC.
- (3) Bai, Chunguang; Dallasega, Patrick; Orzes, Guido; Sarkis, Joseph (2020): Industry 4.0 technologies assessment: A sustainability perspective. In International Journal of Production Economics 229, p. 107776. DOI: 10.1016/j.ijpe.2020.107776.
- (4) Braccini, Alessio; Margherita, Emanuele (2019): Exploring Organizational Sustainability of Industry 4.0 under the Triple Bottom Line: The Case of a Manufacturing Company. In Sustainability 11 (1), p. 36. DOI: 10.3390/su11010036.
- (5) Carvalho, Núbia; Chaim, Omar; Cazarini, Edson; Gerolamo, Mateus (2018): Manufacturing in the fourth industrial revolution: A positive prospect in Sustainable Manufacturing. In Procedia Manufacturing 21, pp. 671–678. DOI: 10.1016/j.promfg.2018.02.170.
- (6) Felsberger, Andreas; Reiner, Gerald (2020): Sustainable Industry 4.0 in Production and Operations Management: A Systematic Literature Review. In Sustainability 12 (19), p. 7982. DOI: 10.3390/su12197982.
- (7) Ghobakhloo, Morteza (2020): Industry 4.0, digitization, and opportunities for sustainability. In Journal of Cleaner Production 252, p. 119869. DOI: 10.1016/j.jclepro.2019.119869.



- (8) Javaid, Mohd; Haleem, Abid; Singh, Ravi Pratap; Suman, Rajiv; Gonzalez, Ernesto Santibañez (2022): Understanding the adoption of Industry 4.0 technologies in improving environmental sustainability. In Sustainable Operations and Computers 3, pp. 203–217. DOI: 10.1016/j.susoc.2022.01.008.
- (9) Kamble, Sachin S.; Gunasekaran, Angappa; Gawankar, Shradha A. (2018): Sustainable Industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives. In Process Safety and Environmental Protection 117, pp. 408–425. DOI: 10.1016/j.psep.2018.05.009.
- (10) Voigt, Kai-Ingo; Kiel, Daniel; Müller, Julian Marius; Arnold, Christian (2018): Industrie 4.0 aus Perspektive der nachhaltigen industriellen Wertschöpfung. In : Digitalisierung im Spannungsfeld von Politik, Wirtschaft, Wissenschaft und Recht: Springer Gabler, Berlin, Heidelberg, pp. 331–343. Available online at https://link.springer.com/chapter/10.1007/978-3-662-56438-7_23.
- (11) Rojko, Andreja (2017): Industry 4.0 Concept: Background and Overview. In Int. J. Interact. Mob. Technol. 11 (5), p. 77. DOI: 10.3991/ijim.v11i5.7072.
- (12) Alayón, C.; Säfsten, K.; Johansson, G. (2017): Conceptual sustainable production principles in practice: Do they reflect what companies do? In Journal of Cleaner Production 141, pp. 693–701. DOI: 10.1016/j.jclepro.2016.09.079.
- (13) Brauner, Philipp; Brillowski, Florian; Dammers, Hannah; Königs, Peter; Kordtomeikel, Frauke; Petruck, Henning et al. (2020): A Research Framework for Human Aspects in the Internet of Production – An Intra-company Perspective. In. International Conference on Applied Human Factors and Ergonomics: Springer, Cham, pp. 3–17. Available online at https://link.springer.com/chapter/10.1007/978-3-030-51981-0_1.

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OF APPLIED SCIENCES

AACHEN

- (14) Mertens, A.; S. Pütz; P. Brauner; F. Brillowski; N. Buczak; H. Dammers et al. (2021): Human Digital Shadow: Data-based Modeling of Users and Usage in the Internet of Production. In: 2021 14th International Conference on Human System Interaction (HSI). 2021 14th International Conference on Human System Interaction (HSI), pp. 1–8.
- (15) Imran, Faisal; Shahzad, Khuram; Butt, Aurangzeab; Kantola, Jussi (2021): Digital Transformation of Industrial Organizations: Toward an Integrated Framework. In Journal of Change Management 21 (4), pp. 451–479. DOI: 10.1080/14697017.2021.1929406.
- (16) Warner, Karl S.R.; Wäger, Maximilian (2019): Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. In Long Range Planning 52 (3), pp. 326–349. DOI: 10.1016/j.lrp.2018.12.001.
- (17) Harwardt, Mark (Ed.) (2022): Management der digitalen Transformation. Eine praxisorientierte Einführung. 2. Auflage. Wiesbaden, Germany: Springer Gabler (MOREMEDIA).
- (18) Kotter, John P. (2009): Leading change: Why transformation efforts fail. In IEEE Eng. Manag. Rev. 37 (3), pp. 42–48. DOI: 10.1109/EMR.2009.5235501.
- (19) Renda, Andrea/Schwaag Serger, Sylvia/Tataj, Daria/Morlet, Andrew/Isaksson, Darja/Martins, Francisca/Mir Roca, Montserrat/Hidalgo, César/Huang, Ailin/Dixson-Declève, Sandrine/Balland, Pierre-Alexandre/Bria, Francesca/Charvériat, Céline/Dunlop, Kirsten/Giovannini, Enrico (2021). Industry 5.0, a transformative vision for Europe. Governing systemic transformations towards a sustainable industry. Luxembourg, Publications Office of the European Union.

About the Paradox of Sustainable Production and What We Can Do About It!





OF APPLIED SCIENCES

- (20) Steuer-Dankert, Linda; Bernhard, Sebastian; Langolf, Jessica; Leicht-Scholten, Carmen (Submitted for publication): Success Factors in Digital Transformation: An exploratory expert study in the manufacturing sector in Germany.
- (21) The-Sustainable-Development-Goals-Report-2022. Available online at https://unstats.un.org/sdgs/report/2022/The-Sustainable-Development-Goals-Report-2022.pdf (accessed 9/20/2022).
- (22) Pufé, Iris (2012). Nachhaltigkeitsmanagement. München, Hanser Verlag.
- (23) Pufé, Iris (2017). Nachhaltigkeit. 3rd ed. Konstanz/München, UVK Verlagsgesellschaft mbH mit UVK/Lucius.

