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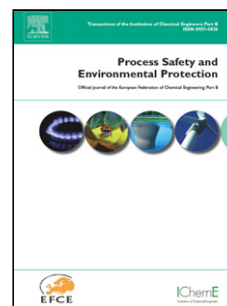
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**Pharma Industry 4.0: literature review and research opportunities in
sustainable pharmaceutical supply chains**

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Abstract:

The exploitation of the emerging technologies of Pharma Industry 4.0 facilitates sustainable value creation, leads to more agile, smart and personalised pharma industry, and thereby, in the long-run, enables pharma companies to obtain competitive advantages. A more sustainable pharmaceutical supply chain (PSC) should be implemented to match future operations and management of the pharmaceutical products across the entire life cycle. The main purpose of this study is to identify the potential sustainability barriers of PSC and to investigate how Industry 4.0 can be applied in the sustainable PSC paradigms. This paper systematically reviews 33 relevant articles concerning sustainable PSC and Industry 4.0, taken from peer-reviewed academic journals over a decade (2008-2018). Based on content analysis, we find that the major challenges that inhibit inclusion of sustainability in the PSCs are: high costs and time consumption, little expertise and training, enforcement of regulations, the paucity of business incentives, ineffective collaborations and coordination across the PSC, lack of objective benchmarks, and poor end-customer awareness. The technologies and innovations based on Industry 4.0 can solve these barriers with regards to four aspects: enhancing the flexibility of the PSC for patient-centric drug supplies; improving the effectiveness of coordination and communication across different entities within the PSC; mitigating waste and pollution at different stages; and enabling a more autonomous decision-making process for supply chain managers. Our analysis reveals that future research interest should focus on: cross-linking coordination and cooperation, eco-friendly end-of-life products disposal, proactive product recall management, new benchmarks and measurement of sustainable performance, new regulation system design, and effects

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