Industry 4.0 and Lean Production – A Matching Relationship? An analysis of selected Industry 4.0 models

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***Abstract*—The increasing digitalization of business and society has led to drastic changes within companies. Nearly all enterprises are facing enormous challenges dealing with topics such as Industry 4.0/Industrial Internet. With the goal of supporting companies to handle these challenges and "move" in an Industry 4.0 environment, several frameworks or reference models already exist. Here, we share the results of a detailed analysis of selected Industry 4.0 models. In particular, we foster in our analysis Lean Production aspects since the basic principles of Lean Management/Lean Production in existence since the 1980s have yielded appropriate measures to optimize production. These principles can and should be addressed and included by Industry 4.0 models as well. Our study provides a classification of 31 Industry 4.0 models/frameworks as well as the identification of needs for further research to enhance existing Industry 4.0 models more holistically.**

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SUPPLEMENTARY MATERIAL

CATEGORIZATION OF THE IDENTIFIED ARTICLES ACCORDING TO THE CLASSIFICATION CRITERIA

		General criteria							Industry 4.0 implementation aspects (see [9])			
No.	**Reference**	Manufacturing environment	Holistic Industry 4.0 concept	Software (S) / hardware (H) consideration	Lean production principle	Business application	Mathematical / statistical aspects	Assessment of Industry 4.0 suitability	Horizontal integration across the value network	Vertical integration (e.g., in a factory)	PLCM / consistency of engineering	Employees as a conductor in the value networks
1	Ayadi et al. 2013	●	○	S&H	◔	●	○	○	◕	◕	◕	◑
2	Azevedo et al. 2010	●	●	S	◔	◑	○	◑	◑	●	◕	◑
3	Bagheri et al. 2015	●	●	S	◑	●	◔	◔	◔	●	◕	◔

4	Brettel et al. 2016	●	○	S	●	◔	◔	○	◕	◑	●	○
5	Debevec et al. 2014	●	○	S&H	○	◕	◑	○	◑	◑	○	○
6	Diez et al. 2015	●	○	S	●	◕	●	◕	◑	●	◔	◕
7	Flatscher and Riel 2016	●	○	S	◔	◕	○	○	●	◑	○	●
8	Francalanza et al. 2017	●	○	S	◔	●	◕	◔	◔	●	◕	◕
9	Ivanov et al. 2016	●	○	S	◕	◔	●	◔	◕	●	◔	◑
10	Jufer et al. 2012	●	●	S&H	◑	●	◔	◕	◕	●	◑	◑
11	Kolberg and Zühlke 2015	●	●	S&H	●	◕	◔	◔	◑	●	◔	◕
12	Long et al. 2016	●	●	S	◑	◑	◕	◕	◑	●	○	◑
13	Matsuda and Kimura 2015	●	●	S	○	◕	○	◑	◔	●	●	◑
14	Matsuda et al. 2012	○	○	S	○	●	○	◔	◔	●	○	◑
15	Matsuda et al. 2016	●	●	S	◔	◕	○	◑	◔	●	●	◕
16	Oesterreich and Teuteberg 2016	○	○	-	◑	◑	○	○	◕	◑	◑	◑
17	Qin et al. 2016	●	●	S&H	◔	●	○	◕	◑	●	◔	◑
18	Rennung et al. 2016	○	●	-	○	○	●	●	◑	◑	●	◕
19	Rix et al. 2016	●	○	S	◔	●	○	◑	◔	◕	○	◑
20	Schuh et al. 2015	●	○	S&H	◔	○	◔	◔	○	●	○	●
21	Schuh et al. 2014a	●	○	S	◔	◔	●	○	●	◑	◑	○
22	Schuh et al. 2014b	○	○	-	◔	●	◑	○	◕	◕	◑	●
23	Schuh et al. 2014c	●	●	S&H	◔	◕	◑	●	◔	●	○	◕
24	Schumacher et al. 2016	●	●	S	◑	◑	●	●	◔	●	◑	◑
25	Shafiq et al. 2015	●	○	S	◔	◑	◔	◔	◔	●	◔	◑
26	Sivard et al. 2016	●	●	-	○	◕	◔	◔	◑	●	○	◑
27	Stef et al. 2013	●	○	S	◔	◑	○	○	◕	◕	◕	◑
28	Terkaj and Urgo 2015	●	○	S	○	◕	○	◑	◔	●	○	◔

29	Tolio et al. 2013	●	●	S&H	◔	◑	○	○	○	●	◑	◔
30	Veza et al. 2015	●	●	S	◔	◑	◕	◕	●	◑	◕	◑
31	Wang et al. 2016	●	●	S	◔	◕	◕	◔	◑	●	◔	◕

LIST OF IDENTIFIED ARTICLES

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