OPTIMIZING PRODUCTION PROCESS AND MANAGERIAL DECISION-MAKING IN CONTEXT OF INDUSTRY 4.0 USING AN ERP SYSTEM

TĂNASE ANDREEA GABRIELA
PH.D. STUDENT, BUCHAREST UNIVERSITY OF ECONOMIC STUDIES
e-mail: andreeag.tanase@gmail.com
ORCID: 0009-0007-4346-0735

GRIGORESCU (STĂNESCU) ANDREEA
PH.D. STUDENT, ROMANIAN ACADEMY, SCHOOL OF ADVANCED STUDIES OF THE ROMANIAN ACADEMY, DOCTORAL SCHOOL OF ECONOMIC SCIENCES, NATIONAL INSTITUTE FOR ECONOMIC RESEARCH "COSTIN C. KIRIȚESCU", INSTITUTE OF NATIONAL ECONOMY, BUCHAREST, ROMANIA
e-mail: andreea_grigo@yahoo.com
ORCID: 0009-0003-6135-3918

CREȚU RALUCA-FLORENTINA
PROFESSOR PH.D HABIL, BUCHAREST UNIVERSITY OF ECONOMIC STUDIES
e-mail: raluca.cretu@cig.ase.ro
ORCID: 0000-0002-1751-1021

RĂPAN IVONA
ASSOC. PROF. PHD HABIL. SR IIND, INSTITUTE OF NATIONAL ECONOMY, ROMANIAN ACADEMY
e-mail: rapan.ivona@gmail.com
ORCID: 0000-0001-8436-9494

BANȚA VIOREL COSTIN
LECTURER PH.D HABIL, BUCHAREST UNIVERSITY OF ECONOMIC STUDIES
e-mail:viorel.banta@cig.ase.ro
ORCID: 0000-0003-1337-9374

Abstract

The digital transformation specific to Industry 4.0 is driving industrial organizations to adopt smart technologies to optimize production processes and improve managerial decision-making. This article analyzes how the implementation of a modern ERP system, integrated with artificial intelligence solutions, robotic process automation, and cloud-based technologies, contributes to increased operational efficiency and organizational performance. The case study highlights the integration of the SAP ERP platform with related applications, as well as the use of SAP Signavio-type process management tools for modeling, monitoring, and optimizing operational flows. From a managerial perspective, the implemented system architecture provides extensive visibility into economic and production processes, facilitating data-driven decisions based on real-time data and performance indicators. The research is based on an interventionist approach, complemented by quantitative methods for analyzing the relationships between operational and managerial variables. The economic processes modeled in the ERP system, the intelligent technologies adopted, and their impact on employee activity and production flows are analyzed. The results obtained indicate a significant reduction in execution times, improved information traceability, and an increase in the quality of managerial decisions supported by integrated process and data analysis. In conclusion, the combined use of the SAP ERP system and the SAP Signavio platform, together with associated intelligent technologies, is a determining factor for optimizing production processes and supporting effective management in the context of Industry 4.0, providing organizations with an adaptive digital framework geared towards continuous improvement.

Keywords: *SAP, Signavio, AI – artificial intelligence, ERP – Enterprise Resource Planning, RPA – Robotic Process Automation, Industry 4.0.*

Clasificare JEL : *M21, M31, M15*

1. Introduction

The fast evolution of digital technologies has brought big changes in the way industrial production processes are organized and managed. Within the context of Industry 4.0, companies are face increasing pressure to enhance efficiency, flexiblility, and responsiveness to adapt to the ever-changing market. These challenges are driving organizations to adopt integrated system architectures capable of supporting both the execution of production processes and managerial decisions-making based on real-time data. Modern ERP systems represent a core component of these digital architectures, providing a unified platform for managing economic, logistical, and production-related processes. By integrating functional modules dedicated to sales, procurement, production planning, and accounting, ERP systems enable the correlation of operational flows with financial and managerial information. As a result, organizations can achieve end-to-end traceability of activities and obtain a coherent picture of overall performance. The development of artificial intelligence and robotic process automation technologies amplifies the potential of ERP systems, transforming them from simple transactional tools into intelligent decision-support platforms. Advanced analytics algorithms enable trend identification, planning optimization, and operational risk anticipation, while automation solutions contribute to improving the efficiency of repetitive activities. At the same time, SAP Signavio process management tools enable detailed analysis of actual production flows through modeling and process mining techniques, highlighting process variation, bottlenecks, and deviations from standard procedures. By correlating operational data extracted from ERP system with process performance metrics, management decisions regarding optimization are grounded on empirical data, not just on theoretical models. However, the literature reveals a significant gap regardind the integrated use of ERP systems and process analysis platforms in assessing the concrete impact on production optimization and managerial decisions-making. Most studies tend to focus either on ERP implementation or on isolated artificial intelligence applications, without proving a coherent analysis of real process flows and their performance in industrial environment. In this context, the research problem addressed in this article is to determine how the integration of an ERP system with process analysis tools, such as SAP Signavio, and intelligent technologies influences the effective optimization of production processes and the quality of managerial decisions. The aim is to identify the relationship between integrated digital architecture and actual operational performance, as measured by process indicators extracted directly from the production environment. Therefore, the study proposes an applied approach based on the analysis of real production processes, starting from the sales order (the initial customer request), inventory analysis, production, storage, and product delivery for a customer. Data extrcated from both the ERP system and SAP Signavio are used to assess the impact of intelligent technologies on operational and managerial efficiency. This approach contributes to strengthening the theoretical framework of Industry 4.0 by demonstrating the practical value of integrating ERP systems , process mining, and artificial intelligence in optimizing industrial processes.

2. Literature review

The literature highlights that, in Industry 4.0, ERP systems are no longer viewed solely as transactional solutions for recording economic operations, but as platforms for integrating data and processes, capable of connecting operational activities (production, procurement, delivery) with management and control processes. A consistent line of research emphasizes that the value of ERP increases significantly when it is integrated with Industry 4.0 technologies such as IoT, cloud, and advanced data analytics, as this promotes real-time visibility and coordination of decisions across functions [1].

At the same time, review studies show that ERP–Industry 4.0 integration has direct potential for operational efficiency and supply chain resilience, but remains conditional on factors such as interoperability, data security, architectural complexity, and workforce readiness [2]. This type of conclusion supports the need for methodological frameworks that simultaneously address technology, processes, and the managerial dimension [1] [3]. A central component of Industry 4.0 is the shift from decisions based on periodic reports to decisions supported by up-to-date data and predictive analytics. Recent research emphasizes that the effectiveness of Industry 4.0 technology implementation depends significantly on the quality of the decision-making process, as organizations must transform large volumes of data into relevant operational actions [4].

The digital transformation specific to Industry 4.0 has led to the integration of ERP systems as a central tool for optimizing production processes and supporting managerial decisions. Recent studies highlight that modern ERPs facilitate real-time collection of operational data, increasing the visibility of production flows. Several authors emphasize the role of automation and advanced analytics in reducing losses and improving resource efficiency. The integration of IoT technologies with ERP platforms enables continuous equipment monitoring and predictive maintenance [5]. Research shows that quick access to performance indicators supports data-driven strategic decision-making. ERPs also contribute to supply chain coordination and rapid adaptation to market demands. Some studies highlight challenges related to implementation costs and organizational resistance to change. However, the long-term benefits often outweigh the initial barriers [6]. The literature suggests that successful implementation depends on aligning technology with business processes. Thus, we can say that ERPs are an essential pillar of smart manufacturing in the context of Industry 4.0 [7]. Another significant documented aspect is the ability of ERPs to support integrated planning between the operational and strategic levels of the organization. By centralizing information, ERPs facilitate analysis tools that allow for the anticipation of production bottlenecks and the dynamic adjustment of work schedules, which is crucial in an Industry 4.0 environment. [8]. However, the literature also points to significant barriers: complex technological integration, interoperability issues between systems, high implementation and adaptation costs, and the need to develop digital skills at the organizational level. These managerial and technical challenges may limit the widespread adoption of Industry 4.0 solutions without a clear strategy and adequate resources [9]. In conclusion, integrating ERP systems with key Industry 4.0 technologies significantly contributes to optimizing production processes and making data-driven management decisions, transforming ERPs from simple operational support tools into essential components of smart factories. The literature suggests that the success of these integrations depends largely on system architectures, data analysis capabilities, and organizational readiness for change[10].

3. Process Intelligence analysis of operational flows in the context of Industry 4.0

This research used the Process Intelligence component of the SAP Signavio platform to analyze operational flows within the sales and distribution area, which is closely interconnected with the production processes specific to the Industry 4.0 paradigm. The image presented in Figure 1 illustrates a process map automatically generated based on data extracted from the ERP system (in this case, a 10-year-old SAP ECC system), highlighting the actual sequence of activities including delivery, goods movement, invoicing, and financial clearing. As shown in the figure included in this research, there is a clear highlighting of the links between activities, reflecting the frequency of their execution, allowing the identification of dominant routes and process variations. The analysis reveals the presence of operational loops and deviations from the standard process flow, which are relevant for performance optimization and the reduction of operational inefficiencies.

This example demonstrates the capability of Industry 4.0 technologies to transform ERP data into valuable operational information for management, thereby supporting decision-making based on actual process execution data. Integrating process mining analysis with ERP systems provides a

dynamic perspective on the performance of sales and distribution processes, with a direct impact on production planning and customer satisfaction. Thus, SAP Signavio Process Intelligence becomes an essential tool for identifying bottlenecks, optimizing flows, and operational alignment within the context of smart factories.

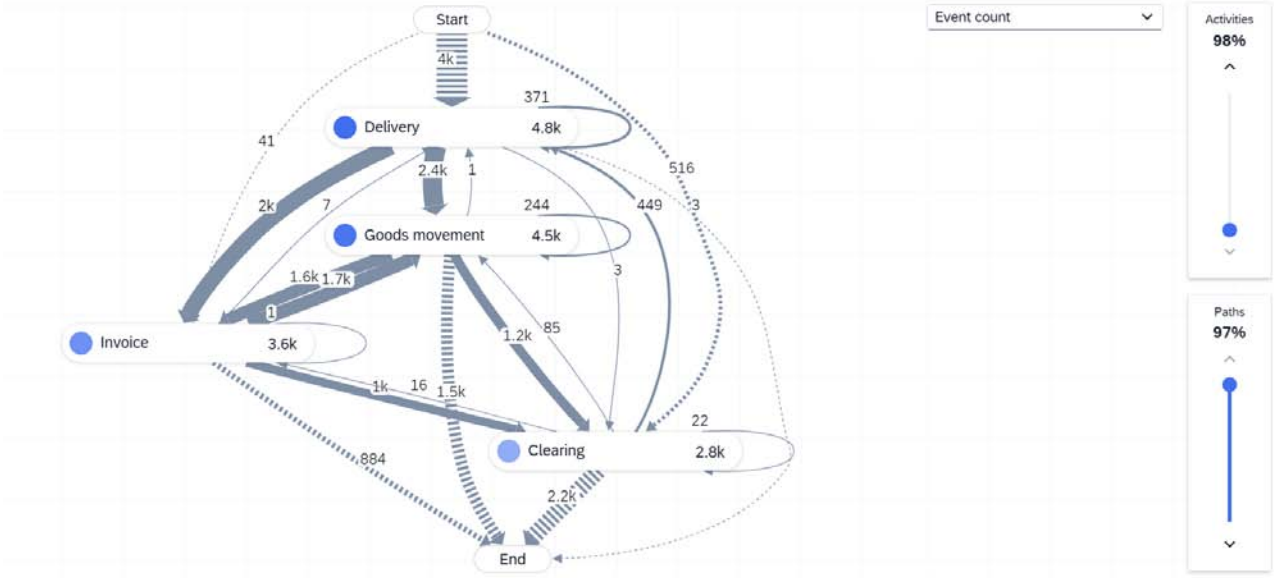

Figure no. 1 Integrating Process Intelligence into the optimization of production and distribution processes.

The business process generated by SAP Signavio Process Intelligence, as shown in Figure 1, provides a detailed overview of operational flows within the sales and distribution area, processes that are directly related to production planning and execution. The analyzed activities, including delivery, goods movement, invoicing, and financial clearing, reflect not only commercial operations but also stages that influence inventory levels, production orders, and industrial capacity utilization. Integrating these processes into an ERP system allows market demand to be synchronized with production processes, an essential principle of Industry 4.0. It can be seen that the high volumes of events, as shown in Figure 1, between delivery and movement of goods indicate a strong interdependence between logistics and production execution, where delays or deviations can have knock-on effects on production scheduling. Operational loops identified in the image may signal repeated stock adjustments or corrections in delivery documents, which can lead to interruptions in production flows. From an Industry 4.0 perspective, these variations become visible in real time through the integration of operational data, providing opportunities for rapid and automated interventions. The use of Process Intelligence allows sales and distribution events to be correlated with production-related data, such as execution times, capacity levels, or resource availability. This approach supports the transition to smart production systems, in wh managerial decisions are based on actual operational data rather than estimates. Consequently, the analysis highlighted in the image demonstrates how Industry 4.0 technologies, when integrated with ERP and process mining techniques, contribute to the coordinated optimization of production and distribution processes, improving both operational performance and organizational responsiveness. The analysis performed using SAP Signavio Process Intelligence provides operational management with detailed visibility into how workflows actually function, enabling the rapid identification of process steps that cause delays, errors, or process rework. By comparing dominant process paths with secondary process variants, points where the standard workflow is frequently deviated from can be highlighted. These deviations signal indicate process malfunctions such as logistical

bottlenecks, lack of synchronization with production, or ERP data quality issues. Process mining tools transform large volumes of operational data into easy-to-interpret visual information, supporting corrective decisions based on facts, not subjective perceptions. Management can thus prioritize interventions on critical stages that affect the overall performance of the process. In addition, continuous analysis allows the impact of implemented measures to be monitored and processes to be dynamically adjusted. The effective use of such intelligent tools requires the development of specific skills among users, such as understanding business processes, data analysis, and interpreting performance indicators. Digital skills related to the use of ERP platforms, data source integration, and the application of advanced analytical tools are also required. In the context of Industry 4.0, operational managers must combine functional expertise with analytical skills to fully leverage the potential of Process Intelligence solutions. Thus, analysis with SAP Signavio not only optimizes operational flows, but also contributes to the transformation of organizational skills towards a data- and innovation-oriented model.

4. Conclusions

This research highlights the essential role of ERP systems integrated with Process Intelligence solutions in optimizing operational processes in the context of Industry 4.0. The performed analysis using SAP Signavio has demonstrated the ability of digital technologies to transform transactional data into relevant information for operational and strategic management. Visualizing actual sales and distribution flows has enabled the identification of process deviations, operational bottlenecks, and stages with a major impact on organizational performance. The results underscore the strong interdependence between commercial and production processes, confirming the need for an integrated approach within modern ERP systems. Real-time data integration, specific to the Industry 4.0 paradigm, supports the synchronization of demand with production capacities and contributes to increased operational flexibility. At the same time, the use of process mining provides an objective basis for managerial decisions based on concrete facts. Another important aspect highlighted is the impact of these technologies on the required skills in industrial organizations. Operational management must develop analytical, digital, and data interpretation skills to effectively leverage intelligent tools. Thus, digital transformation involves not only technological implementation, but also adapting human capital to the new requirements of Industry 4.0. In conclusion, integrating ERP systems with Process Intelligence solutions, such as SAP Signavio, is a key factor in increasing process performance, optimizing production, and strengthening managerial decisions. The study confirms that the intelligent use of operational data is a major competitive advantage in today's industrial environment and provides relevant directions for future research on decision automation and intelligent production systems.

Limitations of the study: A first limitation of this research is that the analysis was performed on a specific set of processes in the sales and distribution area, which may restrict the generalization of the results to other functional areas, such as procurement or production itself. Although these processes are closely interlinked with production, internal manufacturing flows were not directly analyzed in detail. Another limitation is related to the study's dependence on the quality and completeness of the data extracted from the ERP system. Possible recording errors, lack of accurate timestamps, or inconsistencies in process logs can influence the accuracy of the process maps generated by SAP Signavio. In addition, the research focused primarily on the qualitative and visual analysis of operational flows, without integrating detailed quantitative indicators such as average cycle times, rework rates, or capacity losses. This approach limits the assessment of the numerical impact of the proposed optimizations. Furthermore, the study did not include a comparative analysis between multiple organizations or industries, which could have provided a broader perspective on the applicability of Process Intelligence solutions in different industrial contexts.

Future Research Directions and Future Work: Future research may extend the analysis to the actual production processes, integrating data directly from industrial equipment and IoT systems to obtain a complete picture of Industry 4.0 flows. This approach would allow a direct correlation between production performance and the business processes analyzed in ERP. Another important step is the integration of quantitative performance indicators, such as lead time, cost per process, defect rate, or capacity utilization, to assess the concrete impact of managerial interventions on operational efficiency. Furthermore, the application of artificial intelligence and machine learning techniques in combination with process mining could support the prediction of bottlenecks and the automation of operational decisions. Thus, ERP systems could evolve into proactive decision support platforms. Future studies could include comparative analyses between several companies or industrial sectors to identify common optimization models and best practices in the implementation of Industry 4.0 solutions. Last but not least, it is necessary to investigate the impact of digital transformation on organizational skills, managerial culture, and the adoption of advanced analytical tools. This direction would contribute to understanding the human factors that influence the success of Industry 4.0 initiatives.

5. Bibliography

[1] **Balaha, F., et al.,** An analytical review of data integration for decision support in smart manufacturing, Decision Analytics Journal, Volume 17, December 2025, 100647, https://doi.org/10.1016/j.dajour.2025.100647

[2] **Gervalla, M., & Ternai, K.,** The Impact of Industry 4.0 to the ERP Approach, SEFBIS Journal, 2019, Issue 13, p56

[3] **Handoyo, S., et al.,** A business strategy, operational efficiency, ownership structure, and manufacturing performance: The moderating role of market uncertainty and competition intensity and its implication on open innovation, Journal of Open Innovation: Technology, Market, and Complexity, Volume 9, Issue 2, June 2023, 100039, https://doi.org/10.1016/j.joitmc.2023.100039

[4] **Tashkinov, A.G.,** The application of industry 4.0 into the company's production activities through effective decision-making, Scientific Reports volume 15, Article number: 34202 (2025). https://doi.org/10.1038/s41598-025-15688-0

[5] **Upadhyay, A., et al.,** Implementing industry 4.0 in the manufacturing sector: Circular economy as a societal solution, Computers & Industrial Engineering, Volume 177, March 2023, 109072, https://doi.org/10.1016/j.cie.2023.109072

[6] **Madanhire I., & Charles Mbohwa C.,** Enterprise Resource Planning (ERP) in Improving Operational Efficiency: Case Study, Procedia CIRP, Volume 40, 2016, Pages 225-229, https://doi.org/10.1016/j.procir.2016.01.108

[7] **Polívka M., & Dvořáková L.,** The importance of Industry 4.0 technologies when selecting an ERP system – An empirical study, E&M Economics and Management, Technical University of Liberec, Faculty of Economics, vol. 26(3), pages 51-69, September, 2023, DOI: 10.15240/tul/001/2023-3-004

[8] **Frank A.G., et al.,** Industry 4.0 technologies: Implementation patterns in manufacturing companies, International Journal of Production Economics, Volume 210, April 2019, Pages 15-26, https://doi.org/10.1016/j.ijpe.2019.01.004

[9] **Anbesh J., et al.,** Industry 4.0 Technologies for Manufacturing Sustainability: A Systematic Review and Future Research Directions, Applied Sciences, 2021, 11(12), 5725, https://doi.org/10.3390/app11125725

[10] **Zhonh Y.R., et al.,** Intelligent Manufacturing in the Context of Industry 4.0: A Review, Engineering, Volume 3, Issue 5, October 2017, Pages 616-630, https://doi.org/10.1016/J.ENG.2017.05.015