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Taras Shevchenko National University of Kyiv***Oleh Hustera,***PhD in Economics, Associate Professor, Department of Statistics, Information-Analytical Systems and Demography,
Taras Shevchenko National University of Kyiv***THE ROLE OF PROCESS MINING IN PROCESS TRANSFORMATION
AND ESG INTEGRATION FOR SUSTAINABLE DEVELOPMENT
OF UKRAINIAN ENTERPRISES**

This article examines the transformative role of Process Mining and digital process management in the context of integrating Environmental, Social, and Governance (ESG) criteria into the operations of Ukrainian enterprises. The research addresses the growing necessity for organizational transparency, efficiency, and predictability as global requirements for sustainable development and standardized ESG reporting intensify. The primary objective is to substantiate the strategic importance of Process Mining as a tool for ensuring the consistency and sustainability of modern business models.

The study analyzes contemporary scientific approaches to digital transformation and the integration of ESG indicators throughout the product life cycle. It is demonstrated that the combination of process-oriented management, advanced data analytics, and digital platforms significantly increases the accuracy of ESG data collection, optimizes operational decision-making, and strengthens the competitive position of companies in international markets. Furthermore, the research investigates how Process Mining facilitates the discovery of real business processes, allowing for the identification of inefficiencies that hinder sustainable growth.

The results indicate that embedding ESG principles directly into automated business processes enhances organizational resilience and fosters long-term institutional stability. By improving reputational standing and ensuring compliance with international disclosure standards, Ukrainian enterprises can better navigate the challenges of post-war recovery and European integration. Ultimately, the study concludes that Process Mining serves as a vital bridge between operational excellence and the achievement of strategic sustainability goals, providing a data-driven foundation for ethical and efficient corporate governance.

Keywords: ESG, process management, Process Mining, digital transformation, sustainable development, Ukrainian enterprises.

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РОЛЬ PROCESS MINING У ПРОЦЕСНІЙ ТРАНСФОРМАЦІЇ ТА ІНТЕГРАЦІЇ ESG ДЛЯ СТАЛОГО РОЗВИТКУ ПІДПРИЄМСТВ УКРАЇНИ

У статті розглядається роль процесного управління та цифрової трансформації бізнес-процесів у контексті інтеграції ESG-критеріїв. Постановка проблеми визначає необхідність підвищення прозорості, ефективності та передбачуваності діяльності компаній в умовах зростаючих вимог до сталого розвитку та ESG-звітності. Мета дослідження – обґрунтувати значення процесного управління і застосування Process Mining для забезпечення ефективності, прозорості та стійкості бізнесу. У статті проаналізовано сучасні наукові підходи, методи цифрової трансформації та інтеграції ESG-показників у життєвий цикл продукту. Результати дослідження показують, що поєднання процесного управління, аналітики та цифрових платформ дозволяє підвищити точність і узгодженість ESG-даних, оптимізувати операційні рішення та змінити конкурентні позиції компаній. Результати дослідження свідчать, що інтеграція ESG-принципів у бізнес-процеси підвищує ефективність організацій, сприяє їхній довгостроковій стабільності та зміцнює репутаційні позиції на ринку.

Ключові слова: ESG, процесне управління, цифрові рішення, сталий розвиток.

Statement of the problem. The development of process management in Ukraine is key to ensuring transparency, efficiency and predictability of organizations' activities. At the same time, global trends in sustainable development and the spread of ESG standards challenge companies to integrate environmental, social and management metrics into business processes, as well as create digital architectures capable of supporting the Record – Report – Act logic. The growth of ESG data volumes, new reporting requirements European Sustainability Reporting Standards (ESRS), Corporate Sustainability Reporting Directive (CSRD) and risks of "greenwashing" emphasize the need for high-quality analytics and process transparency. Traditional methods of data management and processing do not allow for a full assessment of the impact of companies on sustainable development, identify process risks and ensure consistency of ESG indicators. This forms a key scientific question: how digital transformation of business processes, which includes process management and the use of Process Mining, can ensure efficiency, compliance with ESG requirements and promote the sustainable development of organizations in Ukraine.

Analysis of recent research and publications. In modern scientific literature, Process Mining is considered a key technology for digital transformation, providing deep analysis of business processes based on event logs. The theoretical and methodological foundation of the field was laid by the works of Van der Aalst [18; 19], who formed the conceptual foundations of process discovery, compliance verification and improvement, and also determined the place of Process Mining in the broader context of data science. The Process Mining Manifesto [1] outlined strategic principles and challenges that continue to determine the vector of development of this field. Further research focuses on deepening the applications of Process Mining in various sectors of the economy. In production systems, Process Mining is used to create digital models and support operational decisions, in particular through event-centric and data-driven approaches [2; 5], as well as through multi-flow analysis and simulation models [6]. In works devoted to the healthcare industry, the effectiveness of Process Mining for optimizing clinical procedures and improving medical processes [11] has been shown. In the field of financial technology, Process Mining has demonstrated effectiveness in reducing fraud risks and detecting anomalies in digital interactions [13].

A separate direction is research aimed at overcoming the limitations of classical workflow approaches and expanding the analytical capabilities of Process Mining. In particular, object-centric and multi-flow Process Mining [6; 16] are actively developing, which allows taking into account the interaction of several objects and flows in a real environment. Considerable attention is paid to the automation of building digital production models and integrating sensor data into event logs [2; 5]. In the latest research, Process Mining is also integrated with machine learning and predictive analytics, which provides the possibility of early detection of anomalies, route optimization and increased flexibility of business processes [3; 14; 15]. Along with this, a conceptual foundation is being formed for assessing the impact of Process Mining implementation on organizational development and business process transformation [7; 10].

In general, a review of current publications indicates the rapid evolution of Process Mining – from a retrospective analysis tool to a comprehensive technology that supports operational management, strategic planning and digital transformation of organizations [10-20]. The development of new methodologies – multi-flow analysis, object-oriented models, hybrid algorithms and automated generation of digital models – determines the key directions of further research in the field of Process Mining.

Purpose and objectives of the study. The purpose of the article is to substantiate the role of process analytics in transforming business processes and increasing total-factor productivity (TFP) in Ukraine, as well as to identify opportunities for using Process Mining to ensure transparency, identify process risks and improve the quality of ESG data. The objectives of the study: to analyze the relationship between process management, sustainable development and ESG reporting requirements; to determine the role of Process Mining in increasing process

transparency, compliance with ESRS/CSRD requirements and identifying deviations in ESG data; to characterize digital technologies and analytics tools that support the integration of ESG criteria into business processes; to show the integration of ESG indicators into the product life cycle and assess their impact on TFP.

Presentation of the main material. Process management at the macro level in Ukraine is closely related to the need to increase total-factor productivity (TFP), which remains low compared to developed countries, and depends on improving institutions and legislation. In general, the development of the state depends on business productivity, where the state is responsible for creating a favorable business climate. Global and Ukrainian professional organizations contribute to the spread of process thinking in both companies and government institutions, striving for systematicity and transparency in management. This systemic approach has a direct connection with sustainable development, since sustainable development requires process management to build a "sustainable business architecture". Companies with a high level of process maturity are ready for stable growth, scaling, cost optimization and ensuring high quality, which is critical for ensuring long-term sustainability.

In this context, Process Mining becomes particularly important as a tool that allows you to verify the actual course of business processes in accordance with ESG requirements. Based on event logs, the technology ensures the detection of inefficiencies, deviations and hidden process risks that directly affect the transparency, accuracy and completeness of ESG data. Thus, Process Mining complements traditional process management with actual evidence of process behavior, which is critical for increasing TFP and meeting the requirements of sustainable development.

Conceptual foundations of ESG and strategic drivers of transformation. Environmental, social and governance indicators are now a key approach to assessing the non-financial performance of companies, reflecting not only the level of business responsibility, but also its ability to respond to risks and societal expectations. The ESG concept covers three interrelated areas (environmental, social and governance) and is aimed at minimizing negative impact, increasing transparency and building stakeholder trust. In the strategic dimension, ESG is integrated into business policies and operational processes, which expands the traditional understanding of a company's success, complementing financial indicators with sustainable development values [4].

The growing focus on ESG is driven by rising expectations from investors, consumers and regulators. Investors are increasingly relying on ESG analytics and recognizing the importance of high-quality ESG data for decision-making. Consumers are also demanding responsible brand behavior: almost half of respondents expect businesses to demonstrate real leadership in sustainability, creating additional opportunities for companies that meet these requirements to grow their market value.

Regulatory initiatives are reinforcing the need for systemic transformation. In the EU, in particular, the Corporate Sustainability Reporting Directive introduces mandatory standards for assessment and disclosure. Ukraine is also harmonizing its legislation with European requirements, forming a regulatory framework for the implementation of CSRD and ESRS standards. Compliance with these requirements is becoming not only a legal obligation, but also a necessary condition for companies to access the EU market.

The implementation of ESG approaches is becoming a competitive advantage and a strategic positioning tool. Companies determine their own level of integration of sustainable development – from minimal compliance to full inclusion of ESG factors in all decision-making processes and the formation of ambitious long-term goals. Such a transition from reactive to proactive management becomes the basis for the transformation of business models, increasing their sustainability, reputational attractiveness and compliance with global standards.

The impact of ESG on process models and their transformation. ESG requirements are increasingly influencing the organization of business processes, as companies are forced not only to measure sustainability indicators, but also to restructure their operations to achieve them. More than half of the companies surveyed recognize such changes as difficult, but it is precisely the transformation of processes that allows them to move from declarative to managed management of ESG performance.

Process Mining plays a key role in translating ESG requirements into a manageable process model, as it allows you to automatically verify whether the required environmental, social and governance actions are being performed in real operational chains. Conformance checking tools provide control over compliance with regulations, and anomaly detection algorithms allow you to identify operations that create increased ESG risk or may indicate greenwashing.

A process-oriented approach to ESG integration is based on the combination of operational activities with information systems, in particular ERP solutions, which allow for building management based on ESG data. At the heart of this approach is the rethinking of processes through the logic of recording, reporting and action. The recording stage forms a sustainability accounting system that is combined with financial data and ensures the collection of detailed information from various sources. The reporting stage involves fulfilling regulatory requirements through reliable aggregation, reconciliation and auditing of data throughout the organization. The



action stage focuses on implementing sustainability goals within each business process, combining financial results with environmental indicators and allowing for the optimization of decisions taking into account environmental impact.

Full process transformation requires modernization of IT architecture. One of the key problems is that ESG indicators are not embedded in decision-making processes. Modern IT solutions allow for end-to-end interaction between departments, systematically define measurement parameters, organize comprehensive collection, processing and consolidation of ESG information in real time, and integrate ESG management into the company's digital processes. An important component is the inclusion of a greenhouse gas framework in management systems and the addition of carbon accounting mechanisms to financial modules.

Transactional carbon accounting plays a special role, ensuring that the carbon footprint is captured, reported and analysed alongside financial performance for each business transaction. This approach enables decision-making at a high level of granularity, including at the cost centre level, and makes sustainability management part of everyday operations.

In today's digital architecture, Process Mining is integrated into ERP and ESG accounting systems as a layer of operational control: it allows you to verify actual transactions with the process model, monitor the correctness of carbon footprint calculations, and timely detect data gaps and deviations from procedures. For companies, this means the ability to generate fully traceable, audit-ready ESG reporting in real time.

Integrating ESG analytics into the process of developing a technical solution. In the context of business process transformation and increasing ESG compliance requirements, the integration of environmental, social and governance aspects at all key stages of the product life cycle is becoming critical. An example of such integration is the process of developing a technical solution, in which new or changed product requirements serve as a trigger for the formation of technical specifications and relevant documentation. At the initial stage of forming product requirements, ESG criteria are introduced: environmental indicators take into account the use of recycled materials, waste minimization, energy efficiency and recyclability; social indicators – safety and accessibility of the product for end users; management indicators – a clear definition of responsibility for ESG aspects in subsequent processes.

At the central stage of developing and refining a technical solution, a systematic assessment of the product's impact on ESG indicators is carried out, which involves the use of Life Cycle Assessment (LCA), matrices or checklists for analyzing environmental, social and management impacts, as well as compliance with internal policies and international standards (ISO 14001, SA8000). A critical element is the implementation of ESG gates that block the advancement of the solution without a positive assessment of compliance with sustainable development criteria (Fig. 1).

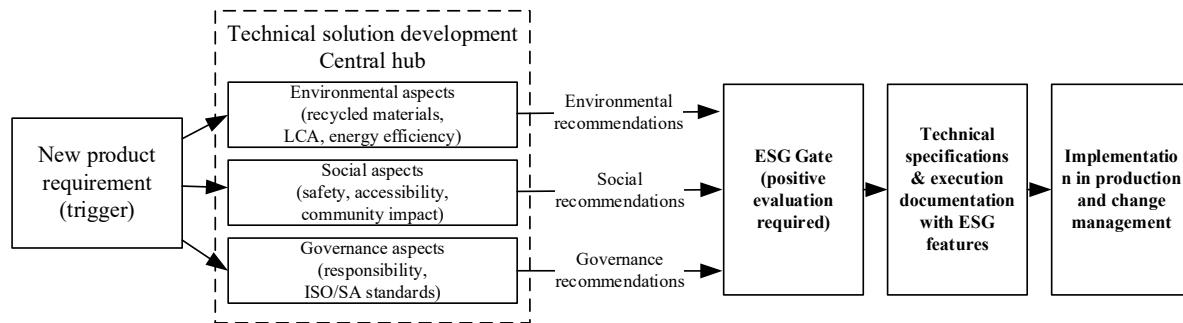


Fig. 1. Integration of ESG analytics into the process of developing a technical solution

Source: built by the authors.

The final output documentation includes the recorded ESG characteristics of the product and process, which provides transparency, control and the possibility of further use in production and change management. ESG impact assessment also extends to requests for changes to technological or design documentation, ensuring continuous adherence to the principles of sustainable development. Such an integrated approach allows to increase the total factor productivity (TFP) of companies, as technical solutions, management processes and environmental and social aspects of activities are simultaneously optimized, which is critical for the long-term sustainability of the business.

ESG reporting, data challenges and the role of analytics. Sustainability reporting requirements are rapidly increasing, and reporting standards are becoming more complex and detailed. In the European Union, the Corporate Sustainability Reporting Directive (CSD) is central, requiring companies to apply the ESRS standards. These

standards cover over a thousand indicators and provide for the assessment of both financial aspects and the impact of a company's activities on the environment and society in accordance with the principle of dual materiality. In Ukraine, the implementation of the CSRD and ESRS is creating new requirements for corporate reporting, including the need for machine-readable data and full disclosure to prevent "green camouflage" practices.

The increasing reporting requirements come with a number of challenges. Companies face a lack of quality and granularity in ESG data, as well as the need to process large volumes of information, which is challenging for most organizations. Despite the scale of the challenges, a significant portion of companies continue to rely on spreadsheets, which limits the accuracy, consistency, and speed of reporting. One of the most significant barriers is ensuring compliance with CSRD requirements, as most organizations recognize the difficulty of collecting reliable data. Process Mining is a tool for ensuring the quality of ESG data: it allows you to automatically check the completeness of records, their origin, the consistency of process chains, the presence of missed events and compliance with regulatory requirements. Combined with machine learning, Process Mining strengthens the process of assessing double materiality, providing previously unattainable depth of analysis of ESG risks. Additionally, there is a shortage of specialists capable of implementing ESG approaches at the level of business processes and IT systems.

In this environment, analytics and digital technologies are becoming key tools that are radically changing the process of preparing ESG reporting. Intelligent platforms such as SAP Sustainability Control Tower allow you to automate the collection, verification and reconciliation of data, providing high granularity and deep integration with existing IT systems. Artificial intelligence significantly reduces the time required to assess dual materiality by automatically analyzing documents and classifying information, as well as scanning public disclosures of competitors. AI technologies support the preparation of draft reports, which can reduce the amount of manual work by up to a quarter.

A key benefit of digital solutions is the ability to create dynamic dashboards that track progress and identify gaps in reporting readiness. Carbon footprinting software plays a key role, as it can quantify corporate and product emissions at scale across the Greenhouse Gas Protocol categories. This level of granularity ensures compliance with stringent regulatory requirements and strengthens the analytical foundation for strategic sustainability management.

Conclusions. The development of process management is key to increasing the transparency, efficiency and predictability of companies' activities. The integration of ESG criteria into business processes allows to minimize the negative impact on the environment and society, increase the trust of stakeholders and strengthen competitive positions. Digital technologies, Process Mining and analytics ensure the reliability, consistency and effectiveness of ESG data, contributing to the adoption of informed management decisions. Process Mining is a critical tool for ensuring ESG data transparency, monitoring processes for compliance with ESRS/CSRD requirements, and identifying anomalies that impact sustainability and performance. Its integration enables the transition from declarative to evidence-based ESG performance management. The implementation of ESG approaches into the product life cycle and operational processes creates the prerequisites for sustainable business development and long-term stability of companies.

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