

## Assessing the Impact of Industry 5.0 on Operational Excellence Practices

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### **Abstract:**

This paper explores the impact of Industry 5.0 on operational excellence by addressing the growing need for businesses to integrate human-centricity, sustainability, and resilience into their operations, especially as they move beyond the automation-focused framework of Industry 4.0 [1, 2]. Industry 5.0 introduces a paradigm where advanced technologies such as Artificial Intelligence (AI), Big Data Analytics (BDA), and Digital Twins (DT) are coupled with human insight and well-being to drive long-term value [3]. However, despite its conceptual appeal, there is a lack of structured research assessing the actual influence of Industry 5.0's key enablers on operational excellence. The main objective of this study is to identify and rank twelve key enablers of Industry 5.0, grouped under sustainability, resilience, human-centricity, and digitalization, according to their impact on operational excellence. These enablers include economic sustainability (S1), environmental sustainability (S2), social sustainability (S3), risk management (R1), adaptability (R2), restorative capacity (R3), human-machine collaboration (H1), work conditions (H2), skill development (H3), simulation and digital twins (D1), artificial intelligence (D2), and big data analytics (D3), drawn from existing literature [1, 2, 3]. To carry out the assessment, the Fuzzy TOPSIS method, a multi-criteria decision-making approach, was adopted that accounts for uncertainty in expert opinions by using Triangular Fuzzy Numbers [4]. This methodology was chosen because it is particularly well-suited for handling uncertainty, vagueness, and subjectivity in expert evaluations. Unlike classical TOPSIS, which relies on crisp numerical values, Fuzzy TOPSIS allows the use of linguistic terms. This latter uses the TFN to convert experts' opinions, providing a more realistic and flexible way to model human judgment. Data was collected from seven experts who evaluated the enablers using linguistic terms, which were then converted into fuzzy values and aggregated into a fuzzy decision matrix. Since the data ranged within [0,1], normalization was deemed unnecessary. The results showed that risk management (R1) had the highest impact on operational excellence with a CC of 99.8%, followed by work conditions (H2) and artificial intelligence (D2) both with 89.3%, while simulation and digital twins (D1) ranked lowest with 0.2%. These findings suggest that human-centric and resilience-focused enablers are perceived as more critical to enhancing operational performance in the Industry 5.0 [5] context than some digital technologies that may still face practical integration challenges [2, 3]. More details are available in our work untitled "Assessing the Impact of Industry 5.0 on Operational Excellence Practices" that was accepted in The International Conference on Intelligent and Fuzzy Systems (INFUS 2025). In conclusion, this paper contributes a structured evaluation of Industry 5.0 enablers using Fuzzy TOPSIS and offers a practical tool for decision-makers aiming to align their operational strategies with emerging industrial paradigms. The study's implications lie in helping organizations prioritize impactful enablers, though it acknowledges the subjectivity inherent in expert judgment and the need for broader validation. As a perspective for future research, a possible direction is to expand the scope of analysis by incorporating additional enablers of Industry 5.0 that were not covered in this study. Another valuable direction would be to apply the model across different industrial sectors or regions, allowing for comparative studies that consider sector-specific challenges and priorities. The integration of real-world case studies or longitudinal data could enhance the validity and practical relevance of the findings, supporting the development of more tailored and actionable Industry 5.0 strategies.

### **References:**

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