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Industry 4.0 Enabling Technologies Contribution to the Sustainable Development Goals Achieving: A Content Analysis

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ABSTRACT

The aim of the paper consists in the monitoring of Industry 4.0 enabling technologies (ET) adopting by the most innovative companies ranked by BCG classification, for Sustainable Development Goals (SDG) reaching. The development of Industry 4.0 ET has been considerably studied in the literature and its relationship to sustainability in its three pillars has been much investigated in recent years. The results show the three-years temporary dynamics of Industry 4.0 ET application in sustainability practices based on the communication process in the firms' Sustainability Reports (SR) with the proven prevalence of IoT technology.

Keywords: *Industry 4.0; Industry 5.0; Sustainability; Enabling Technologies; Content Analysis; Sustainability Report; Temporary Analysis; Sustainable Development Goals*

RESEARCH HIGHLIGHTS

- The modern enterprises are still characterized by quite a modest level of Industry 4.0 practices adoption;
- The SDGs "Sustainable cities and communities", "Peace, justice and strong institutions" and "Quality education" related to the social sustainability pillar are among the most cited in reference to the Industry 4.0 ET application in 2019-2021;
- Internet of Things and Cloud are the most cited Industry 4.0 ET in the SRs in 2019-2021;
- "Industrial Goods and Manufacturing" and "Technology Hardware" are the most cited sectors in the SRs in 2019-2021.

Research Objectives

Different studies aimed to fill the gap in the literature analyzing the ET of Industry 4.0 in relation to sustainability to investigate possible applications and contributions (Buchi et. al., 2020; Narula et. al., 2021; Piccarozzi et. al., 2023). The content analysis of the world's most innovative companies according to BCG SRs was employed and it also created a solid base for the deepening of such type of analysis. This article evidenced that the majorly used technologies in the analyzed sample were IoT, Big Data, Cloud and Cybersecurity. We concentrate our attention on the selected technologies and we choose the sample assuming that companies with high innovative vocation should have adequately and extensively applied the innovations introduced by Industry 4.0 and be able to critically comment their contribution to the achievement of SDGs.

Hence, this paper aims to front the following research questions (RQ):

RQ1. What are the most cited/reported technologies among IoT, Big Data, Cloud, Cybersecurity in the 2019-2021 period?

RQ2. What are the business sectors mostly involved in the usage of the Industry 4.0 ET in the 2019-2021 period?

RQ3. What is the dynamics of the SDGs in the analyzed period?

Methodology

We apply the content analysis methodology because it is a qualitative approach to understanding the relevance and pertinency of the information to the research topics (Kracauer, 2022). While to answer our questions it is necessary to count and measure the number of the chosen keywords, it is also necessary to analyze and understand the essence of the content and the specificity of the information presented in the SDRs: the interpretation and role of the researcher has extremely high importance (Bryman, 2022).

We use a content analysis of the SRs of the world's most innovative firms as ranked by BCG because it is considered one of the most comprehensive and reliable by prior studies (Bayrak, 2022).

We choose the sample based on the assumption that highly innovative companies should appropriately and actively use the innovations introduced by Industry 4.0 and we did a temporal analysis, from 2019 to 2021, of companies' Sustainability Reports to keep track of changes in the adoption of technology tools to reach sustainability goals. To conduct a coherent analysis, we chose the companies with the same type of report (Sustainability Report) over the three years, in total 17 companies. Besides, 14 out of 17 utilized GRI standards, except the company in the Wholesale and Retail sector; while 2 companies in the Computer Science and Software and Services sectors applied the GRI standards only in 2021.

Results

Our contribution outlines the following important considerations related to the three research questions described in the beginning of the present work. The shift from IoT to Cybersecurity in the analyzed period reflects how the process optimization and things connection has increased security threats that exposed citizens' private information as a negative side effect. In 2021, the most cited SDG was the 17 – "Partnership for the goals". Actually, collaboration between stakeholders is crucial to prevent attacks on information systems and protect customers and consumers. Our research also demonstrates how in 2019, Industrial Goods and Manufacturing was the sector with the major part of keywords, followed by Computer Science and Hardware and Software sectors. In 2020, the sector with most of the keywords was Technology and Hardware and in 2021, we find again Industrial Goods and Manufacturing sector as the sector with several keywords.

Industry 5.0 is the new global trend emphasizing the future human and machine collaboration. In fact, SDGs 7 "Clean Energy", 9 "Industry and Infrastructure", 11 "Sustainable cities and communities" and 16 "Peace, justice and strong institutions" have the clear advantage in the cases of Industry 4.0 ET application.

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