How Digital Tools Support a Sustainable Supply Chain in Healthcare – a Scoping Review on the Status Quo of Circular Economy

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OVERVIEW AND CHALLENGES:

The healthcare sector is characterized by high resource consumption and considerable amounts of plastic waste while being directly affected by health-related social and economic impacts of climate change.[1] Digitalization offers various measures to reduce the environmental burdens of the healthcare sector for instance by reducing waste and resource consumption.[2] However, an overview on its contribution to a more sustainable healthcare sector with regard to the complete healthcare supply chain (HSC, Fig. 1) – instead of single institutions – focusing on different circularity strategies like 10R[3], is still missing. This study explores the impact of digital components of industry 4.0 on the circular economy (CE) and their distribution in the healthcare supply chain.

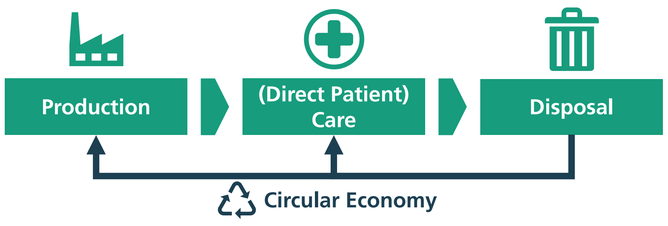

Fig. 1: Schematic depiction of the healthcare supply chain

METHODS:

A systematic literature analysis on digital solution approaches and circular economy in the healthcare supply chain following the PRISMA guidelines was conducted, using the Scopus and Web of Science databases based on selected search terms (Tbl. 1).[4]

The approaches were evaluated, focusing on their impact on supply chain sustainability and their contribution to 10R-strategies for CE. In a focus group all approaches were clustered regarding the respective industry 4.0 digital component facilitating the analysis. A distribution model for the digitalization clusters was applied, evaluating their 10R-strategies and supply chain applicability, resulting in a heatmap of solution approaches.

Tbl. 1: Search terms used for SLR in Scopus and Web of Science

circular economy* AND healthcare*
circular economy* AND healthcare* AND digital*
circular economy* AND healthcare* AND supply chain*
circular economy* AND health* AND digital*
circular economy* AND health* AND supply chain*

RESULTS:

Out of 844 hits in the initial literature survey, publications prior to 2018, duplicates, books, book chapters, and those that were not available in full text were removed. Out of 129 papers, 19 publications were extracted as relevant, which included 38 digital components of industry 4.0, affecting circular economy in the HSC. These components were separated into 7 clusters to assess their impact:

- Additive and progressive manufacturing
- Data and analytics
- Networked systems
- Artificial intelligence
- Interaction and communication
- Tracking and monitoring
- Automated systems

The publications often mentioned more than one solution approach, such as in the "Additive and progressive manufacturing" cluster with 36 approaches from 8 publications and "Data and analytics" with 22 approaches from 9 publications, representing a rather broad distribution across HSC and 10R-strategies (Tbl. 2). In turn, the "Automated systems" and "Tracking and monitoring" clusters had a comparatively narrow focus, applied mostly in Disposal. Overall, many approaches focused on Disposal in healthcare supply chains, while only few approaches addressed the section Production. A clear gap in the section (Direct Patient) Care became visible.

RESULTS (cont.):

Tbl. 2: Heatmap based on the distribution model of solution approaches in 7 developed clusters across CE-strategies (10R) in the healthcare supply chain; based on 19 publications.

	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle	Recover
Additive and progressive manufacturing										
Production			7	7		1	2		1	
Care	1		2	2	1	1	1			
Disposal			5						5	
Data and analytics										
Production			1	1	3	1	1			
Care			1			1				
Disposal			3	2			1		7	
Networked systems										
Production				1	1	1	1			
Care										
Disposal			1	1			1		6	
Artificial intelligence										
Production				1						
Care										
Disposal			2	2					5	
Interaction and communication										
Production					1	1				
Care			1	2	1					
Disposal			1	1					1	
Tracking and monitoring										
Production										
Care			1							
Disposal			1	1		1			2	1
Automated systems										
Production										
Care			1							
Disposal			1						1	

CONCLUSION:

Valuable applications in healthcare gain attention and have the potential to support CE, while some are applicable across the complete HSC such as "Data and analytics" and "Interaction and communication", others were only reported in specific sections such as "Tracking and monitoring". We also observed some clusters being applicable to various CE-strategies, e. g. "Additive and progressive manufacturing" and others focusing on only few, such as "Artificial intelligence". Based on our developed distribution model, an untapped potential of digitalization, supporting circular economy is concluded, especially in (Direct Patient) Care. The identified gaps may indicate that existing solutions in healthcare are not yet sufficiently associated with a circular economy.

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3 Potting, J., et al., 2017. Circular Economy: Measuring Innovation in the Product Chain. https://www.pbl.nl/sites/default/files/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf.
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