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The use of Open Data for strategic planning of machine-building enterprises in the context of innovative and sustainable development

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Abstract. The relevance was determined by the increasing importance of the machine-building industry in promoting innovative development, strengthening national economic competitiveness, and supporting integration into global value chains. Under conditions of digital transformation and the transition toward sustainable development during 2020-2025, the use of openly accessible data emerged as an important instrument for improving the effectiveness of strategic planning at industrial enterprises. The aim was to investigate the potential of openly accessible data for increasing the effectiveness of strategic planning in machine-building enterprises under conditions of innovation and sustainable development. The study was based on statistical and analytical data from the State Statistics Service of Ukraine, Eurostat, the World Bank, the OECD, UN Comtrade, and WIOD. The methodological framework included general scientific and specialised methods, namely analysis and synthesis, comparative and statistical analysis, systemic and structural-logical approaches, economic and analytical methods, as well as strategic assessment instruments for evaluating political, economic, social, technological, strengths, weaknesses, opportunities, and threats factors. The results demonstrated that the use of openly accessible data significantly improved the informational support of strategic decision-making and contributed to greater adaptability of enterprises to changing market conditions. An algorithm for strategic planning of machine-building enterprises based on data integration and analytical processing was developed and substantiated. A strategic development map for the industry was designed, reflecting interconnections among financial, production, innovation, customer-oriented, and environmental priorities. The study also assessed the development indicators and structural characteristics of Ukraine's machine-building industry in 2020-2025 and identified its development prospects in the context of European integration and digital modernisation. In addition, the findings confirmed that integrating external data resources into enterprise management strengthened forecasting capabilities, supported evidence-based planning, and increased long-term sustainability and competitiveness. The practical significance of the study consisted in providing methodological and analytical support for managers and policymakers to improve strategic decision-making and enhance the resilience and innovative capacity of machine-building enterprises

Keywords: industrial management; publicly available datasets; evidence-based decision-making; technological modernisation; enterprise competitiveness; digital economy; industrial innovation

Introduction

The machine-building industry continues to be one of the key sectors shaping economic development in the period of industrial and technological transformation of 2020-2025 at both global and national levels. It plays a crucial role in ensuring the production of technological equipment, fostering industrial innovation, and supporting the modernisation of nearly all sectors of the economy. During 2020-2025, its importance increased significantly due to intensifying global competition, rapid digitalisation, and the growing emphasis on sustainable development principles. At the same time, the industry operates under a number of challenges, particularly those related to improving production efficiency,

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adopting advanced technologies, and meeting environmental standards. As noted in recent studies, the manufacturing sector is among the major contributors to environmental impact, which makes the transition to sustainable production models and the integration of Industry 4.0 concepts especially relevant (Kannan *et al.*, 2023).

Under these conditions, machine-building enterprises need to reconsider traditional approaches to strategic planning. Effective strategic planning, aligned with current economic trends, allows firms to achieve long-term competitive advantages, respond more flexibly to external changes, and improve resource utilisation. Moreover, as J. Dhlamini (2025) argued, strategic planning continues to be a critical management tool even in highly dynamic environments, as it supports not only strategy formulation but also its practical implementation. In the context of digital transformation, strategic planning is increasingly becoming data-driven. This shift significantly enhances the quality and validity of managerial decisions. In particular, the use of Open Data is gaining growing attention as a valuable source for analytics and forecasting. Open Data provide access to large volumes of information that can improve transparency, stimulate innovation, and increase organisational efficiency. C. Pascu & J.-C. Burgelman (2022) emphasised that Open Data form the foundation of modern scientific and innovation systems, contributing to knowledge creation, research reproducibility, and the integration of artificial intelligence into decision-making processes. Therefore, Open Data can be considered an essential element in the development of data-driven management approaches.

A review of academic literature published in 2021-2025 shows a steady increase in interest in the role of data in strategic management within machine-building enterprises. For instance, A. Romsdal *et al.* (2025) analysed data quality issues in production planning and demonstrated that, despite the widespread use of ERP systems, companies often rely on additional tools such as spreadsheets to maintain flexibility. Their findings suggest that insufficient data quality and delayed updates can significantly reduce the effectiveness of both strategic and tactical planning, highlighting the need for more robust data management practices. Similarly, M. Tahiduzzaman *et al.* (2025) explored the application of Open Data in optimising production processes. Their results indicated that the use of Open Datasets can improve the accuracy of optimisation models and enhance overall production performance. At the same time, the authors point out that the limited availability of structured Open Data remains a significant barrier to the broader adoption of data-driven approaches in the industry. This issue underlines the importance of developing appropriate Open Data infrastructures for industrial applications. Further insights are provided by J. Baecker *et al.* (2025), who focused on the formation of data strategies in modern enterprises. They identify key types of value creation based on data, including efficiency improvement, innovation development, new product creation, and market control. Their analysis shows that the strategic use of data not only strengthens competitive positions but also supports adaptation to rapidly changing market conditions.

In addition, M.F. Mubarak *et al.* (2025) examined the role of strategic foresight and knowledge management in fostering open innovation. Their empirical findings suggest that integrating external data and knowledge into internal processes can significantly improve the effectiveness of new product development. This confirms the growing importance of open information sources as a driver of innovation and competitiveness. B.M. Rodrigues (2025) also highlighted the impact of data analytics and digital technologies on production planning within the framework of data-driven manufacturing management. The study demonstrates that the use of integrated data systems, predictive analytics, and digital platforms contributes to better alignment between strategic and operational goals, while also reducing costs and improving efficiency. Overall, the findings indicate that adopting a data-driven approach is no longer optional but a necessary condition for maintaining competitiveness.

Thus, the analysis of studies published in 2021-2025 suggests that the use of Open Data represents a promising direction for improving strategic planning in machine-building enterprises. However, several issues remain unresolved, particularly those related to data accessibility, quality, and integration, which require further investigation. The aim of this article is to explore the potential of Open Data in enhancing the effectiveness of strategic planning in machine-building enterprises under conditions of innovation and sustainable development. To achieve this aim, the study addressed the following objectives: to assess the current state and development trends of the machine-building industry using open statistical and analytical datasets; to identify the methodological foundations and key stages of strategic planning in industrial enterprises through the application of systemic and comparative analysis; to determine the analytical potential of Open Data for supporting managerial decision-making at different stages of strategic planning; and to develop and substantiate a practical framework for integrating Open Data into the strategic management process of machine-building enterprises, including environmental assessment, strategy formulation, implementation, monitoring, and adaptation. The accomplishment of these objectives enabled the development of a strategic planning algorithm and the identification of practical directions for applying data-based approaches to improve enterprise competitiveness and long-term sustainability.

Materials and Methods

The methodological framework of this study was based on an interdisciplinary approach integrating the principles of strategic management, digital transformation, data-informed managerial decision-making, and sustainable development. The application of a comprehensive methodological approach ensured the scientific validity, analytical consistency, and reproducibility of the research outcomes and complied with contemporary academic standards.

The empirical basis of the study was formed using open statistical and analytical data from national and international organisations. The research relied on publicly available datasets obtained from the State Statistics Service of Ukraine (n.d.), Eurostat (n.d.), the World Bank (n.d.), the OECD (n.d.), the United Nations (2021), and the World input-output database (n.d.). These sources were selected because they provide standardised, internationally comparable, and regularly updated indicators necessary for assessing macroeconomic conditions, industrial performance, foreign trade, and participation in global value chains. The use of open datasets corresponded to the principles of transparency and reproducibility in scientific research (OECD, 2023; Pascu & Burgelman, 2022).

The study covered the period from 2020 to 2025. This time horizon was selected because it allowed capturing several consecutive stages of industrial transformation: the effects of post-pandemic recovery beginning in 2020, structural disruptions caused by geopolitical challenges and military impacts in 2022-2023, and the early phase of economic stabilisation and recovery expected for 2024-2025. Such a period enabled the assessment of both short-term fluctuations and medium-term strategic changes affecting machine-building enterprises. The information base included statistical databases, analytical reports of international organisations, official government portals, and scientific publications. To ensure the reliability and comparability of open data, a triangulation procedure was applied through cross-verification of indicators obtained from multiple independent sources. Data consistency was checked using harmonised statistical classifications and methodological descriptions provided by official institutions. Indicators measured in different units were standardised into relative indicators, growth rates, indices, and percentage values to ensure comparability across countries and periods.

The methodological framework combined general scientific and specialised research methods. Methods of analysis and synthesis were applied to systematise theoretical approaches to strategic planning and to identify the role of open data in enterprise management (Bryson, 2017; Grant, 2021). Comparative analysis was employed to benchmark Ukraine's machine-building industry against selected European Union countries, while statistical analysis was used to assess macroeconomic and sectoral dynamics based on open datasets. The comparative analysis included Germany, Poland, Czechia as reference countries due to their different levels of industrial specialisation, technological intensity, export orientation, and relevance for Ukraine's economic integration processes. The comparison was conducted according to the following criteria: the share of machine-building in industrial production, the share of high-technology manufacturing, research and development expenditure as a percentage of gross domestic product, export orientation of production, and indicators reflecting digital transformation and industrial modernisation.

The systemic approach ensured a comprehensive examination of relationships among economic, technological, social, and environmental factors influencing the development of machine-building enterprises. The structural-logical method was used to organise the sequence of strategic planning stages and to substantiate the integration of open data into managerial processes. Economic and analytical methods supported the interpretation of quantitative indicators and facilitated the formulation of evidence-based managerial conclusions. Strategic analysis tools occupied a central place in the study. Political, Economic, Social, and Technological analysis was applied to assess external conditions affecting machine-building development. The political dimension included indicators related to industrial policy, regulatory changes, state support measures, and European integration processes based on data from the OECD (n.d.) and the European Commission (2023). Economic factors were evaluated using gross domestic product growth, inflation, foreign direct investment, industrial production, and export indicators derived from the World Bank (n.d.), Eurostat (n.d.), and the State Statistics Service of Ukraine (n.d.). Social factors included employment levels, laubor market indicators, demographic trends, and workforce qualifications obtained from Eurostat (n.d.) and the OECD (n.d.). Technological factors were assessed using indicators of digitalisation, innovation activity, research and development expenditures, and technology implementation derived from Eurostat (n.d.), the OECD (n.d.), and McKinsey & Company (2022).

SWOT analysis was performed to integrate external and internal assessment results. Internal factors (strengths and weaknesses) were selected according to production performance, export capacity, innovation activity, technological readiness, labour productivity, and resource efficiency indicators. External factors (opportunities and threats) were identified through the analysis of macroeconomic trends, digital transformation processes, environmental requirements, international market conditions, and geopolitical challenges. Factor selection was conducted according to three criteria: strategic relevance for machine-building enterprises, statistical support from open data sources, and consistency across at least two independent datasets.

Trend analysis and forecasting methods were additionally employed to estimate development prospects for the period 2024-2025. Forecasting was performed using trend extrapolation based on historical indicator dynamics for 2020-2024 and scenario analysis involving baseline, recovery, and optimistic scenarios. The forecast considered changes in industrial production, exports, investment activity, and macroeconomic conditions and was additionally compared with projections from international analytical sources. Methods of generalisation and data visualisation were applied to structure statistical information and facilitate the interpretation of analytical findings. Their application was intended to support the identification of development tendencies, improve the clarity of analytical interpretation, and strengthen the methodological basis for strategic assessment. Data processing and analytical procedures were conducted using Microsoft Excel for statistical

calculations and database integration, Microsoft Power BI for visualisation and dashboard construction, and open analytical platforms and official statistical portals for data verification and comparative assessment. The use of digital analytical tools contributed to increasing transparency in data processing and supporting evidence-based analysis within the research framework. Thus, the selected materials and methods ensured a comprehensive and systematic investigation of the use of Open Data in strategic planning and created methodological conditions for evaluating their applicability in supporting innovative and sustainable development of machine-building enterprises under digital transformation conditions.

Results and Discussion

Strategic planning during the period of industrial transformation in 2020-2025 is one of the key prerequisites for ensuring the long-term competitiveness of machine-building enterprises in the context of economic system transformation, intensifying global competition, and the growing role of innovation (Bryson, 2017). The strategic planning process of a machine-building enterprise is a systematic process of defining long-term objectives, developing the means to achieve them, and ensuring the efficient use of resources in a dynamic market environment (Grant, 2021). The specificity of the machine-building industry is determined by its high capital intensity, long innovation cycles, complexity of technological processes, and significant dependence on macroeconomic and political factors (European Commission, 2023).

In the context of sustainable development, strategic planning at machine-building enterprises involves the integration of economic, environmental, and social dimensions (United Nations, 2021). This implies that, alongside traditional objectives such as profitability and market expansion, it is necessary to consider resource efficiency, reduction of environmental impact, human capital development, and social responsibility. The effectiveness of strategic planning largely depends on the quality of information support used in managerial decision-making (McKinsey & Company, 2022). One of the key sources of such information is Open Data – data that are freely available for use, processing, and dissemination. For machine-building enterprises, Open Data serve as an important source of information for analysing market trends, assessing the competitive environment, identifying investment opportunities, monitoring public policy, and evaluating environmental risks. The strategic planning process involves the implementation of interrelated stages, among which the key ones include environmental analysis, goal setting, and strategy selection (Grant, 2021). The use of Open Data at the analysis stage makes it possible to obtain up-to-date information on markets, competitors, and technological trends (OECD, 2023). Based on the results of the analysis, strategic objectives are formulated, which should meet the criteria of measurability, achievability, relevance, and time-boundedness (Project Management Institute, 2021). The final stage involves the development of strategic alternatives and the selection of the optimal development strategy for the enterprise. Figure 1 presents the algorithm of strategic planning at machine-building enterprises under the conditions of Open Data utilisation.

Open Data play an important role in shaping industrial policy by providing access to information on industry conditions, innovation activity, and environmental performance (OECD, 2023). This contributes to more informed decision-making and better coordination between government and business. The figure presents a step-by-step algorithm for the formation and implementation of enterprise strategic decisions based on data. The first stage involves data acquisition and integration, including the collection of Open Data from external sources (government registers, statistical databases, international platforms) as well as internal enterprise data. At this stage, data are harmonised and integrated into a unified data management system, forming the informational foundation for further analysis.

The second stage focuses on data analytics and environmental assessment. Modern analytical tools (SWOT, PEST), business intelligence systems, and predictive models are applied to identify trends, patterns, and potential changes. Based on this analysis, strategic challenges and opportunities are determined, including the identification of market trends, technological drivers, risk assessment, and the formulation of strategic goals in accordance with the SMART approach. The subsequent stages involve the development of strategic alternatives and the selection of the optimal strategy. Various development options (innovation, diversification, digital transformation, sustainability) are generated and evaluated using economic indicators (NPV, ROI), as well as risk and feasibility assessments. The selection of the most appropriate alternative is carried out using multi-criteria decision-making methods and is grounded in an evidence-based, data-driven approach. The final stages cover strategy implementation as well as monitoring, evaluation, and adaptation. Action plans, programs, and projects are developed; resources are allocated; and key performance indicators (KPIs) are established. In addition, digital monitoring of implementation processes is ensured. A feedback loop enables continuous strategy adjustment based on updated data, ensuring flexibility and adaptability in a dynamic environment.

The proposed approach ensures comprehensiveness and integrates data-driven management with strategic planning. Unlike classical models, the proposed algorithm combines the processes of collecting large volumes of open and internal data with analytical tools and decision-making mechanisms within a unified, closed-loop system. Its novelty also consists in incorporating continuous digital monitoring and an adaptive feedback loop, which enables not only the formulation of strategy but also its dynamic adjustment under conditions of uncertainty and rapid environmental change. This approach enhances the validity of managerial decisions and contributes to achieving long-term enterprise sustainability. The Use of Open Data in

strategic planning of machine-building enterprises involves the integration of national and international information resources, providing access to up-to-date macroeconomic, sectoral, and structural indicators (State Statistics Service of Ukraine, n.d.; Eurostat, n.d.; World Bank, n.d.). Global value chain databases, such as OECD TiVA (OECD, n.d.), UN Comtrade, and the WOID (World input-output database, n.d.), also play a significant role.

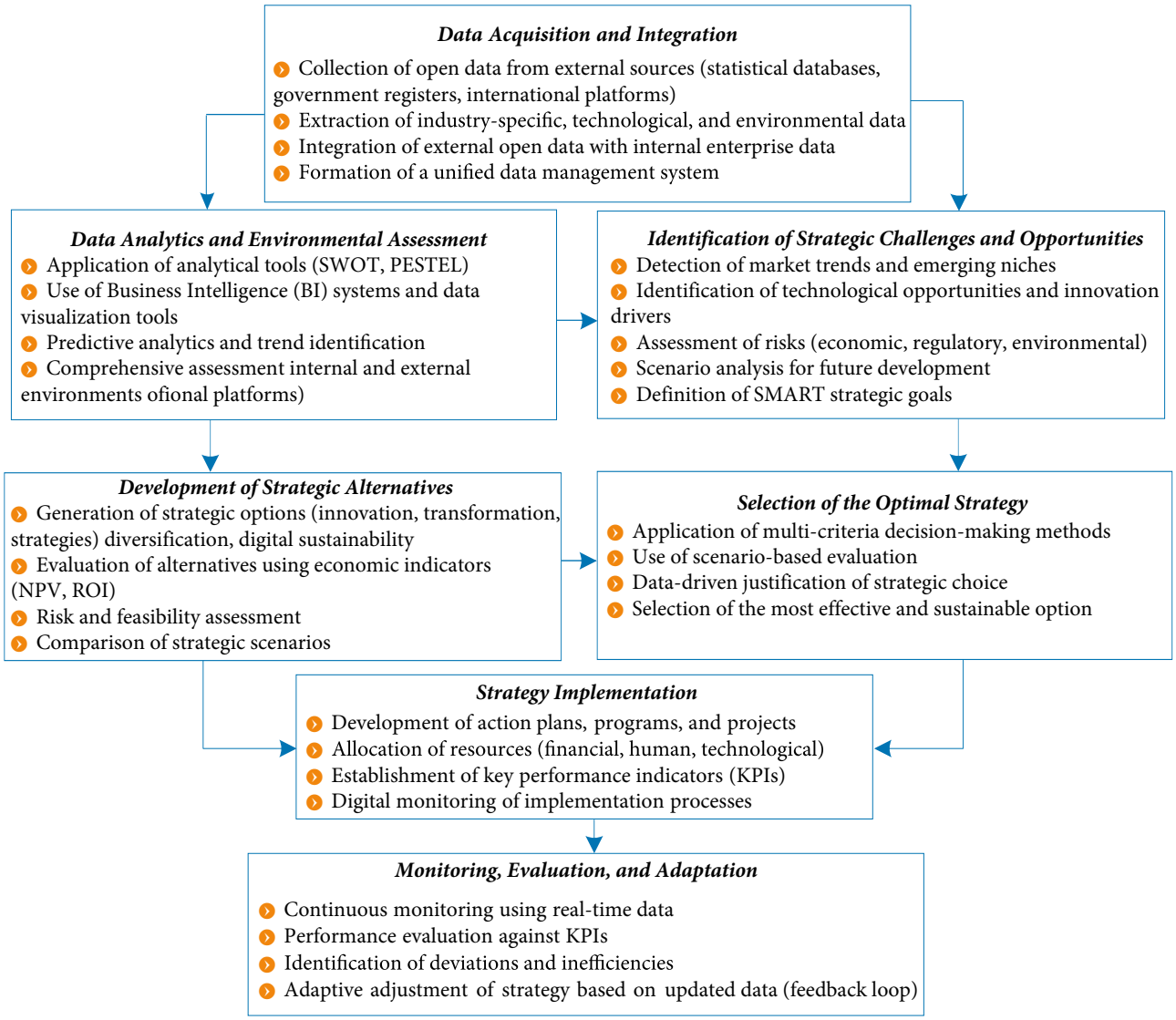

Figure 1. Algorithm of strategic planning at machine-building enterprises under conditions of Open Data utilisation
Source: developed by the author

National statistical resources provide the fundamental informational basis for assessing the state of the machine-building sector in Ukraine. Data from the State Statistics Service of Ukraine cover industrial production indicators, product sales volumes, exports, the number of enterprises, and employment levels. Using data from the State Statistics Service of Ukraine in strategic planning enables the assessment of domestic market capacity, its structural characteristics, market saturation levels, and growth potential. Analysis of key indicator dynamics allows for understanding production cycles, technological structure changes, and enterprise innovation activity. These data also facilitate competitive environment analysis, including the evaluation of the number of market participants, market concentration, and positions of key players. Additionally, they form a basis for economic forecasting and scenario modelling, increasing the validity of strategic decisions in a dynamic external environment.

Particularly relevant in the context of European integration is the possibility of conducting comparative analyses of Ukraine's machine-building development relative to selected European Union countries and aggregated EU averages using Eurostat (n.d.) data. In this study, the comparison was conducted with Germany, Poland, Czechia, and the EU average indicators, as these countries represent different models of industrial development and varying

levels of integration into European manufacturing value chains. Germany was selected as the benchmark of high-tech industrial leadership in Europe; Poland and Czechia were included due to their comparable industrial specialisation, historical transformation trajectories, and active participation in regional manufacturing networks. Such a comparative approach makes it possible not only to identify quantitative differences in industrial structure and innovation activity but also to determine strategic gaps and opportunities for Ukraine's machine-building sector. The use of standardised Eurostat indicators ensures methodological comparability of results and strengthens the analytical validity of cross-country benchmarking within the strategic planning framework.

The macroeconomic environment, shaped in particular by analytical and statistical data from the World Bank (n.d.), plays a significant role in shaping the strategic priorities of mechanical engineering enterprises. The systematic use of open macroeconomic indicators-covering GDP dynamics, inflation trends, investment activity, employment levels, and external economic parameters-provides a comprehensive informational basis for understanding broader economic trends. This, in turn, enables enterprises to more accurately identify potential risks and opportunities, assess the degree of macroeconomic instability, and take into account the cyclical nature of economic development. Moreover, the use of such data supports the development of alternative growth scenarios that consider various changes in the external environment, which is particularly important under conditions of uncertainty and global challenges. The integration of Open Data into strategic planning processes also enhances the validity of managerial decisions, ensuring their adaptability and alignment with the long-term goals of sustainable enterprise development.

Critically important Open Data sources are international databases reflecting global value chains. These allow enterprises to assess not only domestic production structures but also integration into international economic processes. Resources such as OECD TiVA (OECD, n.d.), UN Comtrade, and WIOD enable analysis of component composition, geographical distribution, and dependence on imported inputs, which is especially relevant for high-tech industry segments. Information from global databases allows enterprises to: identify bottlenecks and supply chain risks, e.g., dependency on certain suppliers or countries affecting production stability and costs; plan supplier diversification and production localisation, using global trade flow analyses to strategically relocate production capacities and reduce disruption risks; identify new markets and partnerships, leveraging export-import data to forecast product demand, develop partnerships, and integrate into international manufacturing networks; enhance competitiveness in high-tech segments, by evaluating opportunities to enter high value-added and innovative sectors.

Global Data is particularly significant for transitioning to Industry 4.0 and data-driven production, providing the information foundation for predictive analytics, logistics optimisation, inventory management, and strategic selection of technological solutions. For Ukrainian enterprises gradually integrating into European and global production networks, access to Open Data on supply chains becomes a key tool to reduce dependency on imported components and improve production efficiency. The further development of strategic planning for machine-building enterprises under the conditions of active use of Open Data requires the formation of a systematic methodology for their analytical processing. Such an approach should be based on the integration of modern strategic analysis tools that ensure the transformation of Open Data sets into relevant managerial decisions (OECD, 2023; European Commission, 2023). The use of Open Data in strategic planning should be implemented through the step-by-step application of a set of analytical tools, among which PEST analysis, SWOT analysis, trend and forecasting analysis, and data visualisation methods occupy a central position. The initial stage involves conducting a PEST analysis, which enables a comprehensive assessment of the impact of external environmental factors on the functioning of machine-building enterprises based on Open Data sources.

Within the political dimension (P – political), Open Data provides opportunities to analyse industrial policy, the regulatory environment, innovation support programs, and integration processes with the European Union. In particular, the use of governmental portals and international data resources ensures monitoring of changes in the regulatory framework that determine industry conditions (European Commission, 2023). The economic dimension (E – economic) is based on the analysis of macroeconomic indicators, including GDP dynamics, inflation processes, investment activity, and foreign trade indicators. The use of Open Data from international organisations allows enterprises to identify the phase of the economic cycle and assess the level of effective demand and investment attractiveness of the industry (World Bank, n.d.). Social factors (S – social) include the analysis of the labour market, employment levels, workforce qualifications, and demographic trends. The use of Open Data in this context contributes to assessing the availability and quality of human capital, which is critically important for high-tech production (OECD, 2023). The technological dimension (T – technological) involves assessing the level of digitalisation, innovation activity, R&D expenditures, and the implementation of Industry 4.0 technologies. Based on international Open Databases, enterprises can identify global technological trends and evaluate their competitive positions (McKinsey & Company, 2023).

At the same time, the technological component should not be interpreted solely as a set of production upgrades or isolated digital initiatives. In the context of contemporary machine-building development, technology acts as a systemic factor that determines the adaptability of enterprises to external economic turbulence and the speed of integration into global value chains. Open Data sources provide an opportunity not only to monitor technological indicators

but also to identify structural changes in industrial development patterns, shifts in investment priorities, and emerging technological niches with high growth potential. For the Ukrainian machine-building industry, technological transformation acquires strategic importance due to the necessity of increasing production flexibility, reducing resource intensity, and improving resilience under conditions of heightened uncertainty. The analysis of open international databases enables enterprises to compare their technological maturity with international benchmarks, identify critical gaps in automation, robotics, digital infrastructure, and engineering capabilities, and determine priority directions for modernisation.

An authorial interpretation of the technological factor suggests considering technological development as a multidimensional category that combines not only innovation capacity but also the ability of enterprises to absorb and scale external knowledge. In this context, digital transformation becomes an instrument for strengthening competitive sustainability rather than an end in itself. The implementation of cloud technologies, industrial analytics, predictive maintenance systems, artificial intelligence solutions, and integrated production management platforms creates conditions for increasing operational efficiency and improving decision-making quality. Furthermore, the use of Open Data significantly expands the analytical capabilities of enterprises by enabling continuous monitoring of patent activity, technological investments, industrial productivity, export specialisation, and innovation ecosystems across countries and regions. Such an approach supports a transition from reactive management practices toward predictive and evidence-based strategic planning. Consequently, the technological dimension within the PEST framework serves not only as a diagnostic element but also as a foundation for forming long-term development trajectories of machine-building enterprises. The results of the PEST analysis of the machine-building industry of Ukraine are summarised in Figure 2.

P	*E*	*S*	*T*
◦ Martial law and geopolitical leading to destruction instability the production capacities and disruption of supply chains; ◦ Active government support for the defense-industrial complex, stimulating the growth of specific machine-building segments; ◦ Ukraine's European integration course, providing access to EU markets and financial support in struments; ◦ Strengthening of the state's role in demand formation (public procurement as a key industry driver).	◦ Economic recovery after the 2022 crisis, albeit at a moderate GDP growth in 2025); of pace (approximately 2% ◦ Low level of investment (6-8% of GDP), insufficient for industry modernization; ◦ Increase in the share of machine building in industry to approximately 9.1% in 2025; ◦ High dependence on imports of technological components.	◦ Reduction in labor resources (employment decreased by to migration and approximately 20% due mobilization); ◦ Shortage of qualified engineering personnel; ◦ Increasing importance of human capital in high-tech segments.	◦ Accelerate d implementation Industry of 4.0 seg ments; technologies in certain ◦ Development of defense and dual-use technologies; ◦ Low level of R&D funding compared to the EU; ◦ Digitalization of production processes and logistics

Figure 2. Results of the PEST analysis of the machine-building industry of Ukraine based on Open Data
Source: developed by the authors

The obtained results demonstrate that external environmental factors exert a differentiated influence on the development of machine-building enterprises and require integrated interpretation rather than isolated assessment. Political and regulatory conditions shape the institutional framework for industrial activity, economic factors determine investment capacity and market dynamics, social changes influence labour potential and demand structure, while technological factors define opportunities for modernisation and long-term competitiveness. Therefore, the practical value of PEST analysis lies not only in identifying key trends but also in revealing interdependencies between external drivers that collectively influence strategic decisions. From the author's perspective, the application of Open Data in conducting PEST analysis increases the objectivity and reproducibility of analytical conclusions, reducing dependence on subjective expert judgments. Unlike traditional approaches, the integration of publicly available international and national datasets enables dynamic updating of assessments and supports continuous strategic monitoring. This is particularly relevant for the Ukrainian machine-building sector, where rapid changes in external conditions require flexible analytical instruments and regular revision of development priorities. The next stage involves conducting a SWOT analysis based on Open Data, which ensures the integration of external and internal environmental analysis results. The summarised results of the analytical procedures are presented in Figure 3.

Strengths	*Weaknesses*
◦ High adaptive capacity of the industry: in 2023, production increased by 57.6% following the decline in 2022; ◦ Development of defense machine building . (production increased several-fold); ◦ Availability of a strong engineering school. and established production competencies; ◦ Integration into alobal value chains.	◦ High depreciation of fixed assets; ◦ Low levels of investment and innovation; ◦ Dependence on imported components (imports reached up to $16 billion in 2022); ◦ Logistical constraints and destruction of infrastructure
Opportunities	***Threats***
◦ Integration into the EU market; ◦ Development of defense and high-tech manufacturing; ◦ Attraction of international financial assistance; ◦ Development of digital manufacturing platforms.	◦ Prolonged war and security risks; ◦ High level of global competition; ◦ Instability of the investment environment; ◦ Outflow of human capital.

Figure 3. Results of the SWOT analysis of the machine-building industry of Ukraine based on Open Data
Source: developed by the author

The synthesis of PEST and SWOT analysis results makes it possible to form a comprehensive vision of the current state and development prospects of the machine-building industry in Ukraine. The study indicates that the industry is in a phase of structural transformation, combining recovery processes with technological modernisation. Despite significant external risks, existing internal capacities and opportunities create preconditions for further development. At the same time, achieving sustainable economic growth requires overcoming internal constraints, primarily through intensifying investment activities, fostering innovation, and developing human capital. In this context, the use of Open Data serves as an important tool for improving the validity of strategic management decisions and shaping an effective model for industry development (OECD, 2023).

Table 1 presents the dynamics of the main indicators of Ukraine's machine-building industry for the period 2020-2025. Analysis of the dynamics indicates that the machine-building industry in Ukraine experienced significant fluctuations due to macroeconomic and geopolitical factors. A particularly sharp decline occurred in 2022, associated with war-related risks and destruction of production capacities. Data for 2024-2025 indicate gradual sectoral recovery, with positive trends in industrial production indices and export growth, reflecting enterprises' adaptation to new operational conditions (State Statistics Service of Ukraine, n.d.). To improve the transparency and analytical validity of the obtained results, the forecast values for 2024-2025 were generated using trend extrapolation combined with scenario-based assessment. The baseline period included statistical observations for 2020-2023 obtained from the State Statistics Service of Ukraine and complemented by analytical estimates of recovery dynamics. Forecast ranges were formed considering three groups of factors: macroeconomic stabilisation indicators, expected export recovery, and gradual adaptation of production systems to wartime and post-war conditions. Instead of deterministic values, interval estimates were applied in order to reflect uncertainty and possible deviations in recovery trajectories. The projected indicators therefore should not be interpreted as exact values but as analytical scenarios illustrating potential directions of industry development under current institutional and economic conditions.

Table 1. Dynamics of indicators of machine-building in Ukraine

Indicator	2020	2021	2022	2023	2024	2025
Industrial production index, %	96.8	107.1	62.4	85-90	95-102	103-108
Share of machine-building in industry, %	10.2	10.8	8.5	9.0	9.5	10.0
Export of machine-building products, USD billion	5.4	6.2	3.8	4.5	5.2-5.6	5.8-6.3
Number of enterprises, in thousands	11.5	11.8	10.2	10.5	10.8	11.0

Note: 2023 – estimates based on open statistical and analytical data; 2024 – preliminary aggregated estimates (recovery trends); 2025 – forecast values based on recovery trends
Source: compiled by the authors based on State Statistics Service of Ukraine (n.d.)

The increase in the number of enterprises in 2024-2025 may indicate the activation of small and medium-sized businesses, the relocation of production, and the emergence of new production capacities. Collectively, these trends lay the groundwork for structural modernisation of the sector, based on digitalisation, innovation, and integration into global value chains. The obtained results demonstrate not only quantitative recovery but also qualitative structural transformation within the industry. Although industrial output and export volumes show positive dynamics in 2024-2025, the recovery process remains uneven and largely dependent on external financing, logistics resilience, and access to technological resources. The slower restoration of the machine-building share in industry compared with production growth may indicate persistent structural imbalances and insufficient expansion of high value-added segments. From the perspective of strategic planning, these findings suggest that future competitiveness should rely not exclusively on restoring production capacities but on accelerating technological modernisation, digital transformation, and deeper integration into European industrial ecosystems. Consequently, Open Data becomes not merely an informational instrument but a strategic resource for continuous monitoring and adaptive managerial decision-making. In EU countries, machine-building is characterised by a high share in GDP (up to 15-20% of industrial production), significant innovation components, and a high level of digitalisation (Industry 4.0). Table 2 presents comparative machine-building indicators (Ukraine vs EU).

Table 2. Comparative machine-building indicators (Ukraine vs EU)

Indicator	Ukraine	EU (average)
Share in industry, %	8-10	15-20
Share of high-tech production, %	5	15-25
R&D expenditure, % of GDP	0.4	2.0-3.0
Export orientation, % of production	50	70-80

Source: compiled by the author on Eurostat (n.d.)

Comparative analysis based on Eurostat data and selected benchmark countries (Germany, Poland, and Czechia) reveals substantial structural differences between Ukraine's machine-building industry and European industrial models. The values presented in Table 2 reflect aggregated EU averages and therefore serve as a generalised benchmark rather than indicators of individual countries. The comparison demonstrates that the gap is particularly visible in technological intensity and innovation investment. While European enterprises maintain higher levels of R&D expenditure and produce a larger share of high-tech output, Ukrainian machine-building remains concentrated in medium- and low-technology production segments. This situation limits productivity growth and constrains integration into high-value global production networks. At the same time, Ukraine's relatively strong export orientation indicates the presence of adaptation potential and opportunities for strengthening international industrial cooperation. Therefore, strategic priorities should focus not only on increasing production volumes but also on improving technological complexity, expanding domestic innovation capacity, and creating institutional conditions for industrial upgrading.

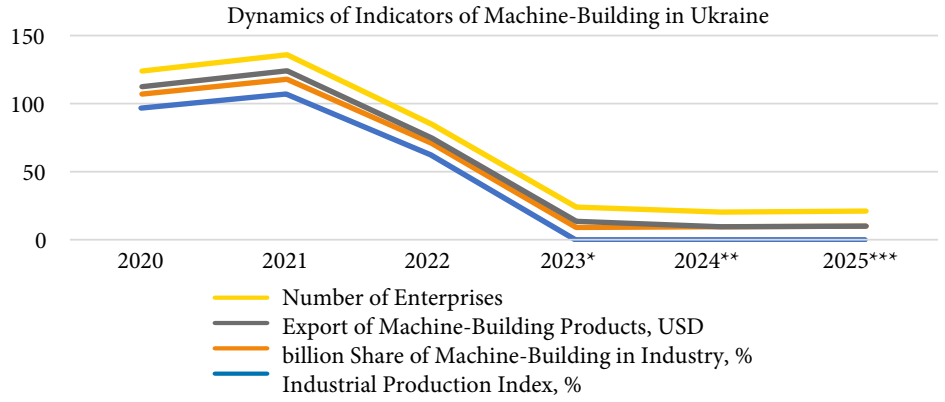

Figure 4. Dynamics of indicators of machine-building in Ukraine

Source: developed by the author based on State Statistics Service of Ukraine (n.d.)

The dynamics presented in Figure 4 indicate that the development trajectory of Ukraine's machine-building industry during 2020-2025 is characterised not only by cyclical fluctuations but also by structural adaptation processes. The sharp decline observed in 2022 reflects the impact of military, logistical, and investment constraints; however, subsequent recovery tendencies suggest increasing resilience and gradual restoration of industrial activity. At the same

time, the uneven pace of recovery across indicators demonstrates that quantitative growth does not automatically imply qualitative modernisation. In particular, the restoration of production volumes and export activity remains accompanied by a relatively slow recovery of the industry's structural position within total industrial output. This indicates the need for strategic reorientation toward technological upgrading and increasing value added. Therefore, the next stage of analysis involves comparing Ukraine's performance with European benchmarks in order to identify development gaps and determine strategic priorities for further integration into European industrial systems.

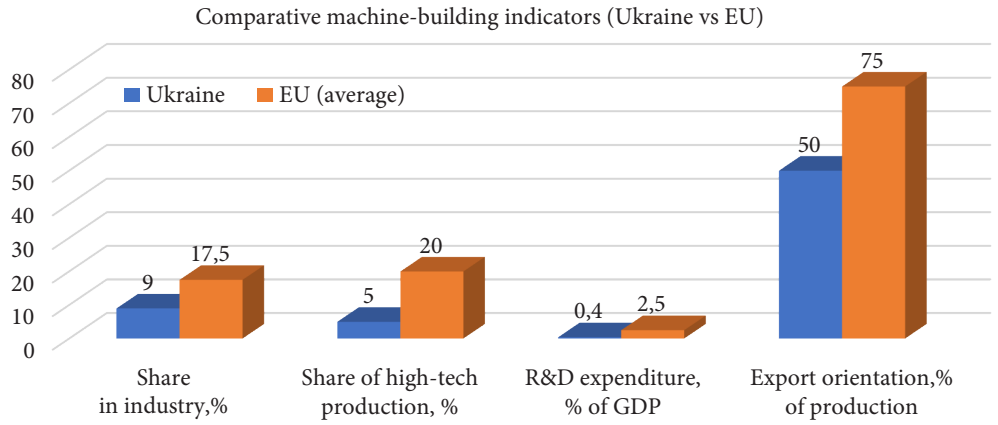

Figure 5. Comparative machine-building indicators (Ukraine vs EU)
Source: Developed by the author on World input-output database (n.d.)

GDP recovery, declining inflation, and increased foreign direct investment in 2023–2025 create favourable conditions for stimulating business activity and modernising machine-building enterprises (Table 3).

Table 3. Macroeconomic Indicators of Ukraine

Indicator	2020	2021	2022	2023	2024	2025
GDP growth, %	-4.0	3.4	-29.1	5.3	4	5
Inflation, %	5.0	10.0	26.6	12-13	8-10	6-8
Foreign direct investment, USD billion	0.2	6.7	-0.2	4.0	4.5-5.5	5.5-7.0
Export of goods and services, % of GDP	40	41	35	38	39-40	40-42

Note: 2024 – preliminary estimates; 2025 – forecast values
Source: compiled by the author based on World input-output database (n.d.)

The indicators reflect the severe economic crisis in 2022, marked by sharp GDP decline, rising inflation, and reduced investment activity. In 2023-2025, gradual macroeconomic stabilisation is observed, including positive economic growth, reduced inflationary pressure, restoration of foreign investment inflows, and stabilisation of foreign trade activity. The identified macroeconomic trends have direct implications for strategic planning in machine-building enterprises. Positive GDP dynamics and investment recovery increase the feasibility of implementing modernisation projects and expanding production capacities. At the same time, the persistence of inflationary pressures and uncertainty in external markets require enterprises to apply flexible planning instruments and scenario-based strategic management. The results also indicate that macroeconomic recovery alone does not automatically ensure industrial competitiveness. Sustainable growth of machine-building enterprises depends on their ability to transform external economic opportunities into internal technological capabilities through investment in innovation, digital infrastructure, and human capital development (Fig. 6). Accordingly, the next stage of the study involves forming a comprehensive vision for the development prospects of the machine-building industry through the design of a strategic map that reflects the key directions of its transformation under conditions of innovative and sustainable development. Such a map serves as an effective strategic management tool, as it ensures a logical interconnection between goals, resources, instruments, and the expected performance outcomes of enterprises. The strategic map for the development of Ukraine's machine-building industry, based on the use of open data, relies on the concept of balanced development and integrates the principles of data-driven management, digital transformation, and sustainable production. It reflects the interdependence among financial, production, innovation, customer, and socio-environmental aspects of enterprise performance, in line with the modern requirements of the global economy and European standards. Figure 7 presents the strategic map for the

development of Ukraine's machine-building industry in the context of Open Data utilisation. The proposed map envisages the transformation of information resources into competitive advantages, thereby enhancing the effectiveness of managerial decision-making and ensuring the long-term sustainability of machine-building enterprises.

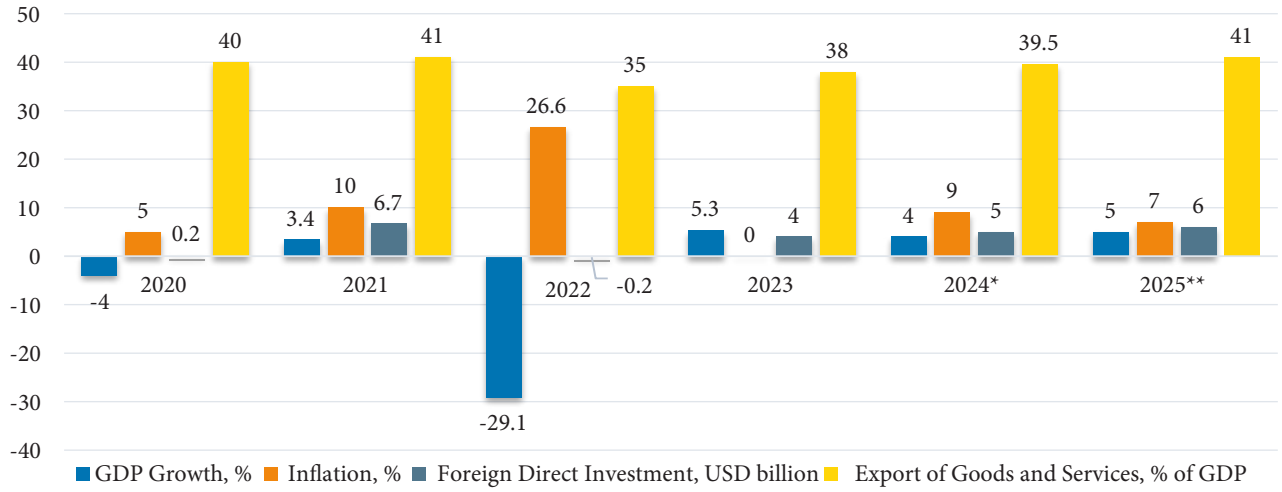

Figure 6. Macroeconomic Indicators of Ukraine
Source: developed by the author based on World input-output database (n.d.)

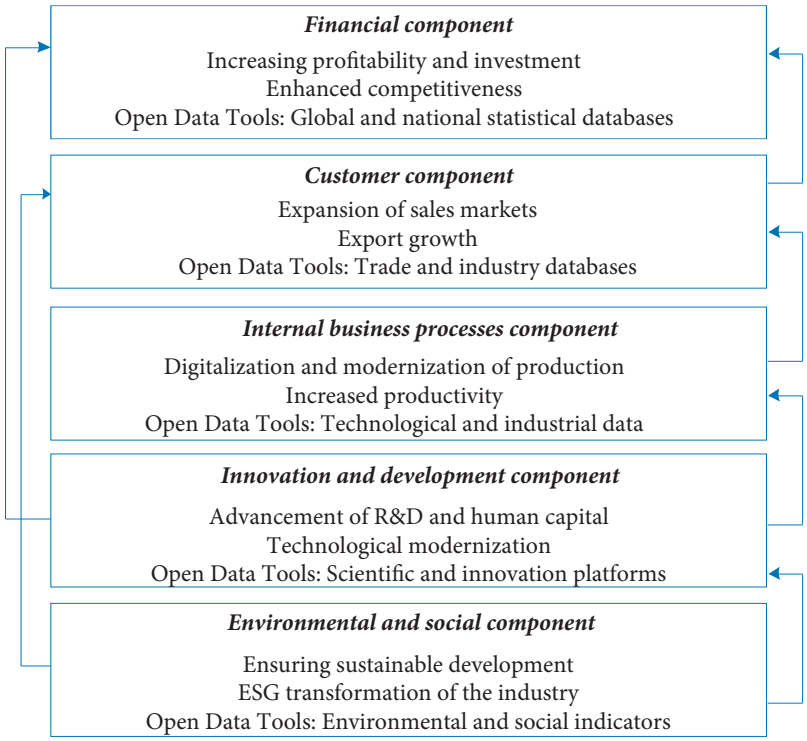

Figure 6. Strategic map for the development of Ukraine's machine-building industry using Open Data
Source: developed by the author

The financial perspective determines the ultimate outcomes of strategy implementation and aims to ensure the economic stability and competitiveness of machine-building enterprises. The primary strategic objectives include increasing profitability, enhancing investment attractiveness, and expanding the export potential of the industry. Accordingly, key strategic priorities involve increasing production and sales volumes, improving profitability, attracting foreign investment, expanding international market presence, and integrating into global value chains. The customer perspective reflects enterprises' orientation toward meeting consumer needs and enhancing product competitiveness in both domestic and international markets. Its key strategic objectives include improving product

quality and technological sophistication, expanding the range of high-tech products, strengthening positions in the European Union market, fostering partnerships and international cooperation, and increasing customer orientation. The internal business processes perspective focuses on improving the efficiency of production and management processes through the implementation of innovations and digital technologies. Key strategic directions include the modernisation of production facilities, the adoption of Industry 4.0 technologies, the digitalisation of manufacturing and logistics, the optimisation of supply chains, the enhancement of energy and resource efficiency, and the implementation of quality management systems.

The innovation and learning perspectives constitute the foundation for the long-term competitiveness of machine-building enterprises. This dimension of the strategic map defines the potential for creating new knowledge and technologies and encourages enterprises to develop research and development (R&D), enhance the digital competencies of personnel, stimulate innovation activity, strengthen cooperation with universities and research institutions, implement artificial intelligence and big data analytics, and utilise open scientific and technological data. In accordance with the principles of sustainable development, the ESG perspective also provides for the integration of ESG principles into the activities of machine-building enterprises. This includes reducing environmental impact, implementing environmentally friendly technologies, improving energy efficiency, promoting the circular economy, ensuring safe working conditions, and enhancing corporate social responsibility. The results of the conducted study confirm the pivotal role of the machine-building industry in fostering innovative development and strengthening economic competitiveness under conditions of digital transformation and sustainable development. The obtained findings demonstrated that the integration of Open Data into strategic planning created additional opportunities for improving environmental assessment, increasing the validity of managerial decisions, and strengthening enterprise adaptability under conditions of uncertainty.

The obtained conclusions correspond with the theoretical position proposed by D.J. Teece (2025), who argued that dynamic capabilities determine the ability of enterprises to respond to environmental changes and maintain sustainable competitive advantages. The findings of the present study extend this argument by demonstrating that the integration of external information resources into strategic planning enhances not only organisational adaptability but also the analytical capacity required for long-term strategic development. The significance of digital transformation for strategic management is also confirmed by P.C. Verhoef *et al.* (2021), who emphasised that digital technologies reshape managerial processes and stimulate the emergence of new business models. Similar conclusions were obtained by K. Schwertner (2017), who demonstrated that digital transformation contributes to higher managerial efficiency and supports organisational sustainability. In the context of the present research, these conclusions were further developed through substantiating the practical role of Open Data as an instrument supporting strategic planning procedures.

The findings are consistent with the conclusions of S. Kraus *et al.* (2022), who identified digital transformation as a critical determinant of industrial sustainability and innovation capacity. Their research primarily focused on organisational readiness for digital change, whereas the present study concentrated on the practical incorporation of open information resources into strategic planning mechanisms and demonstrated their applicability for improving strategic responsiveness. The strategic role of data resources was also emphasised by G. George *et al.* (2021), who characterised data as an important driver of innovation and managerial renewal. Similar observations were made by R. Dubey *et al.* (2020), whose research demonstrated that data analytics positively influences operational performance and resource allocation. Unlike previous studies focused mainly on operational outcomes, the present research showed that Open Data may support not only production efficiency but also strategic forecasting and long-term managerial decision-making.

Comparable conclusions were obtained by S. Wamba *et al.* (2018), who demonstrated that data-oriented management contributes to improving competitiveness and operational effectiveness. The results of this study additionally indicate that the use of external open datasets improves strategic flexibility and facilitates adaptation to changing macroeconomic conditions. The role of external information ecosystems was further examined by S. Nambisan *et al.* (2019), who emphasised that digital platforms and open information exchange create favourable conditions for innovation and strategic renewal. The findings of this research support these conclusions and demonstrate that publicly available international databases can become an important source for strengthening analytical capabilities in industrial enterprises.

The importance of Open Data for innovation systems was also highlighted by C. Pascu & J.-C. Burgelman (2022), who argued that open information environments support knowledge creation and improve decision-making transparency. In comparison with their conceptual approach, the present study focused on practical managerial implementation and proposed a structured algorithm for integrating Open Data into enterprise strategic planning. Recent empirical studies additionally support the relevance of the obtained findings. A. Romsdal *et al.* (2025) demonstrated that insufficient data quality and delayed information updates reduce planning effectiveness in manufacturing systems. The present study complements this conclusion by showing that combining verified external information with internal enterprise data improves strategic assessment and reduces informational uncertainty.

Similarly, J. Baecker *et al.* (2025) identified organisational data strategies as a mechanism for generating competitive advantages and enhancing enterprise performance. The strategic planning algorithm proposed in this

study extends this perspective by integrating Open Data throughout the full strategic cycle, including environmental analysis, strategy formulation, implementation, and monitoring. B.M. Rodrigues (2025) also emphasised that data-driven manufacturing management enables stronger coordination between strategic and operational objectives. The results obtained in this study support these findings and additionally demonstrate that the integration of forecasting procedures and strategic analytics enhances long-term industrial resilience.

Additional support for the obtained conclusions is provided by recent studies on industrial digital maturity. M.P. Hetmanczyk (2024) proposed a methodology for evaluating the maturity of production process automation and demonstrated that sustainable industrial transformation requires not only technological modernisation but also systematic integration of data into managerial processes. These findings reinforce the conclusions of the present study concerning the necessity of combining strategic planning with analytical support mechanisms. Related conclusions were obtained by A.E. Öberg *et al.* (2024), who argued that manufacturing enterprises achieve higher digital readiness when strategic decisions are supported by structured analytical frameworks and continuous assessment of technological capabilities. Overall, the comparison with contemporary scientific literature demonstrated that most previous studies investigated digital transformation, data analytics, and industrial modernisation separately. In contrast, the present study proposed an integrated managerial approach combining Open Data, strategic planning instruments, forecasting procedures, environmental assessment, and strategic mapping within a unified decision-making framework. Such integration contributes to increasing enterprise resilience, supporting sustainable industrial development, and strengthening competitiveness under dynamic economic conditions.

Conclusions

The conducted study confirmed that the machine-building industry remains one of the key sectors influencing innovative development and strengthening the competitiveness of the national economy. It was established that under conditions of globalisation, digital transformation, and increasing attention to sustainable development, the effectiveness of enterprise management increasingly depended on the modernisation of strategic planning approaches and the systematic use of open information resources. The research expanded the theoretical and methodological understanding of strategic planning in machine-building enterprises by substantiating the role of Open Data as an analytical basis for managerial decision-making. Based on the analysis of national and international information resources a comprehensive assessment of industry development conditions and structural changes during 2020-2025 was conducted.

The obtained results demonstrated that the integration of Open Data into strategic planning improved the quality of environmental analysis, increased the validity of strategic decisions, and strengthened the adaptability of enterprises to external changes. In particular, an algorithm for strategic planning of machine-building enterprises under conditions of Open Data utilisation was developed. The proposed algorithm incorporated sequential stages of data collection and integration, analytical processing, environmental assessment, formation of strategic alternatives, implementation of strategic initiatives, and continuous monitoring with feedback mechanisms. The conducted PEST analysis and SWOT analysis identified the main factors influencing the development of Ukraine's machine-building industry and revealed existing structural constraints together with opportunities related to digital transformation and European integration. Comparative analysis with selected European Union countries demonstrated a lower share of high-technology production, lower research and development intensity, and weaker integration into international production chains, which indicated the necessity of technological modernisation and investment support.

A strategic map for industry development was proposed, integrating financial, production, innovation, customer-oriented, and environmental priorities and demonstrating practical directions for applying Open Data at different stages of strategic planning. The practical significance of the study consisted in creating methodological support for managers and policymakers aimed at improving evidence-based decision-making and increasing enterprise resilience. Prospects for further research include the development of quantitative models for evaluating the effectiveness of Open Data implementation in strategic management, the application of artificial intelligence instruments in industrial forecasting, and the assessment of digital maturity and data governance mechanisms in machine-building enterprises under conditions of post-war economic recovery.

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Conflict of Interest

None.

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Використання Open Data для стратегічного планування підприємств машинобудування в умовах інноваційного та сталого розвитку

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Анотація. Актуальність була зумовлена зростанням ролі машинобудівної галузі у забезпеченні інноваційного розвитку, підвищенні конкурентоспроможності національної економіки та інтеграції у глобальні виробничі ланцюги. В умовах цифрової трансформації та переходу до сталого розвитку у 2020-2025 роках використання відкритих даних набуло особливого значення як інструмент підвищення ефективності стратегічного планування промислових підприємств. Метою статті було дослідження потенціалу відкритих даних для підвищення ефективності стратегічного планування підприємств машинобудування в умовах інноваційного та сталого розвитку. Дослідження ґрунтувалося на статистичних та аналітичних даних Держстату України, Eurostat, Світового банку, OECD, UN Comtrade та WIOD. Методологічну основу становили загальнонаукові та спеціальні методи дослідження, зокрема аналіз і синтез, порівняльний та статистичний аналіз, системний і структурно-логічний підходи, економіко-аналітичні методи, а також інструменти стратегічного оцінювання політичних, економічних, соціальних і технологічних чинників та аналізу сильних і слабких сторін, можливостей і загроз. Результати дослідження засвідчили, що використання відкритих даних суттєво покращило інформаційне забезпечення стратегічних управлінських рішень і сприяло підвищенню адаптивності підприємств до змін ринкового середовища. Було розроблено та обґрунтовано алгоритм стратегічного планування підприємств машинобудування, заснований на інтеграції даних та їх аналітичному опрацюванні. Сформовано стратегічну карту розвитку галузі, що відображала взаємозв'язки між фінансовими, виробничими, інноваційними, клієнтоорієнтованими та екологічними пріоритетами. Також здійснено оцінювання тенденцій розвитку та структурних характеристик машинобудівної галузі України у 2020-2025 роках та визначено перспективи її розвитку в умовах європейської інтеграції та цифрової модернізації. Крім того, встановлено, що інтеграція зовнішніх інформаційних ресурсів у систему управління підприємствами посилила можливості прогнозування, сприяла прийняттю обґрунтованих рішень та підвищила довгострокову стійкість і конкурентоспроможність підприємств. Практичне значення дослідження полягало у формуванні методичного та аналітичного забезпечення для керівників підприємств і органів державного управління з метою підвищення якості стратегічних рішень та посилення стійкості й інноваційного потенціалу підприємств машинобудування

Ключові слова: промислове управління; загальнодоступні набори даних; обґрунтоване прийняття рішень; технологічна модернізація; конкурентоспроможність підприємств; цифрова економіка; промислові інновації