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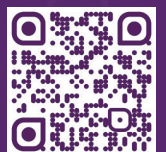
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战略决策和风险管理

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Sustainability through economic diversity: Examining the role of trade diversification, productive population, and foreign direct investment in selected Asian countries

F.V. Bekun^{1,2,3}M.P. Fumey⁴J.Ch. Onwe^{5,6}M.D. Habib⁷G.M. Sackitey⁴¹ Istanbul Gelisim University (Istanbul, Turkey)² University of Economics and Human Sciences (Warsaw, Poland)³ Azerbaijan State University of Economics (Baku, Azerbaijan)⁴ Northwestern Polytechnical University (Xi'an, China)⁵ Federal Polytechnic Ohodo (Enugu State, Nigeria)⁶ Alex Ekwume Federal University Ndufu Alike (Ikwo Ebonyi State, Nigeria)⁷ Air University (Islamabad, Pakistan)

Abstract

This study explore the pertinent role of sustainability, trade direction diversification, productive population, and foreign direct investment across selected countries of Asia is viewed of leveraging on a battery of estimators i.e. Augmented Mean Group (AMG), Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares, and Standard Errors by Driscoll and Kraay methods for robust estimates and accounting for endogeneity and cross-sectional dependence for the selected bloc. Empirical results that foreign direct investment (FDI) exerts a negative effect on sustainability. Thus, implying that FDI growth in the study area dampens economic sustainability while productive population and trade engenders sustainability in the selected Asian blocs. These outcomes have inherent polices implications which highlights the need for robust trade and productive population strategies and policies which will trigger increased sustainability. More insights are renders in the concluding section.

Keywords: FDI, GDP, TRD, productive population and sustainability

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通过经济多元化增强韧性：贸易多元化、经济活动人口及外国直接投资对亚洲各国发展的影响分析

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简介

该研究通过计量经济学方法 (如扩展中位数组AMG、完全修正最小二乘法FMOLS、动态面板模型及Driscoll-Kraay标准误差模型) 系统分析了贸易韧性、劳动力生产率与外国直接投资对亚洲各国经济发展的影响。该分析纳入了研究对象国内各行业间的因果关联与相互依存关系。实证数据显示, 外国直接投资对贸易韧性水平产生了负面影响。因此可以推断, 外国直接投资流入某一地区会削弱其经济稳定性。相反, 经济活跃人口的存在以及活跃的贸易往来则有助于增强亚洲国家的经济韧性。研究结果具有重要的政策意义, 突显了制定有效贸易战略和措施的必要性, 这些措施应旨在提升经济活跃人口的韧性。

关键词: 外国直接投资、国内生产总值、贸易、经济活跃人口、可持续发展

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Introduction

Sustainability being the inevitable reality has become a global agenda for modern business management, emphasising the importance of practicing sustainable practices in global operations [Martins et al., 2023]. The global world faces the challenge of balancing environmental conservation and economic growth [El Khoury et al., 2025]. Economic development is essential for addressing issues related to poverty and human well-being, but it often damages the environment. Nations prioritise material luxury over environmental sustainability [Hunjra et al., 2024]. Economic development often leads to environmental degradation, climate change, and greenhouse gas emissions, which require urgent attention from regulators and policymakers [Cheng et al., 2024]. Therefore, the debate about finding the optimal balance between environmental protection remains a widely discussed issue across all levels of discussion [El Khoury et al., 2025]. The modern economic landscape is increasingly driven by the dual goals of sustainable growth, technological advancement, and integration of innovation with renewable energy [Xuan, 2025].

The increased interest in economic development within the context of environmental research highlights the significance of contributors towards sustainability, such as foreign direct investment (FDI), trade, productive populations and gross domestic product [Yun et al., 2024; Xuan, 2025]. The available opportunities in the global economy encourage businesses and nations to invest in foreign markets [Singh, Kapuria, 2022]. In the past decades, it was found that FDI has considerably increased in the African market over the last two decades [Seker et al., 2015]. However, recent studies reported a decline in global FDI flows in 2016 and for three consecutive years, as well as a decrease in FDI from 5.63% in 2007 to 1.57 in Asian markets in 2018 [Singh, Kapuria, 2022]. The shift in FDI inflows was due to uncertainties in policies for foreign investors, the fragility of the global economy, and increased geopolitical risks. The FDI flows for developed economies declined by 27%, while developing countries saw a surge of 46% from 2017 to 54% in 2018 [Singh, Kapuria, 2022]. FDI is recognised as a driver of economic growth for the host country, and nations are keen to attract FDI for economic development [Chandran, Tang, 2013]. Though FDI is considered to be a significant contributor to economic development, it also raises the debate about potential environmental degradation [Pao, Tsai, 2010]. Recent studies have necessitated research into examine the relationship between FDI and GDP, as well as sustainability-related variables such as renewable energy [Xuan, 2025] in order to better understand the combined effect of these factors.

The Asian countries are suitable for studying FDI flows as they are the leading recipient region, with a significantly positive growth of \$ 493 billion in 2017 and \$ 512 billion in 2018 [Singh, Kapuria, 2022]. The higher growth can be attributed to the strong liquidity and low borrowing costs in the region with significant economic growth [Zahonogo, 2017]. To promote economic globalisation, this region has pushed for sustainable development, and countries have opened their FDI policies [Aust et al., 2020]. The lack of sustainable

considerations such as low-level investment governance, shortages of natural resources, and environmental pollution have resulted in a complex relationship between environment, development, and trade [Wang, Luo, 2020].

The productive population is a representation of the working population that contributes to the national economy [Shahabadi, Pouran, 2023]. Statistical figures show that Asia is the most populous country, representing 59.08% of the global population. This large proportion of Asia's productive population can boost economic growth. The analysis shows an incremental trend in Indian and Chinese populations from 1990 to 2020. The numbers increased from 747 million and 504 million to approximately 978 million and 938 million respectively [Ajmi et al., 2025].

The acceleration of globalisation has created a space for trade openness, specifically for emerging markets such as Africa and Asia [Demiral et al., 2022]. This has resulted in the expansion of international trade, which has grown by 75% between 2000 and 2020. The reports from the World Bank showed that the proportion of international trade in GDP grew from 25 to 52% from 1970 to 2020 respectively [Wang et al., 2024]. While trade openness contributes to economic development and is associated with GDP, it is also linked with sustainability concerns [Zhong et al., 2021]. For instance, it has been reported that global carbon dioxide emissions in 2019 reached 34.34 million kt, indicating a 67% increase from 1990 [Wang et al., 2024]. This alarming situation has led global stakeholders to take actions and put an obligation on regulators to set goals for sustainable development [Yang et al., 2020]. The pandemic situation of COVID-19 and the Russia-Ukraine war have hit the global economy, forcing countries to take protective measures such as non-tariff barriers and raise tariffs to protect their industrial competitiveness and economic interests [Burgess et al., 2021]. This scenario raises the complexity of international trade and requires the intervention of the IMF and WB to promote diversification strategies and trade openness [Wang et al., 2024]. Trade diversification is used to accelerate exports and support competitiveness. However, this strategy may result in increased energy consumption to support production processes [Sun et al., 2023]. The implementation of trade diversification may damage sustainability concerns, but it may be effective in certain industries such as metal and cement, to reduce carbon emissions and achieve sustainability goals. Therefore, it is necessary to conduct a thorough examination to explore the relationship between sustainability and trade.

For this reason, balancing economic growth (trade, investments, productive population) and sustainability has become a pressing concern for Asia [Singh, Kapuria, 2022]. The productive population also drives income growth and technological innovation, which results in economic development [Ajmi et al., 2025]. Therefore, current research on the relationship between sustainability, trade direction diversification, productive population, and foreign direct investment across selected Asian countries is viewed using Fully Modified Ordinary Least Squares (FMOLS) methods along with standard errors. The research is organised into

five sections. The first section introduces the topic, followed by a brief explanation of theoretical literature and hypothesis development. The third section describes the research methodology, and the fourth section presents the findings of research. The fifth section discusses the findings of the study, along with their implications and conclusion.

1. Literature review

Sustainable development is at the top of the agenda in recent global forums [Ajmi et al., 2025]. The development of a sustainable future attracts the attention of global stakeholders and encourages them to set specific targets and long-term goals to achieve sustainable development [Halkos, Gkampoura, 2021]. Sustainable development prioritises traditional development because it offers several benefits through a balanced approach that considers future generations' needs while exploiting environmental, economic, and social resources [Tan et al., 2024]. The UN calls on all nations to work together regardless of their economic status to achieve SDGs in order to promote global well-being and protect the planet [Grzebyk et al., 2023]. The SDGs are a topic of discussion due to their importance and inconsistencies. Specifically the SDG8 'Decent Work and Economic Growth' is of interest [Ajmi et al., 2025]. Available literature shows that economic growth comes at the cost of ecological sustainability [Grzebyk et al., 2023]. Therefore, it is essential to examine the relationship between economic growth, trade diversification, productivity, foreign direct investment and sustainability in order to address certain contradictions and provide policymakers with empirical evidence.

The date of economic literature shifted from economic growth to sustainable growth [Feng et al., 2019] and provided a research avenue to explore the relationship between FDI and sustainability [Singh, Kapuria, 2022]. The relationship between FDI and sustainability has been widely explored under the theories of pollution haven hypotheses [Feng et al., 2019] and Environment Kuznets Curve [Ren et al., 2014]. Research studies have found a significant relationship between FDI, trade and consumption of natural resources [Tang, Jiang, 2024]. Recent studies have also highlighted the importance of research on FDI in the context of sustainability and established a negative relationship between the two constructs [Xuan, 2025]. It was found that FDI represents the growth-pollution nexus in two ways: first, it can increase the national output, resulting in pollution, and second, FDI can be used for the deployment of efficient production technologies to reduce pollution [Pata et al., 2022]. So, there are no conclusions about the relationship between FDI and sustainability, which requires further investigation.

Available literature examined the association between trade openness and carbon emissions as a proxy for sustainable development [Wang et al., 2024]. Research studies found that there is a significant relationship between trade and sustainability in the context of economic integration and globalisation [Wang et al., 2023]. The existing literature establishes this relationship based on two opposing propositions: the first is the pollution

haven, which argues that industrialised countries seek to exploit overseas manufacturing facilities for cost-effective access to raw materials, labour and land [Taylor, 2005]. Most of these countries develop with inexpensive resources and labour, and have weak environmental standards [Solarin et al., 2017]. Consequently, in the context of globalisation, countries with less strict environmental regulations and cheap resources are more attractive to investors, which leads to the worst environmental damage in these countries [Wang et al., 2024]. Contrary to this, the environmental Kuznets curve suggests that industrialisation has a significant and positive effect on pollution at a certain stage, after which countries begin to invest in environmental protection, resulting in a decline in environmental damage [Kaika, Zervas, 2013]. Studies also establish the impact of trade on carbon emissions [Liddle, 2018] and found that the consumption of energy in different countries varies [Jayanthakumaran et al., 2012]. This difference in utilisation of energy consumption for production leads to importing energy-intensive goods from other countries, reducing carbon footprints in the host countries [Wang et al., 2024]. In available literature a significant association was found between trade and carbon emissions. One stream of research found a positive and significant relationship between trade openness and carbon emissions [Shahbaz et al., 2017]. The second stream of research found a significant negative relationship between these variables [Ansari et al., 2020].

2. Data and methodology

To operationalise the present study's objectives. This study relies on panel data analysis, which combines both cross-sectional analysis of selected Asian economies and time series data from 1990 to 2022. The sample size was respected due to the availability of data. Details about the data, variables, and sources can be found in the appendix section, due to lack of space.

The proposition on the endogenous impact of technological residuals in enhancing long-term economic growth is the theological basis for the present study. Additionally, the present study also draws on the existing growth literature from the studies of [Sampene et al., 2024]. Thus, this study complements these studies and advances recent research by incorporating interaction terms for a more robust analysis of the topic under review

$$INCOME = f(PP, TECH, SUS, FDI, PC, TRD).$$

The operational model is appended below:

Model 1

Sustainability = f(Economic growth, trade, Productive Population FDI);

Model 2

Sustainability = f(Economic growth, trade, Productive Population, FDI, Trade × Productive Population).

The graphs illustrate the trends in key variables such as sustainability, economic growth measured by GDP, population growth, foreign direct investment and trade for selected Asian countries. Figure 1 shows changes in sustainability levels over time by country. On this graph, some countries

show upward trends and improved sustainability, while others remain relatively stable. Figure 2 highlights variations in economic growth, and distinct periods of acceleration or deceleration can be identified. Figure 3 shows the population growth trends, which, in some cases are very different and represent demographic dynamics. Figure 4 depicts the flow of FDI with upward or volatile investments depending on the country. Finally, Figure 5 presents trade trends, where some countries have consistent growth and others have fluctuations. These graphs together depict very diverse economic and demographic patterns that are essential for understanding how these factors interact with each other and sustainability.

3. Cross-sectional dependency (CSD) assessment

The study examines the sustainability effects of trade diversification, productive population, and foreign direct investment in several Asian countries. Most countries are highly interdependent due to trade relations, investment flows, and shared regional economic factors, leading to a high likelihood of CSD [Voumik et al., 2023]. Correlated error terms can be interpreted as one country's trade pattern, financial structure, or foreign investment activities influencing others in the region [Li et al., 2022; Sampene et al., 2024]. Such interdependence is worth considering, as it may lead to bias in estimates and inhibit proper identification of the actual effects of variables in question. For instance, an improvement in trade diversification in one country may spur or augment trade diversification among neighboring countries due to regional trade agreements or the typical expansion of global supply chains. Therefore, the CSD test allows for examination of whether economies are affected by external influences in a way that violates the independence assumption in panel data models [Pesaran et al., 2008]. Thus, we adopt the general assessment formula of [Pesaran et al., 2008] in Equation (1):

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{j=1}^{N-1} \sum_{i=j+1}^N \hat{\rho}_{ij} \right). \quad (1)$$

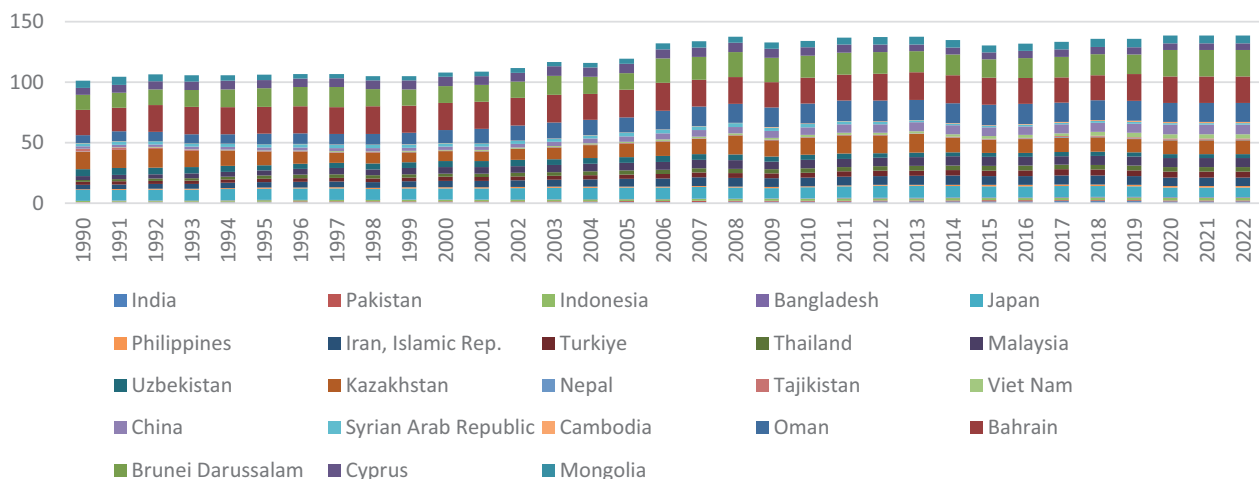
The Slope Homogeneity Test (SHT) is an investigation that helps determine the level of consistency among linkages of trade diversification, productive population, and foreign direct investment in selected Asian countries. Given the diverse economic structures, policies, and development stages characterise Asian countries [Shang et al., 2023], it is essential to ascertain whether coefficients of these variables are identical or different across countries. The tests for slope homogeneity determine whether one-model allocation to countries regarding standard coefficients is sufficient, or whether separate models are required for each country (or group of countries). If the slopes are found to have heterogeneous distributions, this implies that the effects in question will differ from country to country. Thus, the need for adjusting the model according to each country arises. [Pesaran, Yamagata, 2008] establish an estimation model to test for homogeneity among constructs. Therefore, the equations are as follows:

$$\Delta SHT = N^{\frac{1}{2}} 2K^{\frac{-1}{2}} S - K, \quad (2)$$

$$\Delta ASHT = N^{\frac{1}{2}} \left(\left(\frac{2k(T-k-1)}{T+1} \right)^{\frac{-1}{2}} \right) \left(\frac{1}{N} S - K \right). \quad (3)$$

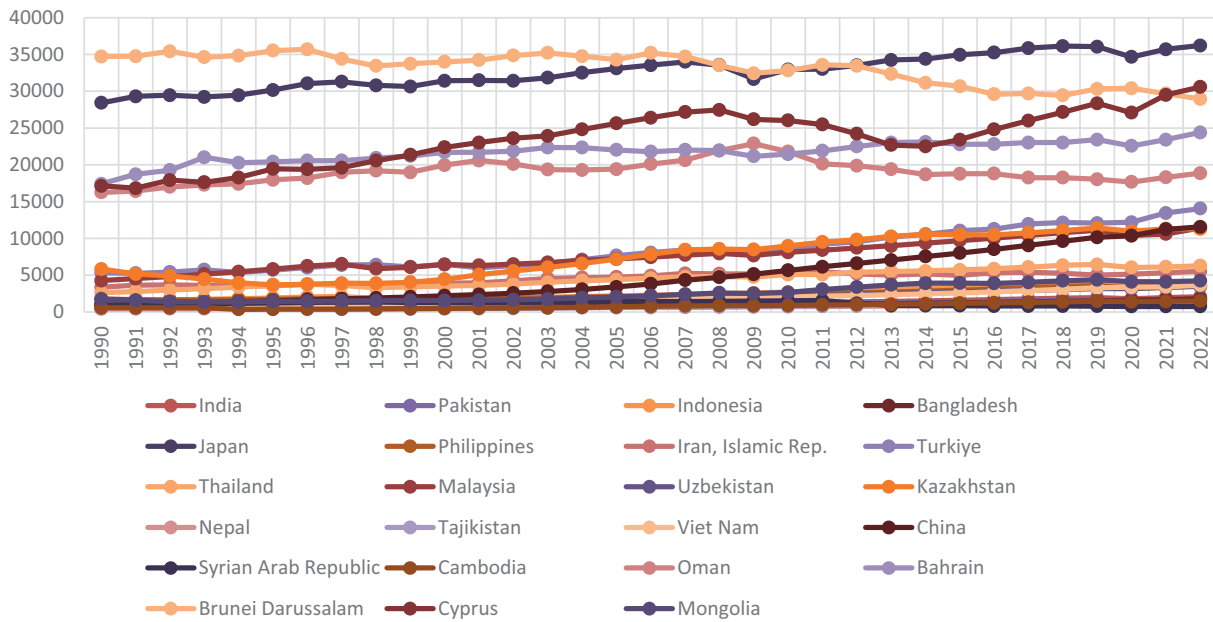
The standard unit root approach, such as the Augmented Dickey-Fuller (ADF) test [Sims et al., 1990; Im et al., 2003], becomes useless when CSD exists. This problem can be addressed by adjusting the classical ADF method by integrating cross-sectional mean adjustments of lagged terms and rearranging structures [He et al., 2021]. This leads to a novel panel unit root assessment that accommodates CSD and heterogeneity. [Pesaran et al., 2008] advanced a cross-sectionally improved CIPS stationarity examination based on the usual individual CADF assessments for the entire group. This identifies certain factors relevant to the CIPS test:

Fig. 1. Trend analysis of sustainability for selected Asian countries



Source: [Sampene et al., 2024].

Fig. 2. Trend analysis of economic growth for selected Asian countries



Source: [Sampene et al., 2024].

$$CIPS(N, T) = \frac{1}{N} \sum_{i=1}^N I_i(N, T), \quad (4)$$

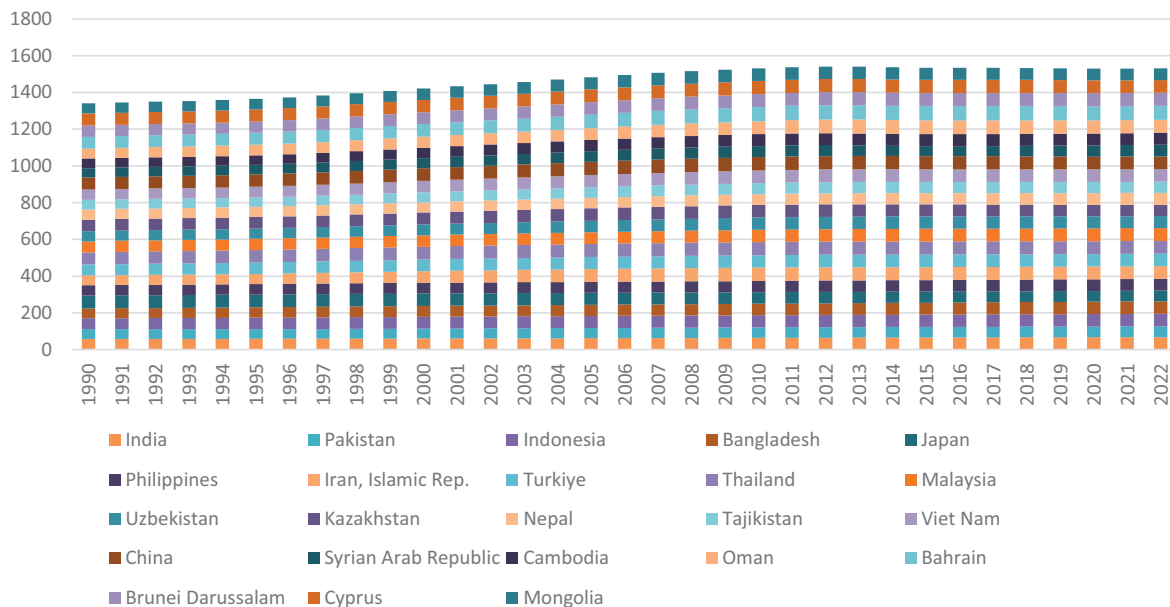
$$CADF = \gamma x_{it} = a_i + \beta_{i-1} + \delta_1 T + \sum_{j=1}^N \gamma_{ij} x_{it-j} + \epsilon_{it}. \quad (5)$$

[Kao et al., 1999] based on a cointegrating regression model. It examines the long-run equilibrium link between dependent and many explanatory variables, allowing for individual-specific coefficients and intercepts. The Kao equation is presented in Equation (6):

$$y_{it} = \beta_{it} + \beta_{1it} x_{1it} + \beta_{2it} x_{2it} + \dots + \beta_{kit} x_{kit} + \epsilon_{it}, \quad (6)$$

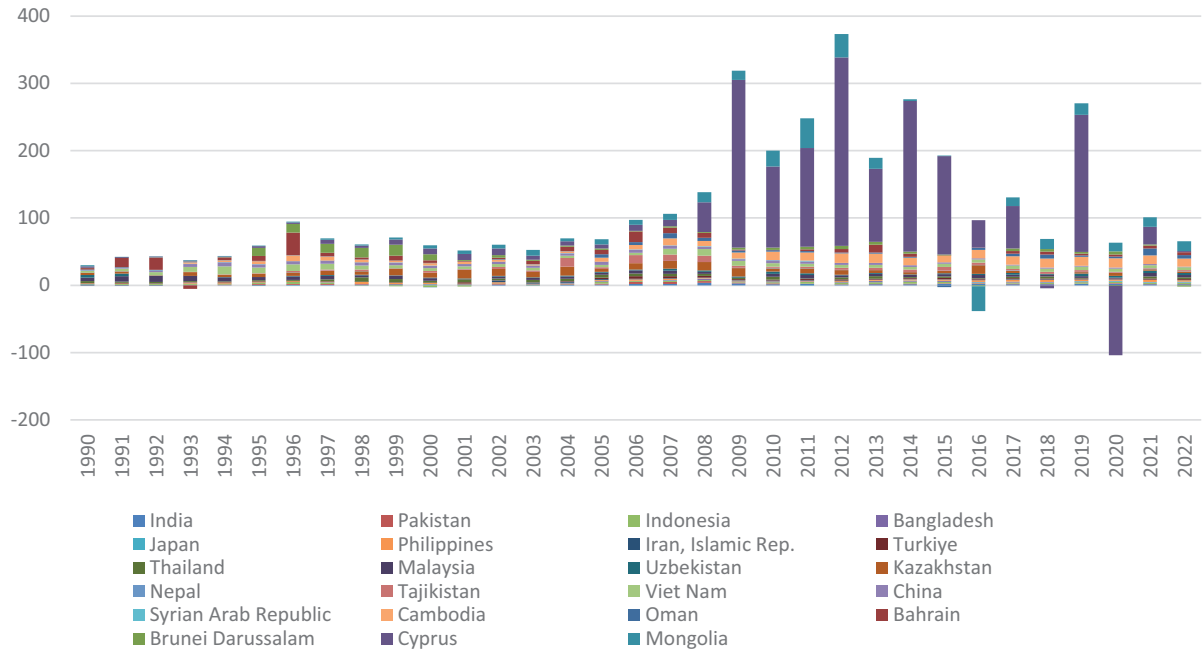
where y_{it} denotes the outcome variable for the individual I at time t , β_{it} is the individual-specific intercept term, β_{1it} , β_{2it} , and β_{kit} are the individual-specific slope coefficients consistent with the respective explanatory variables x_{1it} , x_{2it} , and x_{kit} are the expounding variables or regressors for individual i at time t and ϵ_{it} is the error term for individual i at time t . [Westerlund, Edgerton, 2007] show Equation (7):

Fig. 3. Trend analysis of population growth for selected Asian countries



Source: [Sampene et al., 2024].

Fig. 4. Trend analysis of foreign direct investment for selected Asian countries



Source: [Sampene et al., 2024].

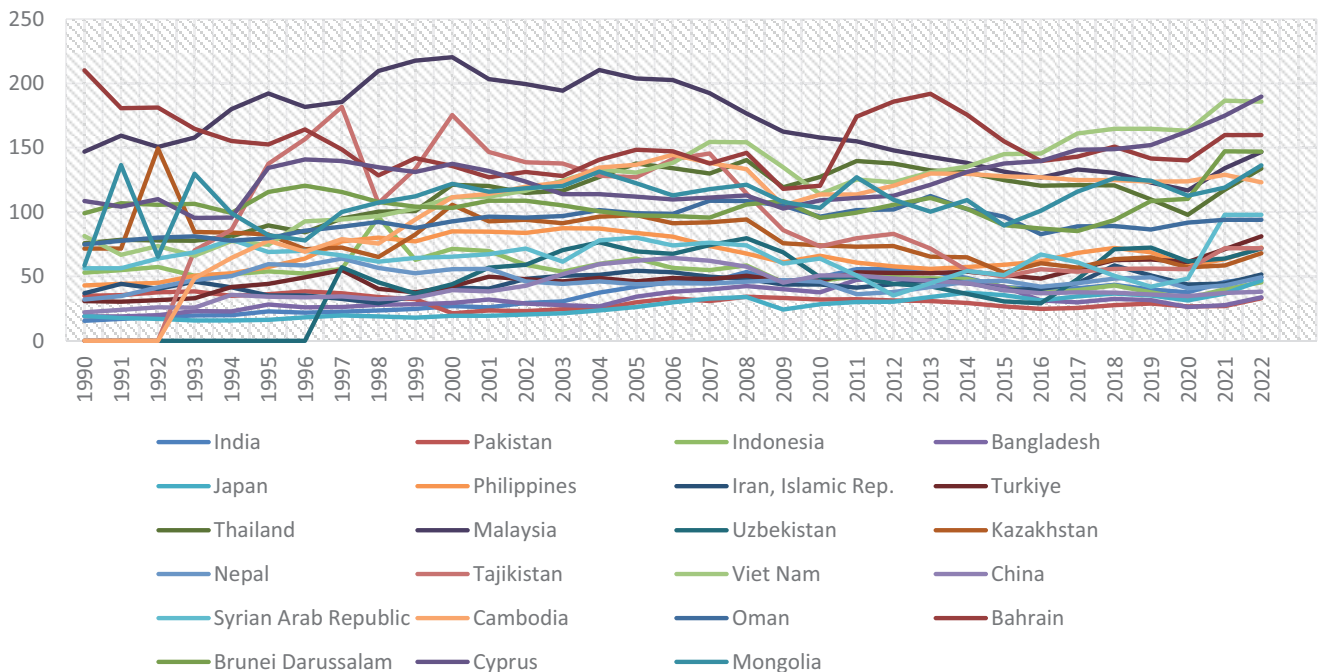
$$\Delta Y_{it} = \psi_i d_i + a_i (Y_{it-1} - \beta_i X_{it-1}) + \sum_{j=1}^p a_{ij} \Delta Y_{it-j} + \sum_{j=-p_i}^p \phi_{ij} \Delta X_{it-j} + \mu_{it}. \quad (7)$$

Such that $d_i = (1, t)$ gives trend elasticity measure $\psi_i = \psi_i$ and ψ_{2i} labels the constant term for the states and i and t specifies the CSD period. Test statistics are visible in equations (8)–(11):

$$G_t = \sum_{i=1}^N \frac{n_i}{S.E(\eta_i)}, \quad (8)$$

$$G_a = \frac{1}{N} \sum_{i=2}^N \frac{T\eta_i}{1 - \sum_{j=1}^k \eta_{ij}}. \quad (9)$$

Fig. 5. Trend analysis of trade for selected Asian countries



Source: [Sampene et al., 2024].

The cointegration is shown as follows:

$$P_{\tau} = \frac{\eta_i}{S.E(\eta_i)}, \quad (10)$$

$$P_a = T\eta_i, \quad (11)$$

where G_{τ} and G_a demonstrations of the group mean figures, P_{τ} and P_a also specifies the statistics in the panel, η_i shows the change from short to long-term equilibrium speed.

The examination of sustainability, trade direction diversification, productive population, and foreign direct investment across selected countries in Asia is conducted using Fully Modified Ordinary Least Squares (FMOLS) methods along with standard errors [Driscoll, Kraay, 1998]. The FMOLS method is suitable for panel data analysis of non-stationary variables, which may include endogeneity and serial correlation. The FMOLS method assumes a common intercept across panels since different countries may have different serial correlations. [Driscoll, Kraay, 1998] provide robust estimates consistent with autocorrelation and cross-section dependencies. In addition to being both potentially serially correlated and cross-sectionally dependent, the Augmented Mean Group (AMG) estimator is a distinct estimator that solves the common problems of serial correlation, cross-section dependency, heteroskedasticity, and slope heterogeneity. These are common in panel data studies involving several countries with different economic structures. Thus, the AMG estimator frees the results from any bias regarding these issues and reflects the genuine relationships of the variables under consideration in the analyzed model. The AMG estimation and the heterogeneous panel estimation of [Eberhardt, Bond, 2009; Eberhardt, Teal, 2010] inspired this analytical estimation, as shown in Equation (12):

$$\Delta Y_{it} = a_i + \beta_i \Delta X_{it} + \sum_{i=1}^{\tau} \pi_i D_i + \varphi_i UCF_i + \mu_{it}. \quad (12)$$

The OLS model of alteration is applied to the AMG test. This is expressed in Equation (13), in that φ symbolizes the estimated slope parameters of X_{it} factors are shown in Equation (12).

$$AMG = \frac{1}{N} \sum_{i=1}^N \varphi_i. \quad (13)$$

4. Results and discussion

4.1. Preliminary estimations

These descriptive statistics in Table 1 provide a general overview of the variables used in the analysis. The dependent variable, sustainability (SUS), has a mean of 5.31 and a standard deviation of 5.77. This indicates that the values in the sample are widely dispersed. The skewness (1.50) and kurtosis (4.58) indicate that the distribution is positively skewed with heavier tails than a normal distribution. The GDP exhibits significant variation around the mean among countries, as shown by the high mean of 8,072.09 and standard deviation of 10,218.82. Consequently, with a value of 1.46 for skewness and 3.78 for kurtosis, further deviations from normality are manifested. On the one hand, FDI ranges from -103.16 to 280.15, while the average value is 4.85. This variable has a highly positive skewness of 9.20, with a very high kurtosis of 105.14; hence, strong outliers may be present. The POPPG has an average of 63.73 and a standard deviation of 5.91, which is relatively steady and less dispersed. Its skewness is -0.08, and kurtosis is 2.33, closer to the typical distribution values. Trade - TRD shows an average of 78.39 with a standard deviation of 45.38, while its skewness is 0.66 and kurtosis is 2.74, showing mild positive skewness and near-normal distribution. Jarque-Bera normality

Table 1
Descriptive statistics

Variables	SUS	FDI	GDP	POPPG	TRD
Mean	5.311670821	4.8542876	8072.092173	63.72871976	78.38762717
Median	3.40963401	1.661436481	3130.910641	64.12880776	66.94695239
Maximum	23.15740473	280.1455104	36202.63927	77.72366532	220.406789
Minimum	0.047857598	-103.1566865	353.95657	50.55155749	0
Std. Dev.	5.770507691	20.62511339	10218.81504	5.912995085	45.38266389
Skewness	1.49932422	9.201524871	1.458621833	-0.079916743	0.664349343
Kurtosis	4.581868034	105.1391583	3.784804331	2.332411426	2.739309265
Jarque-Bera	363.5040414	340635.4018	288.6169744	14.90237195	57.98127044
Probability	1.16E-79	0	2.13E-63	0.000580752	2.57E-13
Sum	4031.558153	3684.404289	6126717.959	48370.0983	59496.20903
Sum Sq. Dev.	25240.45933	322449.6391	79153529066	26502.34124	1561166.326
Observations	759	759	759	759	759

Source: compiled by the authors.

Table 2
Correlation matrix

Variables	SUS	FDI	GDP	POPPG	TRD	TRD*POPPG
SUS	1	0.054906582	0.758104941	0.540653703	0.375917189	0.44672
FDI	0.054906582	1	0.168644949	0.167950374	0.176009476	0.195192
GDP	0.758104941	0.168644949	1	0.42638011	0.229297719	0.28511
POPPG	0.540653703	0.167950374	0.42638011	1	0.346237598	0.473373
TRD	0.375917189	0.176009476	0.229297719	0.346237598	1	0.986319
TRD_POPPG	0.446720318	0.19519182	0.285110187	0.473372559	0.986318603	1

Source: compiled by the authors.

test is highly significant ($p < 0.05$) for all variables indicating distributions not expected.

The correlation matrix provides a relation among the variables reported in Table 2. SUS has shown a high positive correlation with GDP and a medium positive correlation with POPPG, TRD, and their interactive term. This indicates that these variables may influence the sustainability of the country. FDI has weak positive correlations with all variables, suggesting limited direct relationships among them. GDP is moderately correlated with POPPG while trade and interactive terms show stronger associations with. As expected, due to its construction, $TRD \times POPPG$ is highly correlated with trade. The matrix suggests that interrelationships should be best investigated using regression analysis to determine causality and significance.

Table 3 summarises the series of tests for cross-sectional dependency and homogeneity of slope. The statistics from [Breusch, Pagan, 1980; Pesaran et al., 2004; 2008; Pesaran, Yamagata, 2008; Pesaran, 2014] are all significant for the variables SUS, FDI, GDP, POPPG, and TRD. These results indicate the presence of cross-sectional dependence, so the

observations across countries are interrelated. The Delta tilde and adjusted Delta tilde statistics reiterate the heterogeneity of slopes, indicating that the relationships between variables vary across nations with respect to sustainability. Therefore, these characteristics of the dataset support the use of econometric models that incorporate cross-sectional dependencies and the heterogeneity of slopes, such as AMG and DSKE models, for reliable inference.

Table 4 summarises the results of panel unit root tests, PURT, using the CIPS and CADF methods in testing for stationarity. The test statistics are insignificant for most variables, such as SUS, GDP, TRD, and the interaction term $TRD \times POPPG$ were non-stationary at their levels, $I(0)$. Only FDI and POPPG exhibit stationarity at the 5% significance level in one or both tests. However, after the first differencing $I(1)$ -all variables become stationary with significant test statistics under both the CIPS and the CADF methods. This confirms that the variables are integrated in order 1, $I(1)$. The result indicates that the series are underpinned by a unit root process. Consequently, all these variables are non-stationary, with their mean and variance changing over time. These findings lead to long-run equilibrium

Table 3
CSD and SHT Outcomes

Variable	Breusch-Pagan LM Stat (p -value)	Pesaran scaled LM Stat (p -value)	Bias-corrected scaled LM Stat (p -value)	Pesaran CD Stat (p -value)
SUS	3666.368***	151.743***	151.383***	21.380***
FDI	662.291***	18.195186779196***	17.836***	7.4160***
GDP	5887.768***	250.496002199176***	250.1366***	52.577***
POPPG	6251.415***	266.662084843274***	266.302***	63.990***
TRD	1502.869***	55.5634759853373***	55.204***	15.0961***
Delta tilde	28.165***			
Delta tilde adjusted	31.137***			

Notes. Significance levels: *** – $p < 0.01$, ** – $p < 0.05$, * – $p < 0.1$.

Source: compiled by the authors.

Table 4
PURT outcomes

Variables	CIPS			CADF		
	First level I(0)	Fist Diff. I(I)	Status	First level I(0)	Fist Diff. I(I)	Status
SUS	-1.978	-4.285***	I(1)	-1.978	-2.645***	I(1)
FDI	-2.587***	-5.657***	I(0)	-1.965	-3.534***	I(1)
GDP	-1.517	-3.291***	I(1)	-1.515	-2.176**	I(1)
POPPG	-2.333**	-2.504***	I(0)	-1.755	-2.116**	I(1)
TRD	-1.84	-4.924***	I(1)	-1.81	-3.016***	I(1)
TRD*POPPG	-1.784	-4.886***	I(1)	-1.801	-2.894***	I(1)

Notes. Significance levels: *** – $p < 0.01$, ** – $p < 0.05$, * – $p < 0.1$.
Source: compiled by the authors.

relationships between the variables, making the cointegration approach appropriate for further work.

Table 5 presents the results of panel cointegration tests using the [Kao et al., 1999; Westerlund, Edgerton, 2007] tests to see if there is long-run equilibrium relationships between the variables. The ADF statistic from the Kao test for the no-interaction model is significant at the 5% level, suggesting the possibility of cointegration. The model with interaction also provides a significant Kao test result at 10% and, therefore, shows weaker evidence of cointegration in that specification. The Westerlund test provides more substantial evidence of cointegration in both models. All four test statistics, $G\tau$ and $G\alpha$, $P\tau$, and Pa , are significant enough to confirm cointegration for a model without interaction. Also, in the case of a model with interaction, all test statistics are highly significant at $p < 0.01$, reinforcing the notion that there is usually a long-run relationship between dependent and independent variables when there is an interaction term.

Generally, the Westerlund test results indicate strong evidence of cointegration in both models, consistent with the Kao's results. That means that estimation of long-term dynamics is appropriate in the panel framework.

4.2. Regression results

The results from Table 6, without the interactive term AMG, indicate that FDI is negatively related to sustainability, though insignificantly. However, robustness checks through DKSE, FMOLS, and DOLS show that FDI significantly influences sustainability negatively at the 1% significance level. This suggests that higher magnitudes of FDI, as captured in this study, are unlikely to contribute positively to sustainability and may even increase unsustainable practices in the selected Asian countries. Robustness measures support the reliability of this finding, pointing to possible adverse environmental or social consequences of FDI in this context.

Table 5
Cointegration results

Kao Test	Model without interaction		Model with interaction		
	<i>t</i> -Statistic	Prob.			
ADF	-1.638043528**	0.050706	ADF	-1.35967*	0.086967
Residual variance	0.28118657		Residual variance	0.280524	
HAC variance	0.243900575		HAC variance	0.222615	
Westerlund	Model without interaction		Model with interaction		
	<i>t</i> -Statistic	Prob.			
$G\tau$	-1.6572**	0.0487	-3.412***	0.000	
$G\alpha$	-2.1541**	0.0156	-2.453***	0.000	
$P\tau$	-1.0426***	0.000	-3.412***	0.000	
Pa	-1.2875***	0.000	-3.345***	0.000	

Notes. Significance levels: *** – $p < 0.01$, ** – $p < 0.05$, * – $p < 0.1$.
Source: compiled by the authors.

The AMG results indicate that GDP positively affects sustainability with a small, statistically insignificant coefficient. This implies that economic growth positively impacts achieving sustainability in selected countries. Robust models such as DKSE, FMOLS and DOLS confirm this observation with statistically significant coefficients across all measures, reinforcing the evidence for the importance of economic growth in enhancing sustainability. These findings agree that higher GDP allows for investment in sustainable practices and environmental management.

The coefficient of the productive population with respect to sustainability is positive and significant, indicating that an increase in the proportion of the productive workforce enhances sustainability. This correlation proves to be highly robust across the DKSE, FMOLS, and DOLS series, with latter having statistically significant positive coefficients. Among these the DKSE has the most significant effect. These findings imply that a productive population is instrumental in achieving developmental development goals due to its high level of labour output and its contribution to social and economic development.

While trade shows a positive, but statistically insignificant, relationship with sustainability in the AMG model, DKSE and DOLS show a positive and significant relationship. Thus, trade enhances sustainability in these countries. Interestingly, the FMOLS model yields an insignificant and slightly negative coefficient, reflecting some variability. Significant findings in DKSE and DOLS indicate that, if well governed, trade could be a vehicle for sustainability, by encouraging the diffusion of green technologies and sustainable practices.

While the AMG model provides a first-order insight into the relationships, robustness checks add extra reliability. Whereas the AMG model indicates general trends, the consistent results from DKSE, FMOLS and DOLS support strong positive effects of GDP and POPPG on sustainability and negative

impact of FDI. Trade results suggest that the role of trade in sustainability may need further investigation, since its effect is related to the structure and nature of trade in the selected Asian countries. In general, the findings of this study show that balancing foreign investments, economic growth, productive use of the population, and managing trade will help achieve sustainability.

In the presence of interaction term interplay from Table 7, the AMG model presents FDI as inversely related to sustainability and SUS, though the result is not statistically significant. However, other robustness models, such as DKSE, FMOLS and DOLS consistently show that FDI negatively affects sustainability at a 1% significance level. The DKSE model shows the most significant negative coefficient, indicating that an increase in FDI could work against sustainability in Asian countries. This could mean that FDI in these countries does not aim to achieve sustainability goals due to profit-driven activities without responsibility towards the environment or society. Furthermore, from Table 7, AMG estimates a positive coefficient that is statistically significant but small in magnitude, indicating that GDP supports sustainability. DKSE, FMOLS and DOLS also confirm this finding, showing a similar positive impact of GDP on sustainability at 1% significance. This evidence shows that higher economic growth enables more investments in sustainable projects, technologies and infrastructures, which lead to better environmental and social outcomes.

The coefficient of POPPG is positive and statistically significant in the AMG model, indicating that an increase in the productive population contributes positively to sustainable development. This result is further supported by robust models FMOLS and DOLS, which show significant and favorable coefficients. However, the DKSE model reports a weaker but still positive relationship. These findings underline the importance of an active and productive population in ensuring

Table 6
AMG, DSKE, FMOLS, and DOLS outcomes without interaction

Regression estimates without interaction	AMG	DKSE	FMOLS	DOLS
FDI	-0.0412173 (0.0532)	-0.034082*** (0.0059819)	-0.0113*** (0.0039)	-0.0500*** (0.0124)
GDP	0.0005144*** (0.00013)	0.0003626*** (0.706)	0.00017*** (0.00004)	0.00038*** (2.772)
POPPG	0.0860785** (0.04217)	0.2225497*** (0.05554)	0.14943*** (0.01946)	0.0187* (0.0100)
TRD	0.004508 (0.00475)	0.0217624*** (.003481)	-0.00192 (0.0036)	0.0278*** (0.00731)
Trend	0.8831587* (0.50072)			
Constant	-3.369436 (2.873)	-13.33878*** (3.499409)		
R Squared			0.963	0.897
Adjusted R Squared			0.962	0.846

Notes. Significance levels: *** – $p < 0.01$, ** – $p < 0.05$, * – $p < 0.1$, () – standard error.

Source: compiled by the authors.

Table 7
AMG, DSKE, FMOLS, and DOLS outcomes with an interaction term

Regression estimates with interaction	AMG	DKSE	FMOLS	DOLS
FDI	-0.0338687 (.0430409)	-0.0361492*** (.0062149)	-0.0069*** (0.0016)	-0.0063 (0.0041)
GDP	0.0005159*** (.000148)	0.000356*** (0.806)	0.00016*** (1.918)	0.00016*** (4.693)
POPPG	0.1418228** (.0715899)	0.0155808 (0.0706297)	0.10015*** (0.0145)	0.0976*** (0.0349)
TRD	0.0370655 (.0455598)	-0.1505141*** (0.0211308)	-0.0353*** (0.0094)	-0.0418* (0.0228)
TRD*POPPG	-0.0004803 (.0006879)	0.0026855*** (0.0003791)	0.000578*** (0.00015)	0.00066* (0.00037)
Trend	0.9841526** (.4983889)			
Constant	-6.606663 (4.958739)	-0.2461911 (4.196837)		
R Squared			0.964	0.962
Adjusted R Squared			0.963	0.961

Notes. Significance levels: *** – $p < 0.01$, ** – $p < 0.05$, * – $p < 0.1$, () – standard error.

Source: compiled by the authors.

sustainable economic and social development, possibly due to increased labour and resource efficiency. Whereas the AMG model shows a positive but insignificant relationship between trade and sustainability, DKSE shows a significantly negative impact of trade. FMOLS, on its part, reveals a significantly positive impact, while DOLS shows a small but significant negative impact. This could indicate that the impact of trade on sustainability depends on the nature of trade activities, and whether they involve sustainable practices or pollution-sensitive industries. The impact of trade may be context-specific, and further research is needed to understand this better.

The coefficient of the interaction term representing trade and the productive population, $TRD \times POPPG$, is harmful and insignificant in the AMG model. At the same time, robust models, such as DKSE, FMOLS, and DOLS show that the combined effect of trade and a productive workforce is positive and significant. The finding suggests that, while trade may have numerous effects, it can couple better with an active workforce to ensure more sustainable outcomes through responsible trade and productivity. Notably, the interaction term ($TRD \times POPPG$) is significant; the DKSE, FMOLS, and DOLS models are all substantial and positive, meaning that the interaction

Appendix
Table A1
Variable Description

Variable name	Measurement unit	Source
Income growth (INCOME)	Gross domestic product (GDP) per capita (\$)	World development indicator (2023)
Productive population (PP)	Population ages 15-64, total	World development indicator (2023)
Technological innovation (Tech)	The combination of patent applications by residents and non-residents	World development indicator (2023)
Sustainability (SUS)	Renewable energy use as a share of total energy use	World development indicator (2023)
Technological innovation – Productive population interaction (TECH \times PP)	Captured with technological innovation \times Productive population interaction	Derived
Foreign direct investment (FDI)	Foreign direct investment net inflows (% of GDP)	World development indicator (2023)
Physical capital (PC)	Gross fixed capital formation (% of GDP)	World development indicator (2023)
Trade openness (TRD)	Trade in (% of GDP)	World development indicator (2023)

Source: compiled by the authors.

between trade and a productive population creates scope for fostering sustainable outcome results. This finding highlights an essential aspect of integrating workforce development with a strategic trade policy for maximum sustainable benefits. The results underscore the need to manage economic growth, trade, and foreign investment strategically, drawing on workforce productivity to achieve sustainability goals.

5. Conclusion and policy implications

The quest for sustainability remains urgent to globally cater to current needs and future prosperity of generations. However, the debate about appropriate policy measures and strategies for promoting sustainability that communities and nations can adopt is controversial. In this respect, we examine the interplay between sustainability, trade direction diversification, productive population and foreign direct investment across selected countries in Asia. The study used a panel series covering 23 selected Asian countries between 1990 and 2022. We analysed the data employing a battery of estimators, including Augmented Mean Group (AMG), Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares, as well as Standard Errors [Driscoll, Kraay, 1998] methods to obtain robust estimates and account for endogeneity and cross-sectional dependence syndromes associated with the data.

Following the data analysis, we discovered that FDI has a negative relationship with sustainability. This suggests that FDI retards the advancement of sustainability in selected Asian countries. GDP, the productive population, and trade all have a positive impact on sustainability. This indicates that GDP growth in the selected Asian countries promotes sustainability in the region. Moreover, the positive impact of the productive population on the selected region indicates that the share of the productive population in the sample countries is substantially contributing to the growth of sustainability. However, while trade has a positive effect on the levels of sustainability in the selected Asian countries, the impact is not significant. Additionally, by interacting with trade diversification and a productive population ($TRD \times POPPG$), we find that the interplay significantly enhances the levels of sustainable development in these countries. This suggests that trade and a productive population create the potential for sustainable outcomes. Therefore, it emphasises the importance of integrating workforce development into a strategic trade policy to achieve maximum sustainable benefits.

Following the findings, the study proposes policies for sustainability improvement in Asian countries based on evidence. First, sustainability in Asian countries could be improved through government regulation of FDI, by implementing environmental standards and creating a friendly business environment that encourages eco-friendly investment through FDI. Governments should promote FDI towards renewable energy initiatives, sustainable infrastructure development, and circular economy projects, through strengthened environmental standards to ensure compliance by foreign investors. Secondly, for the countries to maximise sustainable growth through their economic expansion, the study suggests integrating green policies into the national development plans of regional economies. Thirdly, the government authorities can enhance the sustainability strategy in sample countries by providing tax benefits and financial incentives for research and clean technology development (R&D). Through R&D, the government can support workforce development, which is essential for providing green capabilities to employees and supporting sustainability-oriented entrepreneurs. They can also create universal access to training programmes.

Fourth, the outcome of evidence indicates that the advancement of sustainability relies heavily on trade diversification, because it drives sustainable product exports and develops sustainable production incentives within regional trade agreements. Therefore, regional and national authorities should simplify the process of digital trade and e-commerce in order to reduce environmental damage caused by conventional trade operations. Furthermore, combining workforce development programmes with trade policies can lead to maximum sustainability through public-private networks that connect training to environmentally friendly market opportunities. This integration can strengthen green skill development critical to executing sustainable trading practices and fostering overall sustainability level.

The findings of our study support robust policy implications for sustainability, but there is a major drawback: the sample size of the selected Asian countries. We have collected data from 23 of the 48 Asian countries for analysis, and the results of our findings may not be universal as a one-size-fits-all approach for the remaining economies that were excluded. However, our sample size covers about 70% of the Asian economy, which therefore reflects the characteristics of the region. Moreover, the findings are robust, align with the literature and support practical policies for sustainability drive.

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Reaping the benefits: How corporate governance enhances ICT governance in the South African public sector – Insights for developing nations

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Abstract

Corporate governance structures are progressively acknowledged as fundamental facilitators of ICT governance within the public sector. However, within the context of developing nations, the operationalisation of governance principles into tangible ICT outcomes frequently remains an area warranting further scholarly inquiry. This article examines the practical advantages afforded by corporate governance mechanisms as applied within South African governmental ICT settings, drawing upon qualitative data derived from 55 comprehensive interviews conducted with Government Information Technology Officers (GITO). Through the application of thematic analysis, four interconnected domains of benefit were identified: heightened regulatory adherence, enhanced transparency and accountability, optimised information system efficiency, and improved project accomplishment rates. Whilst established governance frameworks, such as COBIT and King IV, are demonstrably institutionalised, their efficacy is primarily evinced through their capacity to foster ethical stewardship, facilitate systematic strategic planning, and ensure coherence across diverse ICT functions. This investigation contributes to the extant literature by furnishing an empirically substantiated, practitioner-informed exposition of governance enactment within intricate administrative ecosystems. The resultant findings possess considerable practical utility for public sector organisations endeavouring to harness governance as a catalyst for digital transformation, particularly within the resource-constrained environments characteristic of many developing economies.

Keywords: governance frameworks, digital transformation, BRICS

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南非公共部门信息通信技术 (ICT) 领域公司治理的优势： 对发展中国家的经验与建议

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简介

在公共部门，人们日益认识到公司治理结构对于有效管理信息通信技术具有关键重要性。然而，对于发展中国家而言，如何通过实施这些管理原则在信息通信技术领域带来具体可衡量的成果，仍是一个亟待通过科学研究来探讨的课题。本文基于对南非公共部门55名负责信息技术的政府官员进行的深度访谈所获得的定性数据分析，揭示了应用公司治理原则于信息通信技术领域所带来的实际效益。通过主题分析研究发现，在四个相互关联的领域取得了显著优势：提升规范合规性、增强透明度与问责制、优化信息系统运作，以及提高项目完成率。公认的治理框架（包括COBIT和King IV）虽已成熟，但其有效性主要体现在促进道德治理、系统性战略规划及ICT职能整合方面。本研究基于复杂行政生态系统中获取的实证数据与从业者信息，对治理实施进行了分析。对于资源禀赋有限的发展中国家而言，致力于通过有效治理实现数字化转型的政府机构，本研究结果具有重要的实践价值。

关键词: 治理结构, 数字化转型, 金砖国家

引用:

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Introduction

Public sector organisations depend heavily on strong Information and Communication Technology (ICT) systems, because digital transformation is required in the present day. The systems provide the foundation for delivering services effectively, while maintaining accountability and transparency [Curtis, 2019]. Public institutions in developing nations face

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considerable hurdles when it comes to overseeing their ICT systems. These challenges often manifest themselves in the form of unsuccessful project implementations, increased cybersecurity vulnerabilities, and widespread inefficiencies in ICT procurement and service delivery [Pangaribuan, 2019]. Given this, corporate governance is a crucial area of focus within public administration and information systems research,

vital for optimising ICT performance and mitigating risks [Latchu, 2022].

Corporate governance, traditionally understood as the system of rules, practices, and processes through which organisations are directed and controlled, has been progressively embraced by public institutions. This adoption serves as a means to ensure ethical leadership, robust financial oversight, adherence to regulatory frameworks, and strategic alignment of ICT initiatives with broader institutional objectives [Ferguson, 2019; Erasmus, Marnewick, 2020]. Within South Africa’s public ICT governance, a range of corporate mechanisms play a vital role. These include dedicated audit and risk committees, strategic steering groups, standardised project methodologies, and rigorous regulatory compliance frameworks. They are routinely guided by pivotal instruments such as the Public Finance Management Act (PFMA), King IV, COBIT, and ISO 38500 [Walt et al., 2014; Ajam, Fourie, 2016; Mathase et al., 2019; Khumalo, Mazenda, 2021].

Despite the growing institutionalisation of corporate governance frameworks within government ICT environments, there is a notable lack of empirical understanding regarding their practical benefits. This is particularly true when viewed from the perspective of those directly responsible for ICT implementation. Current academic discussions often focus on theoretical governance frameworks, often overlooking how these structures actually affect daily operations, impact critical decisions, or contribute to successful projects [Azmi et al., 2018; Khumalo, Mazenda, 2021].

This article fills that research gap. The research uses qualitative data from 55 in-depth interviews with government information technology officers (GITO) in South African public institutions to identify and analyse four main advantages of good corporate governance. The four main benefits are: (1) compliance and regulatory alignment; (2) transparency and accountability; (3) information system efficiency; and (4) project success. By directly focusing on the lived experiences of these GITO, the research offers a dual contribution to both academic theory and practical application. Theoretically, it expands current literature by demonstrating that governance advantages extend beyond simple adherence to rules, actively fostering institutional coordination, ethical leadership, and operational discipline.

1. Literature review

1.1. Corporate governance tools used in ICT operations by government information technology officers

The interview participants emphasised that corporate governance in ICT operations relies on multiple tools and frameworks to achieve compliance and efficiency and maintain accountability [Ako-Nai, 2021]. They specifically identified various corporate governance tools used by government information technology officers (GITO) in South Africa, which are summarised in Figure 1.

The corporate governance tools studied in this research serve as essential instruments for maintaining compliance and transparency, and achieving efficiency in government ICT operations. These tools include the PFMA and MFMA legislative acts, which regulate financial oversight, as well as best practice frameworks such as COBIT and King IV, which

provide structured governance principles. Accountability for ICT governance and its operational alignment is actively enforced through internal mechanisms, specifically through audit and risk committees, as well as dedicated ICT steering and strategy committees. The bar chart in Figure 2 shows the distribution and frequency of governance tools mentioned by participants during interviews, which confirms that South African public sector institutions heavily depend on acts, regulations, compliance & assurance, best practices and internal governance instruments for effective ICT governance.

Governance mechanisms generally fall into two categories: external frameworks (such as legislation and regulations) and internal structures (including committees, policies, and best practices). External instruments, such as the Public Finance Management Act (PFMA) and Municipal Finance Management Act (MFMA), primarily manage financial oversight. Internal frameworks, such as ICT Steering Committees, complement these external instruments and are crucial for maintaining operational alignment.

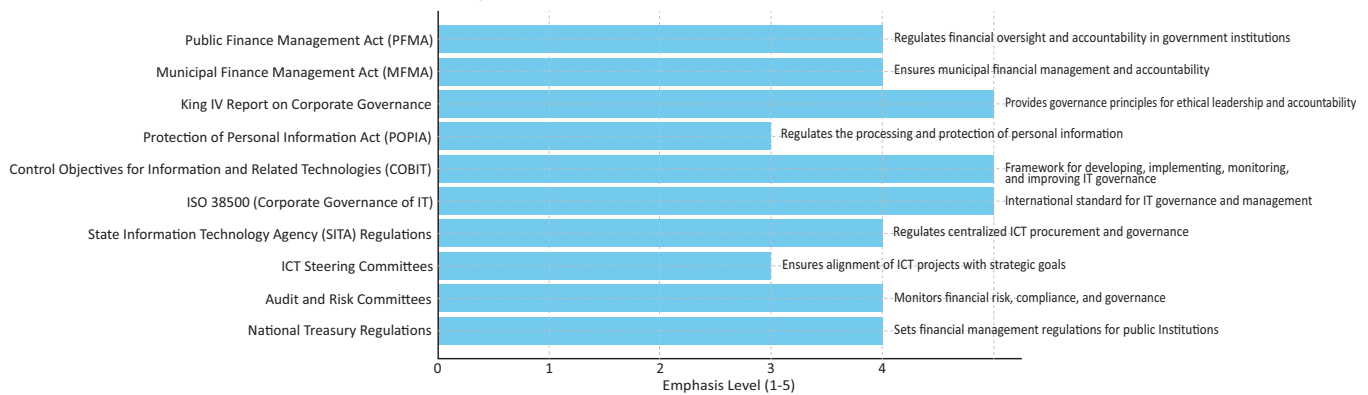
A significant body of academic work suggests that strong ICT governance can effectively reduce cybersecurity risks, safeguard data integrity, and boost overall efficiency. Frameworks rooted in King IV principles and the Department of Public Service and Administration (DPSA)’s directives primarily foster public trust and policy adherence within the South African public sector by emphasising transparency and accountability. Separately, but equally important, are risk management mechanisms. These include compliance audits and bespoke ICT project governance structures. They are indispensable for mitigating system vulnerabilities and maintaining consistent regulatory compliance [Schillemans, Bovens, 2019]. Additionally, [Folorunso et al., 2024] indicate that deploying established governance models such as COBIT and ISO 27001 have yielded significant improvements in operational efficiency and enhanced cybersecurity resilience.

In essence, these various governance tools form the fundamental operational underpinning for ICT governance across the South African public sector. The actual worth of these governance tools emerges from their implementation, as they influence both organisational practices and final results. The following section examines the advantages that result from the proper implementation of these governance mechanisms according to GITO operating in various government institutions.

1.2. Translating governance tools into benefits

The following section examines the particular advantages which these tools provide when they are used in ICT operations and in institutional decision-making processes. Corporate governance continues to play an essential role in determining the effectiveness of ICT governance in public sector organisations [Bogus, Baiesu, 2022]. The public sector has rapidly adopted governance frameworks that originated in corporate environments, because governments aim to modernise their operations and boost accountability and service delivery [Latchu, 2022]. This section examines theoretical and empirical research on the four corporate governance advantages, which include compliance and regulation, transparency and accountability, information systems (IS) efficiency, and project success.

Fig. 1. Governance tools and associated themes



Source: author's analysis based on interview data, 2025.

Corporate governance and compliance in the public sector

Compliance is used to denote how well these institutions comply with the law, regulations and policies. The legal framework behind ICT decision-making in the public sector is rooted in corporate governance legislation, which includes the Public Finance Management Act (PFMA), the Municipal Finance Management Act (MFMA) and the Protection of Personal Information Act (POPIA) [Walt et al., 2014; Ajam, Fourie, 2016; Mathase et al., 2019; Khumalo, Mazenda, 2021]. Regulatory instruments are often put into practice through audit and risk management, which oversee both financial and operational risks. [Erasmus, Marnewick, 2020] argue that formal governance structures help reduce ICT-related risks by ensuring careful financial management and adherence to standard operating procedures. Similarly, [Smith, Marx, 2022] assert that governance frameworks steer ethical conduct, reduce exposure to audit findings, and foster a culture of compliance.

However, compliance extends beyond mere regulatory adherence. It also encompasses internal control systems and operational safeguards designed to ensure disciplined and consistent decision-making. [Lankton et al., 2020] underscore how audit mechanisms enhance organisational trust, even in situations where ICT-specific expertise might be limited. These insights suggest that governance-driven compliance significantly contributes to both legal accountability and institutional resilience.

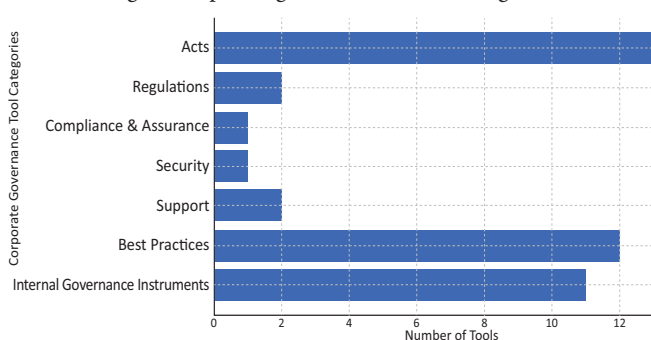
Governance, transparency, and accountability

Transparency and accountability, core tenets of public administration, serve as the foundation for corporate governance simultaneously. Within the ICT domain, these principles are realised through governance structures that facilitate oversight, promote ethical decision-making, and ensure that ICT efforts align with broader organisational objectives. [Schillemans, Bovens, 2019] underscore how governance boards and risk committees strengthen reliable decision-making. [Bhuiyan et al., 2020] explain that external chair-led structures promote impartiality and prevent internal bias. The strategic implementation of governance frameworks creates accountability through standardised processes that establish clear responsibilities. According to [Khumalo, Mazenda, 2021; Santos Castellanos, 2021] ethical ICT governance builds public trust while ensuring departmental goals match ICT strategy. Governance serves as a system for oversight, providing tools for participatory planning and performance tracking, which are essential for the transparent deployment of ICT resources in public service environments.

Information systems efficiency through governance

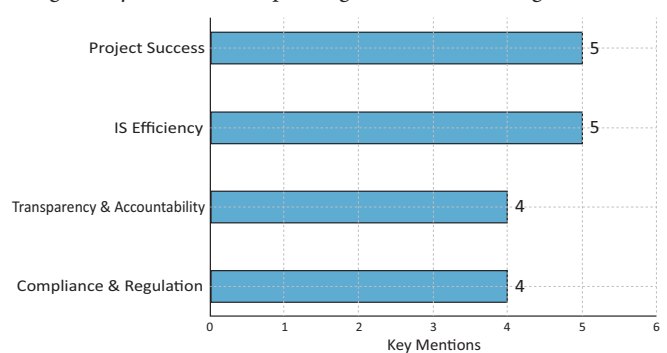
The delivery of ICT services through information systems (IS) requires reliability, security, and actual user needs fulfilment to achieve efficiency. IS efficiency is boosted by the application of best practices such as COBIT, ISO 38500, and King IV, which are facilitated by robust corporate governance frameworks that equip organisations. They offer guidelines to standardise processes, manage IT risks, and critically, ensure system integration and

Fig. 2. Corporate governance and its categories



Source: author's analysis based on interview data, 2025.

Fig. 3. Key benefits of corporate governance for ICT governance



Source: author's analysis based on interview data, 2025.

scalability across the public sector. [Folorunso et al., 2024] point out that ISO-based security standards improve how well public institutions handle cybersecurity. Meanwhile, [Huygh et al., 2022] stress that COBIT's compliance requirements enhance IT service delivery by making governance roles and responsibilities clearer. [Ferguson, 2019] also notes that the King IV principles promote operational resilience by integrating continuity planning directly into ICT operations. Moreover, governance significantly enhances inter-departmental coordination, which is critical for public sector digital projects. As [Halik et al., 2020] explain that administrative effectiveness improves when ICT systems are managed using clearly defined protocols and roles tied to accountability. These observations support the argument that corporate governance enhances institutional performance by incorporating efficiency-focused structures into all ICT operations.

Governance and project success

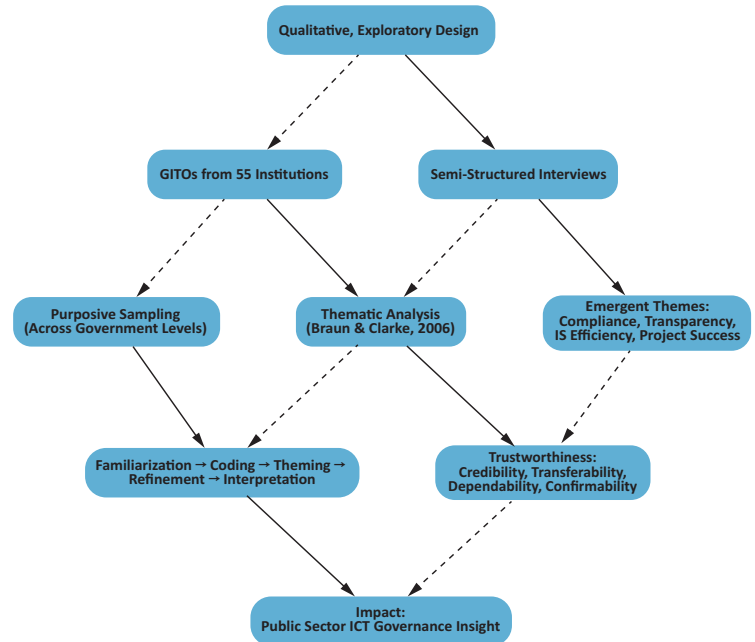
Project governance involves applying established governance principles throughout the entire lifecycle of a project, from initial planning stages through to execution and final evaluation. Public sector ICT projects operate in environments with higher risks. The main causes of these risks are complex procurement systems, fragmented stakeholder involvement, and political interference. Corporate governance structures provide essential value in these situations because they establish standardized methods and clear performance metrics and strict financial oversight to reduce risks. [Ako-Nai, 2021] points out that governance plays a critical role in project success by bringing a structured approach to how stakeholders are involved, and how policies align. Research from [Ferrer et al., 2020] indicates a clear benefit: projects underpinned by robust governance frameworks tend to encounter fewer budget issues, and are more likely to complete on schedule. [Gamlath et al., 2024] present findings indicating that project governance boosts both cross-functional teamwork and sustainability. This is because it emphasises integrated learning systems and robust accountability measures. These insights are particularly relevant for South Africa, which is actively involved in significant digital initiatives such as ERP system deployment, online registration platform establishment, and cloud migration projects. Public institutions can significantly improve the quality of execution and long-term value realisation by embedding strong governance throughout the project lifecycle.

The key constructs from the literature are synthesised in the following conceptual pathway, as illustrated by Figure 4. Corporate governance mechanisms are influenced by both external and internal factors and contribute to ICT governance outcomes in the public sector.

2. Methodology

The research employed a qualitative exploratory design to study how corporate governance enhances ICT governance in South African public sector organisations as shown in Figure 5. The research used a qualitative method to gain deep insights into how ICT leaders in complex institutional settings understand and experience governance mechanisms.

Fig. 5. Methodology flow

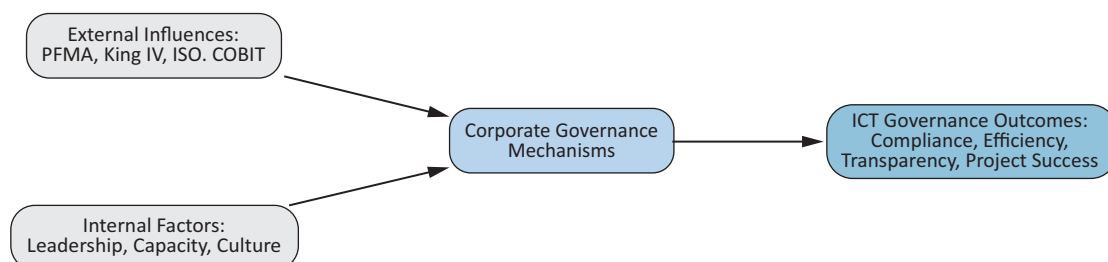


Source: author's analysis based on interview data, 2025.

2.1. Research context and participants

This research focused on government information technology officers (GITOs), who hold the most senior ICT positions within national, provincial and local government departments, state-owned entities and public agencies across South Africa. The

Fig. 4. Pathway from governance mechanisms to ICT



Source: author's analysis based on interview data, 2025.

GITOs have demonstrated exceptional capability to assess the practical corporate governance value of public ICT environments, as they actively participate in ICT strategy development, policy implementation, risk management and digital transformation initiatives. The researcher conducted 55 in-depth semi-structured interviews with GITOs across various public institutions. Participants were selected through purposeful sampling and professional networks to ensure a diverse representation of government levels, functional domains, and geographic locations. This sampling approach allowed the researchers to study both institutions with abundant resources as well as those with limited resources, which resulting in a broad spectrum of governance experiences.

2.2. Data collection

Data were collected over a six-month period using a semi-structured interview guide, as illustrated in Figure 6. The guide focused on eliciting participants' experiences with governance tools (e.g. PFMA, King IV, COBIT), the operationalisation of governance structures (e.g. audit committees, steering committees) and the perceived outcomes of governance in areas such as compliance, transparency, IS efficiency and project performance. Interviews were conducted via secure video conferencing platforms. All interviews were audio recorded with informed consent, and transcribed verbatim, with interview durations ranging from 45 to 90 minutes. Prior to data collection ethical clearance was obtained and anonymity maintained throughout the research process.

2.3. Data analysis

The data were analysed using the method described in [Braun, Clarke, 2006]. The analytical method chosen was flexible and produced detailed findings from large qualitative datasets. The analysis proceeded in the following stages:

- Familiarisation: We reviewed transcripts to find patterns of meaning.
- Coding: Initial codes were generated from repeated mentions of governance structures and outcomes associated with them.
- Theme development: These codes were then organised systematically into higher-level themes, specifically chosen to resonate with both established academic literature and discernable patterns within the dataset.
- Theme refinement: A thorough examination followed to verify the internal consistency and empirical strength of these themes of these themes.
- Interpretation: The final themes were interpreted based on the objectives of the study and corporate governance theory.

The analysis revealed four primary themes, which included: (1) compliance and regulation; (2) transparency and

accountability; (3) information system efficiency; and (4) project success, as Figure 7 demonstrates. The credibility of the study was supported by direct quotations that we linked to relevant literature, establishing its credibility.

2.4. Trustworthiness and rigor

To ensure the trustworthiness of the findings, we implemented several strategies:

- Credibility: The credibility of our research was derived from our deep engagement with participants and our analysis of relevant policy documents and existing governance frameworks.
- Transferability: The transferability of the study was improved through detailed descriptions of the specific public sector context under study.
- Dependability and confirmability: Research dependability and confirmability was supported by maintaining an audit trail and conducting regular peer debriefing sessions, which helped to reduce researcher bias.

The strict methodology enabled researchers to conduct a thorough analysis of corporate governance advantages in ICT governance from the perspectives of those who implement it.

The authors used the QuillBot writing enhancement tool during the preparation of the original manuscript to improve the grammar and clarity of the language in the final version. Throughout this process, the research analysis, data interpretation and findings of the article remained unchanged.

3. Findings and discussion

The thematic analysis of 55 interviews with government information technology officers (GITOs) revealed four interconnected benefits of corporate governance within the public sector ICT environment. These were identified as: (1) compliance and regulation, (2) transparency and accountability, (3) information systems (is) efficiency, and (4) project success. These emergent themes shed light on the practical application of governance frameworks and their influence on both institutional performance and broader ICT outcomes.

3.1. Compliance and regulation

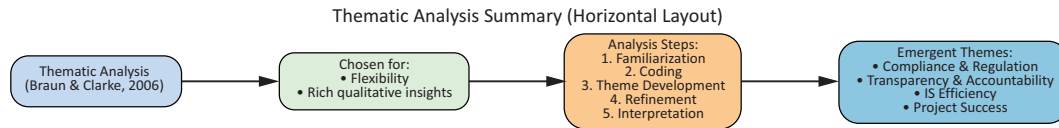
The government IT departments identified corporate governance as their essential driver for success. The participants emphasised that governance serves as an essential element for maintaining regulatory compliance, institutional accountability, and operational discipline. They emphasised the importance of governance structures that include legislative requirements, such as PFMA and MFMA, as essential safeguards. The frameworks function as the main tools to ensure compliance with essential areas, including procurement protocols, data protection requirements, audit benchmarks, and general legal compliance

Fig. 6. Data collection process



Source: author's analysis based on interview data, 2025.

Fig. 7. Data analysis process



Source: author's analysis based on interview data, 2025.

[Bakare, Ajani, 2023; Suresh et al., 2024]. The participants emphasised the importance of proper governance systems, which enable organisations to systematically identify risks and take steps to minimise them. A proactive approach helps departments successfully handle vulnerabilities in the face of an evolving complex regulatory environment [Jonathan et al., 2019; Human, 2023].

As one GITO noted, 'Good ICT governance enables the department to maintain fiduciary diligence. It helps in risk identification and ensures compliance with South African laws and regulations.' Another added, 'It describes the rules and processes for operating, which also minimises audit findings. They also help with the behaviour of staff. They guide the use of IS by the entity. They assist in reducing organisational IS risk.'

The pivotal function of audit committees has undeniably emerged as a cornerstone within this intricate public sector compliance ecosystem. These committees have received widespread recognition for their essential independent oversight, despite their general lack of deep ICT-specific expertise. Their work has reinforced established governance principles and provided essential ICT-related accountability for the public sector.

One participant observed, 'Ensure that the project follows identified project methodology. This will help to ensure project delivery compliance. The project risks are minimised and all stakeholders take responsibility. For example, Charter will be signed outlining roles and responsibilities.'

These discoveries resonate significantly with [Lankton et al., 2020] the characterisation of audit committees as the 'compliance backbone' crucial for sound corporate governance. Moreover, they reinforce [Couchoux, 2023] the argument that robust auditing practices demonstrably improve financial stewardship, strengthen institutional trust, and reduce the probability of governance failures. Beyond compliance, participants consistently emphasise that robust governance frameworks actively improve operational efficiency, cultivate strategic alignment, and build institutional resilience. [Suresh et al., 2024] demonstrates that proper governance structures reduce IS risks through standardised protocols and accountability measures according to [Hartatik et al., 2021] who state that these frameworks establish a culture that supports continuous improvement and responsible innovation.

The essential viewpoints on governance were consistently reinforced by participants through their discussions. Participants explained that governance provides detailed instructions on staff conduct, which leads to reliable service delivery and improved information security, and promotes ethical leadership through integrity, transparency and accountability. The research supports the conclusion of [Erasmus, Marnewick, 2020] about how governance structures help organisations comply with regulations. Furthermore, it aligns with [Smith, Marx, 2022]

claim that governance frameworks play an instrumental role in integrating ethical controls into IT systems directly.

In summary, the gathered evidence unequivocally demonstrates that corporate governance serves as more than a compliance instrument. It is, in fact, a strategic lever for adeptly managing risks, strengthening public trust, and promoting enduring sustainability within South Africa's public sector ICT domain. The essential nature of governance structures becomes profoundly vital for enhancing institutional credibility and fostering public confidence because government departments face increased scrutiny regarding transparency and cybersecurity, as well as service delivery.

3.2. Transparency and accountability

The implementation of ICT governance by government departments has consistently demonstrated its ability to enhance transparency and accountability. Participants have highlighted that strong governance frameworks serve several purposes, including improving ethical oversight, clearly laying out roles and responsibilities, and establishing effective reporting mechanisms. Crucially, such a system ensures that every decision-making process unfolds in complete transparency and impartiality, always in strict adherence to the institution's guidelines.

As one interviewee shared, 'As a National Government Department, we follow the Batho Pele principles. One of the important principles is transparency.'

Another interviewee noted, 'The King IV Report promotes principles such as accountability, transparency and ethical leadership which are fundamental to good governance including IT governance. It also emphasises the importance of risk management as an integral part of corporate governance for the IT department, identifying, assessing and mitigating risks associated with IT systems, data security and compliance with technological changes. Following the King IV guidelines helps the IT Department to establish robust risk management processes and ensures alignment with organisational goals.'

[Ernstberger et al., 2024] clearly recognised the significant value of externally chaired committees such as audit and risk boards. These committees enhance legitimacy, reduce internal bias and foster greater public trust. Participants emphasised that external oversight provides impartiality and reduces conflicts of interest, reflecting [Bhuiyan et al., 2020] view that external governance improves accountability and curbs unethical behaviour. [Schillemans, Bovens, 2019] emphasise the importance of credible external oversight. [Couchoux, 2023] further adds that these mechanisms boost financial stewardship and transparent decision-making. The participants in the study also saw a clear strategic benefit in governance frameworks, as these frameworks ensure that ICT initiatives directly support

departmental goals and broader public service mandates.

As one interviewee shared, ‘Top Management should take responsibility for the committee’s work and implementation. Committees chaired externally are very helpful in keeping governance pure.’

This finding is consistent with what [Chau et al., 2020; Khumalo, Mazenda, 2021] indicate when they emphasise strategic alignment as a key feature of effective IT governance. Moreover, [Santos Castellanos, 2021] emphasizes how governance actively establishes clear roles within digital operations, thus enhancing both execution consistency and overall coherence.

The participants understood governance as a method to enhance transparency and alignment, but they saw it as an essential proactive tool for risk management. They recognised governance as an important proactive instrument for risk management. The consistent application of standard rules to all ICT decisions through governance reduces cyber threats, streamline procurement, and minimises budget issues. [Viana, 2025] supports this concept by demonstrating how ethical ICT governance builds trust among stakeholders and improves organisational resilience.

One participant explained that, when governance frameworks are applied consistently, ‘To ensure effective corporate governance and ICT compliance, the university has developed systems for managing ICT risks, auditing, and compliance. This ensures integrity in ICT operations and reduces mismanagement and reputational risk.’

Our research demonstrates that ICT governance functions as a driving force rather than a management tool. Strategic power functions as an ethical leadership framework that establishes discipline in operations and builds institutional trust. When it reaches its full implementation stage, the governance framework becomes deeply embedded in organisational core processes. That’s when you get better service delivery and more efficient decision-making. Most importantly, it ensures that every ICT investment truly triggers meaningful, long-lasting digital transformation. In the face of increasing demands for regulatory compliance, public oversight, and careful resource management, corporate governance is essential for reliable and efficient public sector ICT operations.

3.3. Information systems (IS) efficiency

Participants largely credited governance frameworks with boosting the efficiency, reliability, and resilience of public sector information systems. Government IT officers (GITOs), particularly stressed that structured governance facilitates IT operations that are standardised, repeatable, and strategically aligned. The adoption of globally accepted frameworks, such as King IV, COBIT, ISO 38500, and ISO 27001, was regarded as critical to the integration of best practices throughout IT service delivery, cybersecurity, risk management, and resource optimisation [Ranzatti et al., 2019; Valencia, 2023].

As one participant explained, ‘The Department has a number of governance systems that include CGICTPF, King IV and compliance policies to ensure effective ICT oversight.’ Another added, ‘Governance encourages the adoption of best practices such as King IV, COBIT, and ISO standards for IT operations.’

The interviewees also emphasised how governance systems effectively used to drive operations, facilitate performance

tracking, and organise compliance. This intersection provides IT departments with greater precision and higher responsibility in their operations. Major digital initiatives, such as the roll-out of the COVID-19 social relief grant, are examples of excellent governance-led implementations.

As one interviewee noted, ‘Digital transformation projects, including the rollout of the social relief grant, were only possible thanks to governance-enabled collaboration across units and partners.’

[Ndzendze, 2024] posits that governance frameworks are indispensable for effective decision-making. This is because they ensure clear roles and responsibilities are in place, alongside well-defined approval procedures. Similarly, they align with [Halik et al., 2020], who link a governance-driven approach to administration with improved public service delivery. Beyond just making operations more efficient, participants emphasised the vital contribution of governance to boosting system security and fostering digital resilience. The incorporation of cybersecurity protocols directly into governance structures was considered essential for mitigating emerging risks, lessening organisational vulnerability, and fostering a culture that is mindful of security [Azmi et al., 2018]. Well-governed ICT environments typically feature measures such as multi-layered access controls, continuous monitoring, and robust incident response planning.

[Folorunso et al., 2024] state that security-focused governance enhances an organisation’s readiness and [Ferguson, 2019] emphasises King IV’s significant role in operational resilience. Participants repeatedly emphasised governance as the key factor in maximising IT resource management. Participants described how well-defined policies and procedures help organisations streamline procurement processes, improve vendor relationships, decrease technical debt, and enable proper IT asset lifecycle planning. They elaborated on the importance of defined policies and procedures that directly streamline procurement. This helps to improve how vendors are managed and effectively reduce technical debt. It also robustly supports IT asset lifecycle planning, helping to eliminate duplication and ensuring that technology investments align with long-term institutional goals. This leads to more reliable services and less downtime.

Ultimately, these findings clearly demonstrate that governance frameworks go beyond mere regulatory instruments. Instead, they act as fundamental enablers for information system (IS) efficiency and strategic value creation in the public sector. Through standardisation, seamless collaboration across different functions, robust security practices, and alignment of IT operations with core business objectives, governance enables public institutions to navigate complex challenges successfully, deliver impactful digital services, and maintain long-term institutional resilience.

3.4. Contribution to project success

The last theme demonstrates how corporate governance acts as a key driver for ICT project success in public sector organisations. The participants emphasised that governance frameworks establish order and discipline, and maintain accountability throughout the entire project lifecycle starting from planning and execution, and ending with monitoring and evaluation. Implementation of structure becomes vital for

achieving efficiency, transparency, and sustainable outcomes in high-risk and resource-constrained environments.

As one GITO noted, ‘Projects follow a formal methodology - charters are signed, responsibilities are clear, and audit findings are minimised.’ Another added, ‘Ensure that projects follow the identified project methodology. This helps to ensure project delivery compliance. Project risks are minimised and ensure that all stakeholders take responsibility. For example, a charter will be signed outlining roles and responsibilities.’

These insights echo broader academic findings. Corporate governance plays a critical role in enforcing structured methodologies, clear performance metrics, and essential compliance checkpoints, significantly lowering the chance of project failure [Bakare et al., 2024]. It also bolsters financial oversight, helps reduce risks like scope creep and budget overruns, and ensures project objectives align with the institution’s main priorities [Erasmus, Marnewick, 2020; Ferrer et al., 2020]. [Poniatowicz et al., 2020] additionally stress that governance improves institutional coordination, while [Lankton et al., 2020] highlight how oversight deters wasteful spending and strengthens public trust.

When governance actively steers project oversight, it ensures that teams follow consistent practices and are held accountable for their schedules, resource use, and final outputs. This methodical strategy enables agile risk management, where early identification of issues prompts rapid corrective action. Moreover, it encourages leaders to participate because decisions are made transparently. [Gamlath et al., 2024] affirm that integrating governance across the entire lifespan of a project boosts its staying power, aligning it better with strategy and helping the institution learn for the long haul. Interestingly, interviewees cited numerous large-scale successes - like new ERP rollouts, cloud shifts, and online student registration platforms – which were directly enabled by robust governance structures.

These initiatives require coordinated stakeholder engagement, regulatory compliance, and disciplined oversight, emphasising the importance of governance in facilitating digital transformation on a large scale. As [Ferrer et al., 2020; Ndzendze, 2024] suggest, structured governance forms the basis for consistent service provision and effective collaboration between departments. Beyond just making projects run more smoothly, corporate governance ensures their long-term sustainability. It does this by building ways for them to expand, connect with other systems, and create value down the line. Projects with strong governance inherently reduce technical debt, encourage learning across the organisation, and establish proven methods that future efforts can draw upon. When governance reinforces ethical leadership, standardises how work gets done, and nurtures a culture of constant improvement, it significantly boosts an organisation’s overall skill in managing projects.

Beyond simply making projects run better, corporate governance also ensures their long-term viability. This is done by building ways for them to expand, connect with other systems and create value in the future. Projects with strong governance inherently reduce technical debt, encourage learning within the organisation and establish proven methods that can be used in future efforts. When governance supports ethical leadership, standardises work processes and nurtures a culture of continuous improvement, it significantly enhances an organisation’s ability to manage projects.

Table illustrates how insights from our 55 interviewees (P1–P55) align with the four primary advantages of corporate governance uncovered in this research: Compliance and Regulation, Transparency and Accountability, Information Systems Efficiency, and Project Success. An ‘X’ indicates that a participant offered perspectives, experiences, or concrete examples relevant to a given benefit area. This comprehensive mapping effectively demonstrates a widespread understanding of the benefits throughout public sector entities. It lends strong support to the thematic completeness and empirical rigor of the study. Moreover, this synthesis of participants distinctly highlights the complex, interwoven nature of corporate governance in ICT, revealing how compliance tools, ethical oversight, operational frameworks, and structured project methods combine to shape effective digital governance results.

4. Conclusion and recommendations

This study examined the benefits of corporate governance in strengthening ICT governance within the South African public sector, drawing on in-depth interviews with 55 government information technology officers (GITOs). The findings underscore that corporate governance goes far beyond promoting regulatory compliance - it shapes institutional culture, enhances decision-making, improves system performance, and drives successful ICT outcomes. Based on the lived experiences of 55 senior ICT leaders, these findings provide an authentic and practitioner-informed perspective of governance’s role in navigating complex public digital ecosystems.

The insights from our data highlighted four primary areas:

Compliance and regulation. Governance mechanisms, such as the Public Finance Management Act (PFMA) and audit committees, serve as essential legal and operational safeguards. They ensure that all ICT practices strictly adhere to statutory and fiduciary requirements while simultaneously reducing associated risks.

Transparency and accountability. Public trust and operational integrity are fostered collectively through ethical leadership, the inclusion of externally chaired committees, and clearly defined roles.

Information systems efficiency. Adoption of global standards (such as COBIT, ISO and King IV) standardises IT processes, enhance security, and promote coordination between departments, resulting in more reliable services.

Table
Participant mapping against corporate governance benefit themes

Participant	Compliance and Regulation	Transparency and Accountability	IS Efficiency	Project Success
P1	X	X	X	X
P2	X		X	
P3	X	X	X	X
P4	X	X	X	X
P5	X	X		
P6	X		X	
P7	X		X	
P8	X		X	X
P9	X	X	X	X
P10	X		X	
P11	X		X	X
P12	X		X	X

Table – ending

Participant	Compliance and Regulation	Transparency and Accountability	IS Efficiency	Project Success
P13				
P14	X	X	X	X
P15	X	X	X	X
P16				
P17	X	X	X	X
P18	X	X	X	
P19	X		X	X
P20	X		X	
P21	X		X	X
P22	X	X	X	
P23				
P24	X		X	X
P25			X	
P26	X		X	X
P27			X	
P28		X	X	X
P29			X	
P30	X	X	X	X
P31				
P32	X	X	X	X
P33		X		
P34	X	X	X	
P35	X		X	X
P36	X		X	X
P37				X
P38	X		X	X
P39			X	
P40	X			
P41	X	X	X	X
P42	X		X	
P43	X	X	X	X
P44			X	
P45	X	X	X	X
P46			X	
P47	X		X	X
P48	X	X		
P49	X	X		X
P50	X	X	X	X
P51	X	X	X	X
P52	X	X	X	X
P53	X		X	X
P54	X		X	X
P55	X	X	X	X

Sources: compiled by the authors.

Project success. Governance plays a crucial role in the successful project execution. This is achieved by enforcing structured methodologies, aligning stakeholders, and maintaining performance accountability throughout the entire project lifecycle.

These findings affirm corporate governance frameworks as being not only essential for ICT oversight, but also being flexible enough to be applied in challenging, resource-limited settings. Nevertheless, the study indicates that the effectiveness of governance hinges on how thoroughly these structures are

adopted and tailored to public institutions. Theoretically, this study advances the literature by demonstrating how corporate governance operates not only as a structural compliance mechanism, but also as a dynamic enabler of institutional trust, digital maturity and cross-functional coordination - particularly through the lens of ICT leaders responsible for implementation.

Recommendations

Build an ethical governance culture. Cultivate accountability and ethical leadership by using training, incentives, and decisions based on core values.

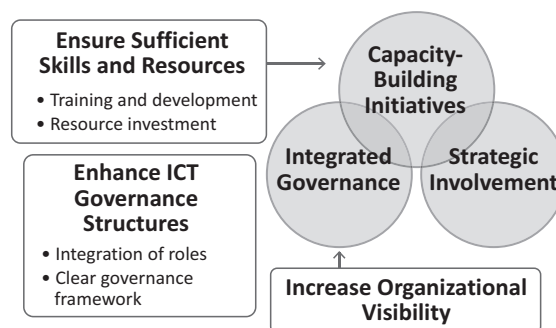
Bolster governance capacity & structures. Invest in audit and steering committees, ensuring that they have strong ICT and project management expertise.

Encourage contextual adaptation of best practices. Tailor established frameworks such as COBIT and ISO to fit local realities and unique circumstances.

Integrate governance into ICT project lifecycles. Apply governance principles at every stage of a project to improve execution and long-term viability.

Boost oversight via external review. Employ independent or external chairs for committees to enhance impartiality and objectivity.

Fig. 8. Recommendations



Source: author's analysis based on interview data, 2025.

Contribution to scholarship and practice

Making a two-fold impact, this article serves both academic inquiry and the practical needs of the public sector in ICT.

Within scholarship, it fundamentally advances our understanding of corporate governance. Our contribution here is solid empirical evidence gathered from arguably the most extensive qualitative dataset ever compiled in the South African public sector. By incorporating insights from 55 senior government ICT leaders (GITOs), this study moves beyond purely theoretical models. It portrays governance not merely as a compliance mechanism, but as a dynamic, continuous practice. Our research provides a detailed understanding of how governance is understood, adapted, and implemented in complex administrative systems, especially in contexts characterised by limited resources and intricate political landscapes. By doing so, this study contributes to the growing body of literature on 'governance-as-practice' and clarifies the impact of institutional thinking, leadership actions, and real-world circumstances on governance outcomes. Additionally, it strengthens existing theories of ICT governance by providing evidence from a developing country where traditional frameworks may lack real-world applicability.

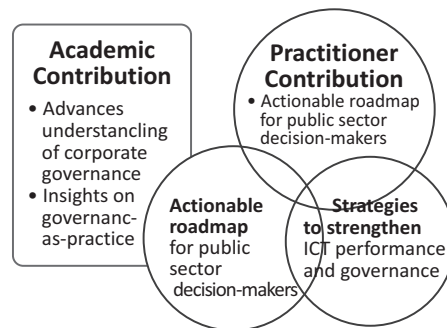
From a practical angle, this study equips public sector decision-makers with a clear, actionable roadmap. The five strategic recommendations it offers - ranging from solidifying ethical leadership to enhancing external oversight – where directly derived from real-world reflections and rigorous thematic analysis. These insights are particularly critical for governments in developing countries, where digital governance often has to contend with issues such as limited capacity, fragmentation, and political interference. The article provides practitioners with evidence-based strategies to improve ICT performance, promote transparency, and provide better services through responsible, inclusive governance. It also highlights the importance of both formal structures, such as legislation and frameworks, and informal elements (leadership and organisational culture), in creating a holistic governance model that can be adapted to different institutional environments.

Figure 9, titled ‘Contribution to Scholarship and Practice,’ visually demonstrates the twofold impact of our study on public sector ICT governance.

The left portion of the graphic highlights the academic contributions. It emphasises how our research enhances theoretical understanding, drawing on empirical evidence from 55 senior government ICT leaders (GITOs). This section also details the unique contribution of the study to the ‘governance-as-practice’ literature, particularly in complex, resource-constrained environments.

To the right, the figure illustrates practical contributions using overlapping circles. These circles represent interconnected digital

Fig. 9. Contribution to scholarship and practice



Source: author’s analysis based on interview data, 2025.

governance strategies and offer actionable recommendations specifically designed for policymakers. For example, institutionalising ethical leadership and enhancing external oversight aim to improve ICT performance and promote transparency, especially in developing countries.

The central alignment of both components in Figure 9 symbolises the effective bridge our study creates between theory and practice. It offers both scholarly depth and practical tools for reform and transformation.

In summary, this research bridges the theory–practice gap by not only deepening theoretical debates on governance in public ICT domains but also offering pragmatic tools for reform and transformation.

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Corporate social responsibility on organizational growth: A case study of the First National Bank Botswana

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Abstract

This paper sought to explore the impact of corporate social responsibility on organizational growth in the context of First National Bank Botswana. First National Bank Botswana is one of the leading organizations in the banking industry that have managed to stay relevant and dominate the banking industry. FNB dedicated itself to contributing to the wellbeing of the communities in which they operate as well as other relevant stakeholder of FNBB through its corporate social responsibility (CSR) mandate. The purpose of this paper was to establish whether these CSR initiatives had an impact in the organization's growth. Specifically, the paper intended to establish the focus of FNBB's corporate social responsibility, to find out the social benefits of FNBB's CSR, to determine person-year impact of CSR and establish the major stakeholders of FNBB's CSR.

Keywords: corporate social responsibility, organizational growth, banking industry

For citation:

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企业社会责任对商业发展的影响： 博茨瓦纳第一国民银行的实践经验

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简介

本文以博茨瓦纳第一国民银行为例，分析企业社会责任（CSR）与组织成长之间的关联性。作为银行业领军机构之一，博茨瓦纳第一国民银行是该国关键参与者，并在银行业占据主导地位。企业社会责任是该银行改善社区生活、实现利益相关方共赢的核心工具。本研究旨在评估企业社会责任（CSR）相关举措对组织发展动态的影响。研究具体任务包括：明确银行的CSR优先事项，识别项目实施带来的社会效益，量化CSR的实际影响，界定核心利益相关方群体。

关键词：企业社会责任（CSR）、组织成长、银行业

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Rena R., Tshukudu T.T. (2025). 企业社会责任对商业发展的影响：博茨瓦纳第一国民银行的实践经验。《战略决策与风险管理》，16(3): 240–249. DOI: 10.17747/2618-947X-2025-3-240-249.

Introduction

This article provides background information on corporate social responsibility and its impact on organisational growth. It also discusses how it is viewed across the world, including Africa, and specifically in the local context of Botswana. It will later discuss the existing research problem pertaining to the impact of CSR on the First National Bank. This way, the problem statement highlights the existing gap in literature or research that this proposed paper seeks to address. The chapter continues to discuss the aims and specific objectives of the paper, as well as research questions derived from the aims and objectives. It is also critical that the paper should discuss the rationale and significance of its research, as well as why it should be conducted

and what implications it will have once it is completed. Finally, this chapter will focus on possible limitations and delimitations of the paper that one should be aware of, both as limits and motivators for the research until it is finished.

Corporate Social Responsibility (CSR) has become one of the ways that many organisations around the world have embarked on in the 21st century to improve their impact on the communities they exist and operate in [Hopkins, 2006]. Different scholars have defined and argued about the meaning of CSR from different angles. However, there has always been a consensus that corporate social responsibility is generally concerned with how organisations treat their customers and members with regard

to their well-being beyond business parameters. Thus, the nature of the relationship between corporations and local citizens is determined by what the corporation does for them [Crowther, Aras, 2008]. For example, how does a company operating within a certain country, town, or even community rise to address the welfare and needs of people in its jurisdiction?

Although the strategies of CSR may differ from organisation to organisation, or from discipline to discipline, the unifying challenge has always been its integration into organisational vision and mission statements. Moreover, organisational strategies are vocal about what the organisation's CSR should contain or look like, and what exactly should be done within such a framework [Santana, Wood, 2016]. CSR has been viewed as both an ethical gesture and a business strategy [Wan-Jan, 2006]. As an ethical gesture, CSR is done by an organisation as their sole commitment without expecting any returns or gains. However, corporations can embark on CSR as a business strategy that enables them to penetrate the market and gain attention from potential customers or business partners.

First National Bank of Botswana is one of the oldest and longest-serving commercial banks, which has enjoyed popularity throughout the country. With more than twenty-four branches located all over the country, it has played a key role in facilitating financial management issues, payment options, and connecting business transactions for various companies and individuals [First National Bank., 2019]. Although it has been praised for its excellent work in this regard, the First National Bank of Botswana (FNBB) had to continue to find measures and new ways to stay afloat within its banking and financial management mandate in order to remain relevant to customer needs. To do so, the FNBB conducted some assessments of the welfare of its customers, their communities, and the general lives of individuals in its areas of operation. Based on these assessments, the bank made some commitments to touch and make changes in [First National Bank., 2019]. This initiative has been adopted as CSR, where the main focus has always been on giving back to communities in a specific and sensitive manner.

It is necessary to establish the impact of First National Bank Botswana's Corporate Social Responsibility on its growth.

Specific objectives:

- to establish the focus of First National Bank Botswana's corporate social responsibility;
- to find out the social benefits of First National Bank Botswana's corporate social responsibility;
- to determine the person-year impact of First National Bank Botswana's corporate social responsibility;
- to identify the major stakeholders of First National Bank Botswana's corporate social responsibility.

The proposed paper seeks to answer the following questions in order to answer the main research question.

1. What is the focus of First National Bank Botswana's corporate social responsibility?
2. What are the social benefits of First National Bank Botswana's corporate social responsibility?
3. What is person-year impact of First National Bank Botswana's corporate social responsibility?
4. What are the major stakeholders of First National Bank Botswana's corporate social responsibility?

1. Literature review

Several theorists and scholars have discussed and explained the concept of CSR in various ways, making it sensible to understand and conceptualise the paper.

1.1. Carroll's CSR pyramid

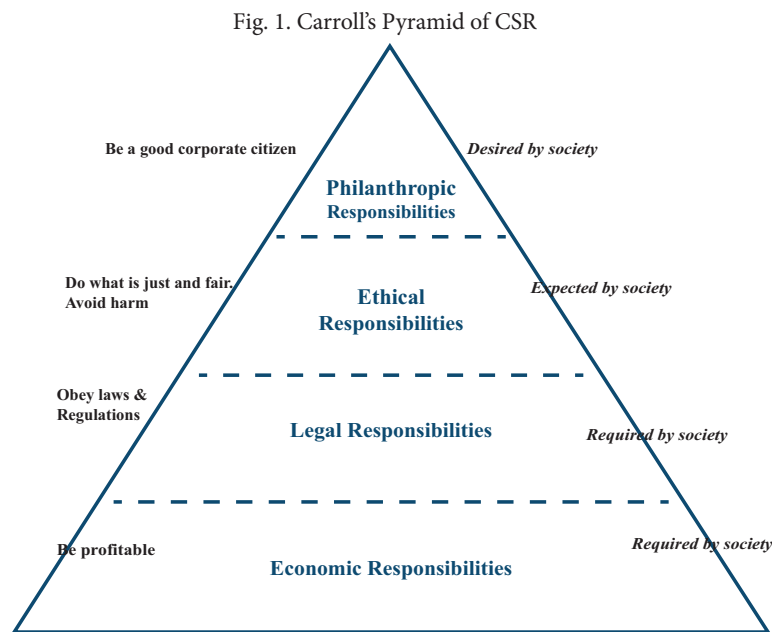
The pyramid of CSR was published in 1991 by A.B. Carroll. Carroll's original definition of CSR states that it entails four pillars: economic, ethical, legal, and discretionary expectations that society has about an organisation at a given point. The definition was later reconstructed into what is now known as Carroll's Pyramid of Corporate Social Responsibility [Brin, Nehme, 2019] as depicted in Figure 1 below. The Pyramid suggests that corporations must fulfill their responsibilities at four levels: Economic, Legal, Ethical and Philanthropic. A.B. Carroll submitted that economic responsibility forms the foundation of Carroll's pyramid [Carroll, 2016].

For a company to fulfill other CSR responsibilities, it first needs to engage in business operations and generate profit [Brin, Nehme, 2019]. Profit is necessary to reward shareholders and promote business growth. Therefore, a business is only beneficial to society if it is profitable and sustainable. The second layer of the pyramid is legal responsibility, which essentially means that businesses must ensure their compliance with laws and regulations. Laws and regulations are society's way of regulating how businesses operate within civil society [Carroll, 2016]. Moreover, businesses are expected to be ethically responsible, meaning they should do what is right, just, and fair, and avoid harming stakeholders [Carroll, 2016]. Finally, businesses should strive to become good corporate citizens and players by voluntarily participating in social activities that are not mandatory or required by law [Brin, Nehme, 2019].

1.2. Triple bottom line theory

The Triple Bottom Line (TBL) theory was founded by J. Elkinton in 1994. The TBL is based mainly on the concept of sustainability and argues that instead of one bottom line, there should be three dimensions: profit, planet, and people [Žak, 2015]. On the first dimension, corporate profit is measured, while the People dimension seeks to explain how socially responsible an organisation is in its operations. Finally, the Planet dimension assesses how much business affects the environment [Žak, 2015]. [Brin, Nehme, 2019] among others defined the dimensions of TBL as Economic, Social and Environmental. Figure 2 shows the dimensions presented by Elkington. T. Dixon [Dixon, 2014] stated that the TBL approach aims to incorporate social and environmental measures into reporting organisational performance, moving away from the traditional focus on profit.

P. Brin and M.N. Nehme agreed, highlighting that adopting the TBL approach is essential to achieving continuous profit and long-term social and environmental goals [Brin, Nehme, 2019]. Simply put, companies should not just be concerned with making a profit, but should also focus on social and environmental values. According to [Dixon, 2014], the main challenge of this approach is measuring environmental and social performance, since they cannot be quantified like economic performance. Figure 2 shows some typical measures of performance using the TBL approach.



Source: [Carroll, 2016].

1.3. The focus of Corporate Social Responsibility

The focus areas of CSR vary among organisations, but as T. Adamek mentions, the activities of CRS fall within three dimensions: Social, Economic, and Environmental [Adamek, 2014]. However, Carroll's definition of CSR [Carroll, 1979] includes legal responsibilities as a dimension of CSR. This paper will discuss the focus of corporate responsibility within these dimensions: Economic, Social, Legal, Environmental.

Carroll [Carroll, 2016] vividly argues that in every business world where any organisation is part of or a player, there is an economic responsibility that must be met by organisations. This is the first layer of responsibility in Carroll's CSR pyramid, upon which other dimensions are based [Liu, Xiao, 2013]. This is because, if a company fails to fulfill its economic responsibility of generating profit, it will go out of business, and other CSR responsibilities will become dormant [Ali et al., 2010]. This source defines economic responsibility as 'The profitability and competitiveness of an organisation and its subsequent socio-economic impact' [Ali et al., 2010]. It necessarily follows that the organisational responsibility is to make economic decisions aimed at generating profit and enhancing good performance of the organisation while keeping society in mind¹. Therefore, a company is regarded as a good corporate citizen if it is able to strike a balance between its economic responsibility and social, environmental, and legal practices.

Environmental corporate social responsibility, as defined by [Rashid et al., 2014], refers to the responsibility of companies to incorporate environmental concerns into their business operations and interactions with stakeholders without compromising economic performance. Hopkins [Hopkins, 2006] mentioned that this approach aims to reduce pollution and greenhouse gas emissions and promote the sustainable use of natural resources.

[Banyte et al., 2010] agree that there is more concern about overprotecting the environment from threats mainly posed by humanity. Therefore, these issues can be addressed through CSR. [Banyte et al., 2010] further state that it is imperative to address these issues through CSR, as environmental responsibility is a dimension of corporate social responsibility. Companies can contribute to addressing environmental issues by integrating them into their business operations. This includes producing eco-friendly products, promoting eco-tourism, and encouraging environmentally friendly behaviours within the workplace and communities in which they operate [Hohnen, 2007]. A growing number of companies are engaging in the environmental initiatives to reduce pollution, improve energy efficiency, and promote industrial ecology. The *Johnson & Johnson Company* focuses on reducing its environmental impact by investing in various alternative energy sources².

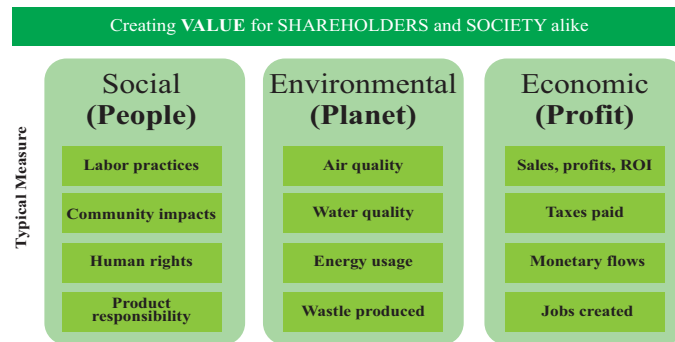
Social responsibilities include how companies integrate their social concerns into their business operations to have a social impact on communities and improve society's status. D. Crowther and G. Aras [Crowther, Aras, 2008] mentioned that social responsibility is the company's responsibility to actively protect the interests of its stakeholders, guided by the corporate vision, by actively participating in public social welfare activities, cultivating social harmony, and promoting social development in the community. Social responsibility is a way for companies to balance their resources with relevant groups and individuals in their social environment. Thus, A.K. Derecke and V. Nagy [Derecke, Nagy, 2020] found that companies contribute through various activities such as employee volunteering in charitable causes, funding sports, arts, and cultural events, and contributing to the overall well-being of their communities.

One paper [Derecke, Nagy, 2020] revealed that companies are involved in the social activities of a community through

¹ <https://www.transparenthands.org/different-types-of-corporate-social-responsibility-csr/>.

² <https://silo.tips/download/mascom-s-corporate-social-responsibility-csr-guidelines>.

Fig. 2. Typical measures of performance using the TBL approach

Industry Standard – Concept of *Triple Bottom-line*

Source: <https://www.klipartz.com/en/sticker-png-lqomi>.

their employees' volunteer activities. Employee volunteering is when employees give their time, energy, or talents to members of the community for charitable purposes. M. Clarke and D. Butcher emphasise that employee volunteering is a corporate social responsibility practice that internally strengthens employee satisfaction and retention, and externally strengthens corporate reputation and connections with stakeholders [Clarke, Butcher, 2006]. This means that employee volunteering provides corporate organisations with an opportunity to address the demands of stakeholders by positively contributing to the community concerns and interests and providing opportunities for employee engagement. Derecke and Nagy further mentioned that employees may volunteer in charitable activities by helping a company to donate materials such as computers, office equipment, commercial products, and offering training services on how to use them [Derecke, Nagy, 2020].

A firm is expected to fulfill its voluntary responsibility, which involves participating in philanthropic activities, such as providing monetary aid to the socially disadvantaged. [Derecke, Nagy, 2020] stated that providing financial support, such as grants, in which money is given to a non-profit organisation to support an individual or community project, contributes to this. A paper [Maignan, Ferrell, 2004] indicated that companies engage in improving the sports and recreation of individuals and communities through financial support for sports activities, which is an essential area for developing life skills, abilities and talents and improving the general health of stakeholders. Similarly, S. Sheikh found that financial assistance may be provided to support the cultural heritage of a community [Sheikh, 1996]. This has also led to many companies working with local music artists to empower them financially, providing financial management skills and support to develop the arts and cultural sector.

As businesses operate within legal boundaries and are protected by national borders, they must strictly adhere to regulations set forth by their respective governments and be transparent to the public and relevant stakeholders [Cho et al., 2019]. To be socially responsible, companies must comply with all relevant laws at the federal, state, local, and municipal government levels to pursue their legitimate business interests within the prescriptions of the law. This means that companies must observe the law when conducting their business. It is therefore necessary for corporate organisations to operate in a

way that is consistent with government and legal expectations. They can do this by adhering to set rules, laws, and regulations. [Cho et al., 2019] highlighted that companies strive to be law-abiding, fulfilling their legal obligations, and providing goods and services that meet the legal prescriptions for those goods and services.

1.4. Overview of major stakeholders for Corporate Social Responsibility

Stakeholders are individuals or groups of people that can affect or be affected by the a company's activities [Freeman, 1984]. [Maignan, Ferrell, 2004] define stakeholders as actors with direct or indirect interests in the business, including managers, employees, customers, investors, suppliers, and shareholders. [Crowther, Aras, 2008; Pérez et al., 2013] mention that society and government can be stakeholders. [Perez et al., 2013] categorise stakeholders into internal (employees and managers) and external (suppliers, investors, customers). Furthermore, [Freeman, 1984] alludes to the fact that employees are voluntary stakeholders because they have a choice to choose whether or not to be part of an organisation, while the community or society are involuntary stakeholders, who cannot choose and must remain stakeholders of an organisation. These stakeholders are the reason why organizations engage in corporate social responsibility. Therefore, stakeholder theory defines corporate social responsibility as a collection of initiatives companies engage in fulfill their obligations to these groups [Maignan, Ferrell, 2004]. In this regard, stakeholders are the primary target audiences for CSR, and are those that companies like FNB must please with their initiatives.

1.5. Social benefits of Corporate Social Responsibility

As far as determining the benefits of CSR approaches or models for different business entities, several studies have been conducted to ascertain such benefits [Galbreath, 2010]. P. Książek supports this, as he mentions that investors are more likely to invest in a company that highly respects social interests, as they perceive it to be less risky and less prone to negative publicity, which in turn leads to a lower stock market [Książek, 2016]. In addition to building a brand image and attracting investors, other potential benefits of CSR include attracting good talent, motivating and retaining staff, as well as achieving

Table 1
Specific objective 1: The focus of FNBB's CSR

The Focus of FNBB's CSR	Strongly agree	Agree	Disagree	Strongly disagree
Sports development and support remain one of the priorities of the FNBB's corporate social responsibility	28.0	44.0	2.0	4.0
FNBB is involved in offering scholarships to the underprivileged in the community	12.0	30.0	44.0	14.0
FNBB offers business guidance and support for young and small-medium entrepreneurs who want to start their own business	48.0	40.0	10.0	2.0
FNBB continues to play an important role in supporting education, from grassroots to university level in the communities it operates	32.0	36.0	28.0	4.0
Building houses for the poor in our areas of operation is part of FNBB's corporate social responsibility	18.0	36.0	32.0	14.0
FNBB has a corporate responsibility to ensure that environmental issues are addressed in the communities it operates	10.0	2.0	54.0	34.0

Source: [First National Bank..., 2019].

customer satisfaction and loyalty [Sprinkle, Maines, 2010]. [Książak, 2016] highlighted that a bad image of an entity can result in consumers boycotting it. Therefore, companies strive to abide by ethical rules in order to stay off the media radar. J. Galbreath suggested a positive correlation between customer satisfaction and economic, legal, and social dimensions of CSR [Galbreath, 2010]. Furthermore, Galbreath's findings suggest that 'firms who demonstrate a strong commitment to their economic responsibility (e.g., through offering highly valued products) and ensure customers are not harmed in by meeting legal standards (legal CSR), or treat employees well with benefits and high salaries (discretionary CSR), might ultimately reap the rewards of higher customer satisfaction' [Galbreath, 2010: 423]. On the other hand, [Galbreath, 2010] suggested that economic and social dimensions of CSR significantly contribute to employee commitment and the financial performance of an organisation. [Sprinkle, Maines, 2010] mentioned that employee volunteerism programmes may benefit organisations in the long term, as employees' abilities, knowledge, leadership, and networking skills are enhanced, as well as their strategic vision. Furthermore, supporting employee's participation in community activities gives them a sense of belonging and encourages their commitment to the organisation. As a result, organisations benefit from staff retention [Ali et al., 2010]. Moreover, CSR activities reduce staff turnover and help attract talent, as people want to work for an organisation with a good reputation for being a responsible corporate citizen. Weber suggested that CSR organisations can also reap rewards from maintaining a license to operate, including ethical standards, risk reduction, efficiency gains and tax benefits [Weber, 2008]. [Sprinkle, Maines, 2010] concurred that cost savings in the value chain and efficiency were the result of CSR activities.

2. Methodology

C. Igwenagu defines methodology as consisting of systematic and theoretical definitions of the methods used in acquiring knowledge that explains a particular phenomenon [Igwenagu, 2016]. This chapter provides the general methodological approaches adopted by the paper starting with the research

design. The chapter then discusses the target population, sampling procedures, and the sample size employed by the study. In addition, it looks at the data collection tools used to collect information to answer the questions posed by the paper. It also discusses the data analysis methods that will be used and the reasons behind their selection over other methods. The study employed a quantitative method using questionnaires to collect objective data to generalise findings in answering the research questions. The choice of using the questionnaires was based on the need for an objective and generalised view of the status of the Corporate Social Responsibility at First National bank of Botswana.

3. Results and discussion

This article presents the results from the data analysis and discusses the findings of the paper, divided into two sections. The first section focuses on the analysis of the collected data and the main findings. The second section examines the findings in relation to the aims and objectives of the study and compares them with previous research on the topic.

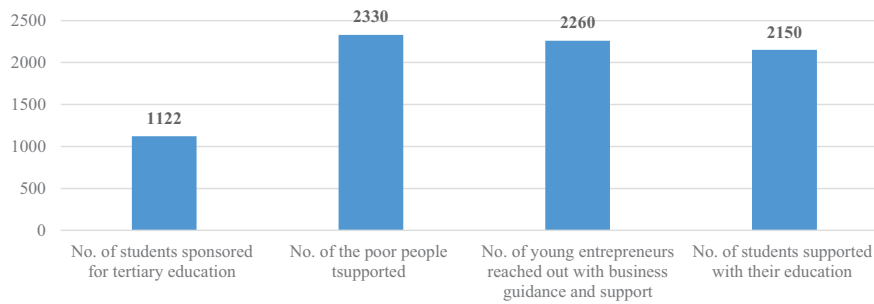
3.1. Presentation of results

This section presents the analysis of the data collected. B.M. Sithole defines data analysis as the process of collecting, cleaning and organising data in order to derive useful information for making conclusions and decisions [Sithole, 2012]. The data were analysed using SPSS and Excel spreadsheets. The data obtained from the open-ended responses were displayed and divided into categories necessary to answer the research questions. The first part presents an analysis of the demographic profile of respondents to get a better understanding of their identity and background characteristics. The second part presents an analysis, findings and conclusion drawn from the research questions discussed in this paper.

3.2. Social and demographic profile of the respondents

This section analyses the characteristics of the sample of employees who were involved in the study. The respondents

Fig. 3. Specific objective 3: The person-year of FNBB's CSR over the past 5 years



Source: [First National Bank..., 2019].

were differentiated in terms of age, gender, occupation, branch/segment, higher education qualification, type of employment, and how long they had been involved in FNBB's corporate social responsibility. Data collection was carried out on a sample of FNBB employees from management and public relations departments.

As denoted from the table above, the majority of respondents (88%) reported that FNBB offers business guidance and support to young and small-medium entrepreneurs who wish to venture into different fields. Of these 72% reported that sports development and support remain one of the focal points of the FNBB's corporate social responsibility. Additionally, 68% indicated that the FNBB continues to play a pivotal role in supporting education, from grassroots to tertiary levels in communities where it operates. Finally, 54% indicated that building houses for the poor s within the FNBBs' corporate social responsibility in its areas of operation. In summary, the findings show that FNBB's corporate social responsibility focuses on sports development and support, providing scholarships for the underprivileged in the community, offering guidance and support for young and small-medium entrepreneurs, supporting education from grassroots levels to tertiary, and building houses for the disadvantaged.

As depicted in Table 2, 94% of respondents indicated that the FNBB's CSR helped to build communities and promote dignity through its CSR initiatives. 84% of respondents agreed that communities, especially those with disadvantaged people received food and shelter assistance from FNBB. 70% supported the idea that FNBB provided substantial support for conservation societies on environmental issues. 68% of respondents agreed that the educational system received significant support

from FNBB over the past five years, and 50% agreed that the disadvantaged students benefited from FNBB's efforts to further their education.

When assessing the extent of FNBB impact over five years based on the person-years, it emerged that the majority of person-years (2,330) were spent on helping poor people, followed by young entrepreneurs (2,260) that FNBB reached with business guidance and support, then supporting students (2,150). Of these, 1,122 students were sponsored by FNBB to further their tertiary education.

The employees were asked to identify the major stakeholders in FNBB's corporate social responsibility. Respondents were allowed to indicate more than one stakeholder. The responses were then categorised. Figure 3 shows the number of responses for each category. The categories include the following:

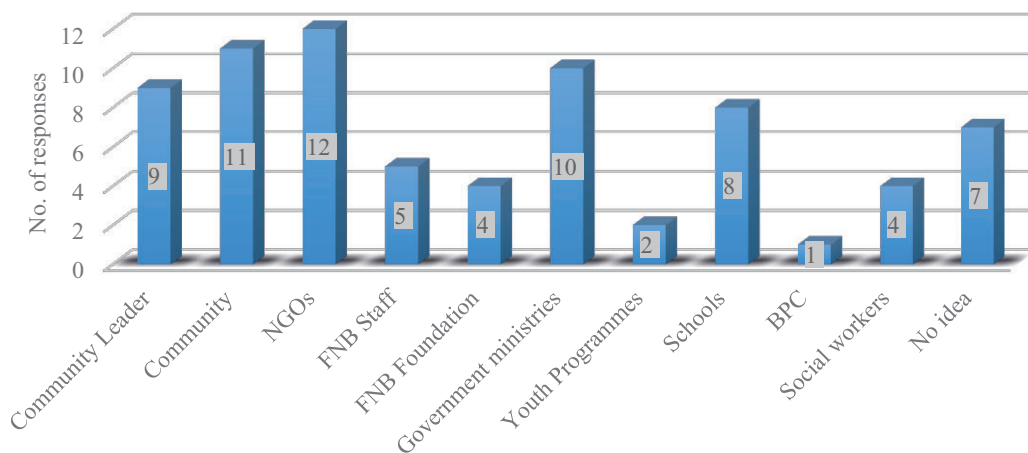
- community leaders: this category includes dikgosi, political leaders, and area counsellors;
- community: this category involves members of the community including the disabled, VDCs, the underprivileged, teenagers and Ipelegeng people;
- NGOs: These were identified as charitable organisations such as The Red Cross, SOS, innovation hubs, and other non-governmental organisations;
- FNBB Staff: FNBB Foundation staff, including champions, staff volunteer programme coordinators, foundation office assistants, and other staff who benefit from FNBB's CSR, are identified as stakeholders;
- FNBB Foundation: according to [First National Bank..., 2019], FNBB administers its social responsibility programmes through the FNBB foundation.

Table 2
Specific objective 2: The social benefits of FNBB's CSR

Social Benefits of FNBB's CSR	Strongly agree	Agree	Disagree	Strongly disagree
FNBB has helped build communities and dignity through its CSR mandate	50	44	6	0
Disadvantaged students have benefited from FNBB as far as furthering their education is concerned	12	38	44	6
Conservation societies have received substantial support for environmental issues from FNBB	18	52	30	0
Communities, especially those with disadvantaged people, have been targeted for food and shelter assistance by FNBB	32	52	7	1
The educational system has received significant support from FNBB over the past five years	42	26	30	2

Source: [First National Bank..., 2019].

Fig. 4. Specific objective 4: Major stakeholders of FNBB's CSR



Source: [First National Bank..., 2019].

According to the results in Table 1, most respondents indicated that the community, NGOs, and government ministries are the major stakeholders in the FNBB's CSR. This indicates that FNBB's CSR activities mostly involve different members of the communities where they operate, as well as government entities such as government ministries and their personnel.

Table 3
Intention to engage stakeholders in FNBB's CSR in the future

Are there any other stakeholders you consider working with in the future?	Frequency	Percent
No	3	6
Not sure	29	58
Yes	18	36
Total	50	100

Source: [First National Bank..., 2019].

The respondents were requested to indicate to stakeholders that they intended to engage in future CSR activities. According to the results in Table 3, 36% of respondents indicated that they would engage with other stakeholders in the future, while 6% reported having no plans to do so; and 58% said that they were unsure about whether they planned to engage other stakeholders.

Paper respondents have indicated that that FNBB should involve several stakeholders in the implementation of its corporate social responsibility activities, including youth, the Botswana Police Service, ChildLine, senior citizens, schools in the Ngami region, youth and culture departments, education authorities and Pudologong in Mochudi, as well as organisations with goals similar to those of FNBB's CSR. They also stated that they intended to include sports sponsorship, donate office furniture to schools and introduce robotics in their future CSR activities.

3.3. Discussion of findings

This section builds on the findings or results shared in the previous chapter, and extends them to discussions where specific references will be made to the aims and objectives of the paper.

It also includes extended references to what other researchers or authors have previously found and discussed. A joint discussion based on the literature review of this paper will be created. Based on this discussion, that a clear direction for the findings will be drawn, informing the way forward for the bank management and relevant stakeholders within the FNBB's corporate social responsibility mandate.

Specific objective 1: The focus of the First National Bank Botswana's corporate social responsibility

The FNBB's corporate social responsibility over the years of its existence has adopted a multi-dimensional approach to benefit both its customers and the communities in which it is doing business. Its CSR focuses on several areas, including the following.

- Supporting and guiding young and small medium-sized entrepreneurs: FNBB aims to reach out to young people and entrepreneurs by providing business guidance and mentoring, especially for those who want to start their own business.
- Sports development and support: the FNBB's corporate social responsibility also focuses on the area of sports development. Different sport codes continue to benefit from this effort with the sole objective of identifying and nurturing reputed sportsmen and women across the communities in this country.
- Educational support: this is another area that the FNBB's corporate social responsibility continues to focus on in the communities. Through this approach, the CSR has two levels of support to facilitate access to quality education for community members. First, the FNBB provides education support at the grassroots level by identifying needs in early education, especially in hard-to-reach areas and disadvantaged communities. They provide support to students by donating books and other educational materials to schools. Second, the CSR offers scholarships for tertiary education for less privileged members of the community, which aligns well with the country's vision of a knowledge-based economy.

- Building houses for the poor is another focus of the FNBB's corporate social responsibility, where the main focus has always been on providing the underprivileged members of communities with a decent shelter, which will improve their living standards and protect them from harsh weather conditions. Through this effort, the FNBB has managed to affect a lot of people across the country in almost all areas of its operation.

These focus areas fall within the scope of economic and social responsibility. Ali [Ali et al., 2016] discusses that companies should balance making profits and how the community benefits from their operations. The same sentiment has also been discussed and advanced by [Caroll, 2016]³. Therefore, it is crucial for companies to extend their corporate mandate to ensure the social welfare of the communities in which they operate. This helps to create and maintain a positive relationship between the organisation and its community.

Specific objectives 2: Social benefits of the First National Bank Botswana's corporate social responsibility

The paper revealed that there are several benefits that the FNBB's corporate social responsibility can provide for communities and customers. These benefits are seen as life-changing initiatives that focus on human development and economic aspects of these communities. One such benefit is the promotion of community dignity through the provision of adequate shelter and food for less privileged members of the community. Crowther and Aras argue [Crowther, Aras, 2008] that companies have a responsibility to participate in social welfare initiatives in order to promote social harmony while ensuring the social development of these communities at the same time. This has been beneficial for both individual recipients and the government's efforts to eradicate poverty among its citizens. Another benefit is linked to the education sector. Respondents indicated that communities benefited greatly from this effort, as their members had better access to schools and their children were supported with better access to education, from lower levels to tertiary levels. This means that the FNBB's CSR holds a high regard for the desire to develop communities through education and has benefited even those who could not access education services. Finally, the conservation societies across Botswana have benefited from the support of FNBB's CSR, which has gone a long way in facilitating their mandate in environmental conservation issues.

Specific objective 3: The person-year impact of the First National Bank Botswana's corporate social responsibility

In assessing the impact of the FNBB's CSR mandate on person-years, the paper reveals that there is indeed a great impact on person-year terms that this mandate has had on the lives of communities. This impact has been felt across several focus areas that the CSR mandate addresses. It is evident that, although not all respondents were able to determine the real number of people impacted over a five-year period, the reported impact so far has been very significant. This means that the FNBB's CSR mandate has touched and had an impact on many lives through its four focus areas: building shelter for poor people in the community, providing support and guidance to young and small medium entrepreneurs, educational support, and sports development and support.

Specific objective 4: Major stakeholders to the First National Bank Botswana's Corporate Social Responsibility

Although it has been reported that the FNBB's CSR has been able to reach a wide spectrum of people and beyond, there is still room for improvement. The suggested stakeholders are seen as critical to forming an effective combination towards reaching more people in the communities served, because they either deal with different segments of the community or have experience working with them. Therefore, this creates a solid foundation on which the success of the FNBB's CSR mandate can thrive.

4. Recommendations

Although the paper was able to bring about very informative findings, as discussed above, there is still room for improvement in how the paper could be modelled to reveal more insights that would adequately cement the impact of this noble responsibility. In addition, recommendations have also been identified as to how FNBB's Corporate Social Responsibility can be best made more impactful than it is now. Some of these recommendations are listed below.

Engagement of strategic stakeholders: the FNBB's CSR has identified several groups of beneficiaries, which to some extent limits its impact and traces and visibility on the ground. As a result, the bank must identify strategic partners or stakeholders to work with to identify the most critical areas of intervention it will focus on. This is because community needs are evolving with time and identifying these strategic partners can create a shared and sustainable impact on communities. Among these stakeholders, there are those suggested by respondents, including the Botswana Police Service, schools, government ministries, youth-based organisations and others.

The FNBB's Corporate Social Responsibility should develop a quarterly reporting system that can capture all necessary data about its impact on the communities they serve. Data elements, in this case, should include, among others, the number of people reached by each activity, their age groups and gender. Such data will help further disaggregate FNBB's CSR's impact on these aspects.

FNBB must hire and engage human resources who are well informed about identifying strategic areas for CSR. They should plan, execute, and evaluate these activities to help adequately understand how CSR is performing or achieving on a regular basis and also give it undivided attention.

In the future, the paper of this nature should give enough time for members of communities or community leaders and alleged beneficiaries to have their say about how the FNBB's CSR has impacted their lives.

Therefore, once these recommendations have been implemented, a more accurate picture can be drawn of the impact that the FNBB's CSR mandate has had so far on the communities of Botswana.

Conclusion

The paper found that the FNBB's Corporate Social Responsibility focuses on several diverse areas, including sports development and support, educational support,

³ See also: <http://spicementor.blogspot.com/2008/04/four-basic-economic-responsibilities-of.html>.

including offering scholarships to the underprivileged in the community, guidance and support for young and small entrepreneurs, support for education from grassroots to higher education and building houses for the poor. Social benefits from the FNBB's CSR include, among other things, building

houses for the poor, supporting education at all levels, and supporting conservation efforts to preserve natural resources. Significant impact on people's lives has been identified, with many people benefiting from the FNBB mandate to build decent homes.

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Predictive planning as a strategic risk management tool for the supply chains of oil and gas industry in Uzbekistan

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Abstract

This article discusses the challenges of strategic risk management in the supply chain operations of the oil and gas industry in Uzbekistan. Using the case of JSC 'Uzbekneftegaz', the study identifies critical weaknesses in the current material and technical supply (MTS) system, including a high level of import dependency, fragmented data, and a low level of digital maturity among suppliers. The need for a shift from reactive to predictive planning is supported by the use of digital tools and advanced analytics. The author proposes three innovative tools for predictive planning — PIRSP (Predictive Index of Risk of Supply Problems), PESI (Predictive Evaluation of Supplier Integrity), and DLI (Digital Literacy Index). These tools allow for a quantitative assessment of supply disruption risks, supplier resilience, and levels of digital integration. The paper concludes that predictive planning has a high potential to strengthen supply chain resilience, reduce operational costs, and enhance strategic agility for oil and gas companies.

Keywords: digitalisation, PIRSP, PESI, DLI, Uzbekneftegaz, import substitution, digital maturity

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预测性规划作为乌兹别克斯坦石油和天然气行业供应链中的战略风险管理工具

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简介

本文研究了乌兹别克斯坦共和国石油天然气行业物资技术保障 (MTO) 系统中的战略性风险管理问题。以乌兹别克石油天然气公司 (AO "Uzbekneftegaz") 为例, 分析了现行MTO模型的薄弱环节, 包括对进口的高度依赖、数据碎片化以及供应商数字化成熟度较低等问题。论证了从被动应对转向基于数字技术与预测分析的前瞻预测性规划的必要性。研究提出了原创性的预测规划工具——PIRSP指数 (供应链中断风险评估)、PESI指数 (供应商稳定性评估) 和DLI指数 (数字化集成水平评估), 这些工具可量化评估供应链中断风险、供应商韧性及数字化整合程度。研究结论表明, 预测性方法在提升石油天然气企业供应链韧性、降低运营成本及保障战略适应性方面具有高度适用性。

关键词: 物资技术保障, 数字化, PIRSP, PESI, DLI, 乌兹别克石油天然气公司, 进口替代, 数字化成熟度

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Introduction

Against the backdrop of increasing volatility in global markets, technological transformation and geopolitical turbulence, the management of supply chains in the oil and gas industry is becoming one of the key areas of strategic management.

For decades, the oil and gas industry has remained the backbone of the global economy. However, 2024 has been marked by persistent unpredictability in energy markets. Experts point to three global trends: rising demand for energy, political uncertainty and uneven progress in the energy transition to alternative energy sources¹. According to the International Energy Agency, growth in global oil demand slowed significantly in 2024: consumption increased by 0.8% compared with 1.9% in 2023. The main reasons for this slowdown are the completion of post-pandemic mobility recovery, slower industrial growth and the stronger impact of electric vehicles². At the same time, experts forecast a 20% increase in global energy demand by 2040, driven by population growth to 9.2 billion and an expansion of the middle class from 3 billion today to 5 billion³. In response to these challenges, digital transformation – a profound rethinking of business processes based on modern digital technologies – is gaining increasing importance. This issue is particularly acute in developing economies such as the Republic of Uzbekistan, where the oil and gas sector plays a system-forming role. The purpose of this article is to demonstrate the potential of predictive planning as a tool of strategic risk management in the system of material and technical supply (MTS) of the oil and gas industry of Uzbekistan.

Joint-Stock Company *Uzbekneftegaz (Uzbekneftegaz JSC)* is the national energy leader of Uzbekistan. As a key element of the country's developed energy sector, the company has a diversified portfolio of assets and income sources and plays a crucial role in hydrocarbon production, petrochemical production and the export of refined petroleum products. *Uzbekneftegaz JSC* operates a unified risk management system (hereinafter, the URMS), which is a set of processes, methods and information systems aimed at achieving strategic and operational objectives through risk management. The URMS has been developed in accordance with the three lines of defense principle and covers the following areas:

- identification and categorization of risks (operational, strategic, financial, project-related, etc.);
- identification and assessment of risks by specialized units using brainstorming;
- development and implementation of risk management measures, including corrective and preventive actions;

- monitoring and review of risks and measures, including regular updating of the risk register;
- informing the governing bodies: risk data are submitted to the Management Board, the Supervisory Board and the shareholders;
- integration of risks into the company's strategic and operational planning.

On 1 March 2023, by decision of the Chairman of the Management Board, the company approved a new version of the Regulation on the Risk Management System. This document regulates the procedure for the assessment and minimization of production and economic risks and assigns responsibility for the implementation of risk-oriented approaches to the Risk Management Department within the Department for Business Development.

The governance structure of the URMS includes a risk management committee reporting to the Chairman of the Management Board. Its tasks include comprehensive risk assessment, development and implementation of measures, staff training, ensuring timely communication with senior management and maintaining the risk register.

Risk assessment is based on an approved matrix. Each month, structural units draw up and submit a list of potential risks, which are assigned a significance level: high, medium or low. Only the highest-category risks are included in the register, which is reviewed on a quarterly basis. At the end of 2023, the register comprised 58 business risks and 8 operational risks.

The company continuously monitors the implementation of measures and tracks emerging threats, which creates a solid foundation for integrating digital predictive models. Thus, the URMS provides the foundation for implementing digital and predictive solutions built on existing processes.

1. Research methodology

The methodological basis of this study is the use of systemic, process and risk-oriented approaches to the analysis and improvement of predictive planning processes in the supply chains of the oil and gas industry of the Republic of Uzbekistan. The research is grounded in the principles of strategic management, the digital transformation of logistics systems and the concept of sustainable development.

To achieve the stated objectives, the following methods were applied.

The method of comparative analysis was used to study international practice in the use of predictive planning tools and to compare them with the current state of planning and supply management processes at *Uzbekneftegaz JSC*.

¹ <https://cdn.equinor.com/files/h61q9gi9/global/16c6bc5a098c3b971979118420c4f83ddee18fb4.pdf>; annual-report-2024-equinor.pdf.

² <https://www.iea.org/reports/global-energy-review-2025/oil>.

³ <https://corporate.exxonmobil.com/-/media/Global/Files/research-and-development-highlights/Innovating-Energy-Solutions-R-and-D-brochure.pdf>.

Economic and mathematical modeling was applied to construct the predictive indices PIRSP, PESI and DLI, which make it possible to quantitatively assess the level of logistics risks, the resilience of suppliers and the digital maturity of the MTS system.

SWOT analysis was carried out to identify the strengths and weaknesses of the current MTS planning system in the oil and gas industry of Uzbekistan, as well as to reveal potential threats and opportunities associated with the introduction of the predictive approach.

Expert surveys and interviews were used to collect qualitative data from specialists in logistics, IT and risk management at oil and gas enterprises, which made it possible to identify practical problems and needs in the field of digital and predictive planning.

Content analysis of regulatory and strategic documents made it possible to assess the degree of institutional readiness for the implementation of modern forecasting and risk management models.

The empirical base of the study includes statistical data of *Uzbekneftegaz JSC*, official reports of the Ministry of Energy of the Republic of Uzbekistan, industry analytics, as well as information from international organizations such as Accenture, *IBM*, *Equinor*, *IEA*, *Exxon Mobil* and others.

The author's concept of predictive planning as a tool for managing logistics risks developed in this study was tested in the form of the proposed Integrated Predictive Planning Cycle (IPPC) model and the author's indices for risk and resilience assessment tailored to oil and gas enterprises of Uzbekistan.

2. Core challenges facing the MTS system in the oil and gas industry

Classical supply planning methods often prove ineffective under high uncertainty, particularly in material and technical supply – an area that is especially vulnerable to disruptions and variability in lead times. The MTS system is affected by several systemic and operational challenges, including data fragmentation, limited integration between production and logistics units, and insufficient supplier transparency.

Material and technical supply is one of the key components of oil and gas companies' operations, as it directly affects the continuity of production, processing, transportation and capital construction. At the same time, in the oil and gas industry of Uzbekistan and other countries with an emerging digital economy, the MTS system faces a number of systemic and operational problems that hinder the achievement of strategic resilience and efficiency. The most critical of these are outlined below.

1. Fragmentation and low transparency of data. The MTS system often relies on fragmented data sources: separate ERP systems, Excel spreadsheets and manual

reports. The absence of a single platform leads to duplicated orders, unreliable demand forecasts and longer approval times. Poor coordination between procurement, production and finance makes integrated control of supply chains impossible and complicates audits.

2. Weak supplier integration and insufficient digitalization. Despite the growth of electronic procurement, most suppliers, especially local ones, continue to use low-tech communication channels. This creates risks of delays in responding to inquiries, errors in documentation and an inability to integrate into automated procurement platforms (MDM, API, etc.). As a result, time lags between request and actual delivery increase, and overall process controllability declines.

3. Insufficient predictability of deliveries and a high share of unplanned procurement. Under conditions of unstable demand for spare parts, reagents, tubular products and equipment due to fluctuations in production and repairs, a significant share of procurement is carried out off-plan. This leads to a growing share of urgent purchases, stockouts for key items and unjustified growth of safety stocks. The system adapts poorly to changes in the schedule of production and investment programs.

4. Dependence on imports and weak development of local supplies of complex materials and equipment. Although local suppliers account for a high share in terms of number of counterparties, their share in total procurement value remains low (43% in 2023), especially in categories such as high-tech equipment and chemical reagents. This is due to the lack of production capacity among domestic manufacturers, technological lag, and difficulties in certifying and standardizing products in line with industry requirements. As a result, vulnerability to external risks rises, including exchange rate fluctuations, sanctions and disruptions in international logistics.

5. Low alignment between departments. In many cases, production, investment and procurement plans are not aligned in terms of timing and volumes. This results in untimely delivery of materials and equipment to sites, conflicts between cost centers and logistics services, and excessive bureaucratization of the approval process. The absence of a mature practice of integrated planning reduces adaptability to changes in the market environment and increases internal risks.

6. Shortcomings in supply risk management. Although *Uzbekneftegaz JSC* operates a unified risk management system, existing procedures often focus on identifying deviations that have already occurred rather than preventing them. Key limitations include the absence of quantitative assessment of the probability of disruptions (predictive indices are not used systematically), the fact that the digital maturity of suppliers is not taken into account in risk analysis, and weak linkage between risk assessment and safety stock planning. As a result, risks

are either underestimated or managed mainly through reactive response.

7. Shortage of competencies and staff overload. Procurement functions face a shortage of specialists in data analytics, ML, digital modeling, qualified buyers with sector-specific expertise, ERP integrators and IT architects. This limits the potential for implementing new digital solutions (including predictive planning), leads to calculation errors and reduces the adaptability of the system as a whole.

Observed disruptions in the supply of equipment and materials, as well as delays in well modernization or infrastructure construction, entail significant financial and production risks. All this necessitates a shift from reactive management to proactive planning based on predictive analytics and digital scenario modeling [Shmueli, Koppius, 2011].

3. Predictive planning: Essence and tools

3.1. What is predictive planning

Predictive planning is a management approach that uses forecasting models and machine learning algorithms to support proactive decision-making under uncertainty. Unlike traditional, reactive planning, which relies mainly on historical data and expert judgment, predictive planning focuses on future scenarios and allows companies to adjust their strategies before potential disruptions or risks materialize. In practice, predictive models can flag an emerging materials shortage 7–10 days in advance, which is critical for minimizing downtime⁴.

At its core, the approach combines three elements: a forecasting model (based on Big Data, AI and ML), a layer of management logic (business rules, KPI, threshold values) and decision-making systems (automated S&OP resource planning systems). Predictive planning not

only addresses the question of what is likely to happen – the focus of predictive analytics – but also suggests an optimal course of action that reflects available resources, constraints and strategic objectives.

Within the digital transformation of material and technical supply (MTS) in the oil and gas industry, predictive planning builds on a set of modern digital technologies. Of particular importance are blockchain, Big Data, the Internet of Things (IoT), Cloud Computing and artificial intelligence (AI) [Waller, Fawcett, 2013; Choi et al., 2018]. Together, these five technologies complement one another, compensate for individual limitations and help reduce labor and material costs while improving planning performance [Haiyan et al., 2019]. AI plays a central role in information exchange at all levels of an oil and gas enterprise and is increasingly seen as a defining feature of the oil and gas company of the future. It helps lower oil production costs, increase average output, streamline enterprise management and support both the economic and social development of the company [Wang et al., 2018]. Industry specialists report a 27% increase in production uptime due to AI-based predictive maintenance of equipment and a 26% improvement in asset utilization⁵.

The current level of AI technology adoption in the various links of the value chain of the oil and gas industry, as well as the expected dynamics over the next three years, are presented in Table 1. As can be seen, the greatest progress in the use of AI is expected in the upstream and downstream segments, where the share of companies using AI will reach 85–93%. A particularly significant increase is projected in production (from 40 to 90%) and refining (from 41 to 93%). This points to the growing role of digital solutions in optimizing production processes, improving operational efficiency and reducing

Table 1
Implementation of AI in the Value Chain of the Oil and Gas Industry (%)

Sector	Activity	Current AI adoption	AI adoption in 3 years
Upstream	Exploration	44	89
	Drilling	28	85
	Production	40	90
Midstream	Transportation	28	85
	Storage	28	77
	Processing	30	85
Downstream	Refining	41	93
	Retail and Marketing	31	66

Source: <https://www.ibm.com/downloads/documents/us-en/12fc84a1f2d95593>.

⁴ <https://www.accenture.com/content/dam/accenture/final/accenture-com/document/Accenture-Decarbonizing-Energy-Full-Report-Digital-LDM.pdf>.

⁵ <https://www.ibm.com/downloads/documents/us-en/12fc84a1f2d95593>.

Table 2
PIRSP Interpretation Scale

PIRSP score	Risk level	Recommendations
0.00–0.30	Low risk	Standard planning
0.31–0.60	Medium risk	Enhanced monitoring, buffer stocks
0.61–1.00	High risk	Supplier diversification, safety stock, prequalification

Source: developed by the author.

costs. At the same time, the midstream segment, which includes transportation, storage and processing, also shows a steady increase in interest in AI, confirming companies' commitment to the digital transformation of the industry's entire logistics infrastructure.

3.2. Proposed predictive planning indices

In an environment of high market volatility, extended logistics chains and reliance on imported materials and equipment, traditional supply management methods do not provide adequate risk control. To quantify losses and integrate them into the overall assessment of MTS performance, this study proposes an integrated assessment model that combines factual data (costs, deviations, downtime) with predictive indicators of logistics risk.

Within this model, a Predictive Index of Risk of Supply Disruption (PIRSP) is developed. It reflects the aggregate probability of disruptions in the supply chain for a specific item based on objective and forecast parameters. PIRSP is a quantitative indicator designed to assess the probability and potential consequences of supply disruptions on the basis of predictive factors. The interpretation scale for PIRSP and an example of its calculation are presented in Tables 2 and 3, respectively. The index is used to:

- forecast the risk of shortages of materials and equipment;
- prioritize inventory;

- configure triggers in the procurement management system.

The PIRSP index is calculated as follows:

$$\text{PIRSP}_i = W_1 \times P_i + W_2 \times T_i + W_3 \times V_i + W_4 \times C_i + W_5 \times D_i, \quad (1)$$

where P_i is the probability of failure of supplier i (based on history, reputation and deviations). SAP data are used, including delivery date deviations (ME2N), penalty history and feedback, and this is modeled as a probability from 0 to 1;

T_i is the transit time of delivery (lead time variability), expressed as the coefficient of variation of delivery times. For example, if the standard deviation of lead time is 3 days and the average lead time is 10 days, the coefficient equals 0.3;

V_i is the volatility of consumption of the given item. It is calculated from the standard deviation of consumption over the period and may be replaced by a forecast error metric (e.g. MAPE);

C_i is the criticality of the item for the technological process. It is assigned manually or on the basis of ABC/XYZ analysis, where 1 means extremely critical (production downtime) and 0 means non-critical;

D_i is the share of a given supplier in the total procurement volume for this item. If 80% of purchases come from a single supplier, the risk is higher. It is calculated as the ratio of the volume purchased from that supplier to the total volume of purchases of the item;

Table 3
Example of Calculation for MRO Item 'Pump Station Filter'

Parameter	Notation	Value	Weighting coefficient	Weighted value
Probability of supply disruption	P_i	0.25	0.25	0.0625
Lead time variability	T_i	0.20	0.15	0.0300
Consumption volatility	V_i	0.15	0.15	0.0225
Item criticality	C_i	1.00	0.30	0.3000
Supplier share	D_i	0.90	0.15	0.1350
Total PIRSP	—	—	—	0.550

Source: author's calculations.

W_1 are weighting coefficients set by experts.

The PIRSP interpretation scale and an example of its calculation are presented in Tables 2 and 3, respectively.

Table 3 illustrates an example of calculating the Predictive Index of Risk of Supply Disruption (PIRSP) for the MRO item “Pump station filter.” The calculation includes five key parameters: the probability of supply disruption, lead time variability, consumption volatility, item criticality and the supplier’s share in the total supply volume. The aggregate weighted result is 0.55, which corresponds to a medium risk level. Recommended measures in this case include tighter control of delivery schedules, the creation of buffer stock and an assessment of alternative suppliers.

Integrating PIRSP into the MTS performance assessment system makes it possible to:

- identify potential bottlenecks before disruptions occur;
- minimize costs associated with unplanned deliveries and downtime;
- strengthen the justification of decisions within predictive and integrated planning;
- prioritize purchasing activities on the basis of forecast risks.

In the scientific literature and in supply chain management practice there is no established formula or model under the name PIRSP that combines predictive probabilistic approaches with a weighted integration of factors influencing the risk of supply disruption. The methods typically used in supply chain risk management

(for example, FMEA, heat-matrix, supplier scorecards) rely on qualitative or semi-quantitative assessments and do not construct a composite numerical risk index based on parameters that can be calculated automatically. SAP Integrated Business Planning (IBP), Oracle SCM and similar systems do not offer a built-in index of this type; users must create it themselves on the basis of KPI and models. The PIRSP index can be implemented as a custom indicator in SAP IBP, SAP S/4HANA or via analytical dashboards in Power BI and SAP Analytics Cloud. The advantage of the PIRSP-based approach lies in its adaptability, the possibility of automatic recalculation and its integration into strategic and operational MTS planning processes.

Compared with existing logistics risk assessment methods such as criticality matrices, FMEA or supplier scorecard analysis, the proposed index is quantitative in nature, incorporates predictive parameters and can therefore be used as an element of intelligent supply chain management.

Thus, the predictive index of risk of supply disruption, PIRSP, represents a novel development that has no direct analogues in current logistics control systems. Its implementation enables oil and gas companies to assess supply chain vulnerabilities more accurately and to make well-founded decisions to ensure the reliability and continuity of MTS.

The Predictive Evaluation of Supplier Integrity (PESI) is a composite predictive indicator that evaluates the likelihood that a supplier will continue to meet its

Table 4
Main Components of the Index and Normalisation Methodology

Factor (S_i)	Assessment and normalization	Weight (w_i)
Delivery timeliness history	Share of on-time deliveries over the past 12 months (%). Normalization: 100% = 1.0, 80% = 0.8, etc.	0.25
Financial stability	Calculated via rating (e.g., D&B, SPARK, internal scores). Converted to a 0–1 scale using thresholds	0.15
Geopolitical/regulatory risk	GRI index, sanctions lists, political stability of the region. Direct normalization by risk level (low → 1)	0.10
Supplier price stability	Standard deviation of prices for this supplier over 6–12 months. The lower the deviation, the higher the score	0.10
Quality issues and claims	Share of orders with claims (%). Conversion: 0% = 1.0, 10% = 0.9, > 30% = 0.5 and below	0.15
Integration with SAP and digital system	Level of EDI/API integration, connection to SAP Ariba, availability of automatic exchange of orders/statuses	0.10
Logistics flexibility (response time)	Average response time to a new order (lead time reaction). Faster → higher score. Normalization: < 2 days = 1, > 5 days = 0.6	0.15

Source: author’s calculations.

obligations in the future (over a 3–12 month horizon), taking into account:

- current logistics and financial characteristics;
- historical data;
- external factors (country, industry, sanctions);
- the supplier's level of digital integration and flexibility.

The index is particularly important in high-risk, fast-changing industries such as oil and gas, where the failure of even a single critical delivery can shut down a well or disrupt a drilling cycle. The main components of the index and an example of its calculation are presented in Tables 4 and 5, respectively. The PESI formula is as follows:

$$PESI = \sum_{i=1}^n \omega_i \times S_i, \sum \omega_i = 1, \quad (2)$$

where S_i is the normalized value of a stability indicator (0–1), ω_i – is the weight of the corresponding indicator, and, n is the total number of factors (6–8 are recommended).

When calculating PESI, additional indicators may also be considered, such as the supplier's ESG profile, its ability to adapt to force majeure (reserve lists, stock levels in the region) and the level of contractual discipline.

Table 5
Example of Calculation (Simplified)

Factor	Normalized stability score	Weight	Contribution
Delivery timeliness	0.90	0.25	0.225
Financial stability	0.60	0.15	0.090
Geopolitical risk	0.80	0.10	0.080
Price stability	0.50	0.10	0.050
Claims rate	0.85	0.15	0.128
Integration into SAP	0.40	0.10	0.040
Logistics flexibility	0.70	0.15	0.105
Total PESI	—	—	0.718

Source: author's calculations.

Potential implementation options in SAP: SAP Ariba Supplier Risk (connection via Supplier Scorecard); SAP SLP (Supplier Lifecycle Performance) as a supplier assessment module; SAP IBP (Integrated

Business Planning) where PESI can be used as a KPI in scenarios; SAP BW/BI for reporting visualization with automatic scheduled PESI calculation. The main differences between PESI and its analogues, as well as the interpretation of PESI values, are presented in Tables 6 and 7, respectively.

Table 6
Differences Between PESI and Scorecards, Z-Score

Criterion	PESI (proposed index)	Existing approaches (Scorecards, Z-Score, etc.)
Predictive orientation	Yes (forward-looking)	No (backward-looking)
Multifactor structure	Yes – logistics, finance, digital integration	Often one-sided (finance or quality)
Assessment of digital maturity	Yes	No
Incorporation of external macro factors	Yes (sanctions, country)	Rarely
Use in SAP IBP	Yes (can be implemented as a KPI)	Partially (financial modules only)

Source: author's calculations.

Table 7
Interpretation of PESI Values

PESI	Interpretation	Recommendations
0.85–1.00	High stability	Recommended for long-term cooperation
0.70–0.84	Moderately high stability	Include in the core supplier pool
0.50–0.69	Moderate stability	Use with mitigation measures in place
< 0.50	Low stability	Review the contract, seek alternatives

Source: author's calculations.

PESI is a universal, flexible and scientifically grounded predictive index that reflects actual risks in supplier logistics, enables management decisions to be made in advance and provides the basis for an early-warning system for disruptions in MTS.

The Digital Logistics Index (DLI) reflects the level of digital maturity in a company's logistics operations,

including warehousing, transportation, monitoring and planning. It is calculated as follows:

$$DLI = \frac{1}{n} \sum_{j=1}^n C_j \times W_j, \quad (3)$$

where $C_j \in [0,1]$ is the maturity level for the j -th component (assessed using a scale or checklist), $W_j \in [0,1]$ is the weight of the j -th component, and n is the number of components (for example, WMS, TMS, IoT, Big Data, e-SRM, AI-based planning).

An example of the index calculation is shown in Table 8. Let us assume that the digital maturity of logistics is assessed using five criteria, with a maximum score of 10 for each criterion.

Interpretation:

- $DLI < 0.4$ – low level of digitalization;
- $DLI = 0.4–0.7$ – transitional level;
- $DLI > 0.7$ – mature digital logistics.

Table 8
Example of DLI Index Calculation

Digitalization criterion	Criterion weight	Score (0–10)	Weighted score
Availability of an ERP system with a logistics module	0.25	8	$8 \times 0.25 = 2.00$
Warehouse automation level (WMS, RFID)	0.20	6	$6 \times 0.20 = 1.20$
Supplier integration via EDI/API	0.20	4	$4 \times 0.20 = 0.80$
Use of predictive analytics (AI/ML)	0.20	3	$3 \times 0.20 = 0.60$
Availability of a transport monitoring system (TMS, GPS, IoT)	0.15	7	$7 \times 0.15 = 1.05$
Total	1.00		5.65

Source: developed and calculated by the author.

The DLI value of 5.65 indicates a medium level of digital maturity, where the company's logistics processes are partially automated but still lack deep integration with suppliers and advanced predictive analytics. This highlights the need to strengthen digital initiatives, primarily by deploying predictive AI tools and expanding integration with counterparties.

The system of indices proposed in this study forms the basis of the author's Integrated Predictive Planning Cycle (IPPC), which ensures continuous identification, forecasting and mitigation of logistics risks at the level of

strategic management. This opens up new opportunities for shifting from reactive to proactive supply management, which is particularly important for high-risk industries such as oil and gas.

The Integrated Predictive Planning Cycle (IPPC) is an original conceptual model that represents a closed management cycle combining predictive analytics tools, risk assessment and digital supply chain management. The IPPC model is aimed at anticipatory risk management and at adapting the logistics system to changing internal and external conditions. Its primary objective is to ensure the resilience, adaptability and predictability of supply chains under conditions of uncertainty and digital transformation in the industry.

The model comprises six interrelated stages, each of which relies on specific predictive indices and digital tools (see the Figure).

Stage 1 – Digital diagnostics of the logistics system:

- assessing the current level of digitalisation of the company's logistics processes;
- calculating the Digital Logistics Index (DLI) to identify weaknesses in digital logistics maturity;
- determining the need for digital improvements (ERP integration, IoT, AI platforms).

Stage 2 – Predictive supplier assessment:

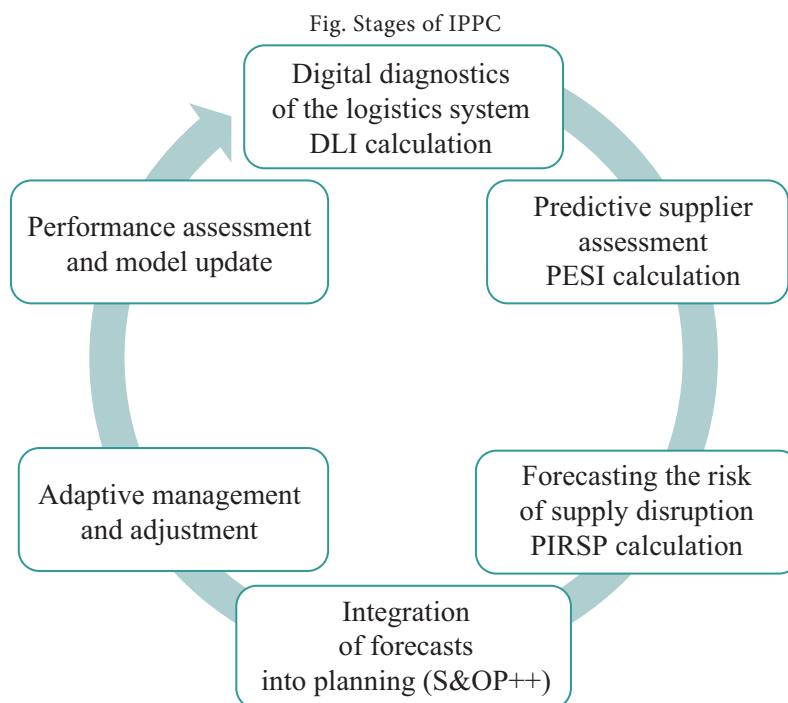
- building supplier profiles that take into account risk, reliability and stability;
- calculating the Predictive Evaluation of Supplier Integrity (PESI);
- ranking suppliers by the level of predictive stability;
- developing recommendations on adjusting the supplier base (expansion, diversification).

Stage 3 – Forecasting the risk of supply disruption:

- identifying external and internal threats to MTS stability;
- calculating the Predictive Index of Risk of Supply Disruption (PIRSP);
- conducting spatio-temporal risk analysis (geographical, seasonal and political factors);
- developing risk scenarios and performing scenario modelling.

Stage 4 – Integration of forecasts into planning (S&OP++). Embedding predictive planning into the integrated planning framework based on the Sales & Operations Planning (S&OP) concept is an objective necessity in the context of digital transformation of oil and gas companies [Zagrebel'skaya, 2021]. S&OP as a process is not only about functional synchronisation but also about providing a platform for joint decision-making. S&OP becomes truly effective only when the decisions made within its framework are based on the future rather than the past [Hansali et al., 2021]. At this stage, the following tasks are carried out:

- extending the traditional S&OP cycle to incorporate predictive data;



Source: author's calculations.

- developing optimal logistics and procurement strategies;
- forecasting demand for materials and equipment with regard to production and external data;
- using digital twins and machine learning algorithms to build scenarios.

Stage 5 – Adaptive management and adjustment:

- implementing mechanisms for automatic adaptation of logistics decisions to changing conditions;
- creating a risk dashboard;
- dynamically reconfiguring the supply chain based on forecasts.

Stage 6 – Final stage: performance assessment and model update:

- monitoring key indicators of supply chain resilience;
- recalculating the DLI, PIRSP and PESI indices on the basis of new data;
- adjusting model parameters and restarting the cycle.

The IPPC can be implemented both within an individual production and logistics unit (for example, in the Procurement Department of *Uzbekneftegaz JSC*) and as part of a corporate digital supply chain management platform. The model enables a shift from reactive management to preventive, strategy-driven decision-making, which is particularly important for companies that are highly dependent on imported resources and operate in an unstable external environment.

4. Preconditions for implementing the indices at Uzbekneftegaz JSC

Against the backdrop of its digitalization agenda, Uzbekneftegaz JSC is pursuing a strategy to introduce intelligent supply planning. In the company's 2025 procurement schedule⁶, expenditures are planned for the automation of MTS, including UZS 6.35 billion for the implementation of, and staff training in, a Master Data Management (MDM) system.

This creates preconditions for integrating predictive models into procurement, maintenance and production risk management processes. For example, developing a risk map using PIRSP makes it possible, at an early stage, to identify potential supply disruptions for equipment used at gas compressor stations, reduce downtime and lower the costs of urgent procurement.

To quantify the state of the MTS system, it is advisable to examine changes in inventories (Table 9). The most significant growth is observed in the following categories: petroleum products – from UZS 1,031 billion to UZS 1,633 billion (+58%), and materials and inventories – from UZS 992 billion to UZS 1,695 billion (+71%). At the same time, there is a reduction in work in progress (from UZS 208 billion to UZS 99 billion) and crude oil (from UZS 211 billion to UZS 40 billion), which may indicate the completion of part of production cycles and a transition to finished products.

⁶ <https://webdev.ung.uz/media/allfiles/files/7abf22aff0474158ac21907e481f1043.pdf>

Table 9
Inventory of JSC 'Uzbekneftegaz' (billion UZS)

Inventory category	As of 31.12.2024	As of 31.12.2023
Petroleum products	1,633	1,031
Materials and inventories	1,695	992
Work in progress	99	208
Crude oil	40	211
Other	23	38
Total inventory	3,490	2,480

Source: <https://webdev.ung.uz/media/allfiles/files/4284a385aba4961814022f9c9180fd9.pdf>.

This increase in inventories may be driven both by intensified procurement activity and by the need to hedge logistics risks, which in turn confirms the relevance of predictive planning as a means to reduce excessive reserves and improve the accuracy of procurement.

At the same time, an analysis of the procurement policy of *Uzbekneftegaz JSC* for 2021–2023 (Table 10) reveals substantial fluctuations in the share of procurement expenditures attributable to local suppliers. While local suppliers account for a very high share in terms of number of counterparties (97–99%), their share in total procurement value fell from 84% in 2022 to 43% in 2023. This may indicate:

- increased dependence on large foreign supplies under conditions of shortage,
- a low share of high-tech products provided by local manufacturers,
- the need to revise the system for assessing supplier risk and resilience.

Table 10
Share of Expenditures on Local Suppliers by JSC 'Uzbekneftegaz'

Indicator	2021	2022	2023
Total number of suppliers	2,681	2,935	3,897
Total procurement amount (billion UZS)	6,271.6	1,003.6	23,161.6
Total number of local suppliers	2,637	2,895	3,788
Procurement amount from local suppliers (billion UZS)	5,097.8	8,392	9,867.8
Share by number (%)	98	99	97
Share by amount (%)	81	84	43

Source: <https://webdev.ung.uz/media/allfiles/files/6a53722d3e904f6db75e57e4c48ee8d2.pdf>.

The procurement structure of *Uzbekneftegaz JSC* in 2023 also confirms active use of a wide range of procurement procedures. In total, 4,006 contracts were concluded for UZS 16,613.8 billion, including:

- 2,367 contracts totalling UZS 1,221.3 billion through electronic marketplaces, auctions, cooperation portals and electronic exchanges;
- 6 tender contracts (under Law ZRU-684) totalling UZS 105.6 billion;
- 209 contracts based on best-offer selection procedures totalling UZS 206.3 billion;
- 423 contracts with single-source suppliers totalling UZS 436.1 billion.

This diversity of procurement channels allows the company to respond flexibly to market conditions, but it also requires accurate forecasts and robust risk assessment when choosing a procedure. This reinforces the case for adopting predictive planning as a tool to optimize the company's procurement strategy. The trend also underscores the importance of implementing the PESI index as a predictive diagnostic tool for assessing counterparty reliability, as well as the need for digital monitoring of the geographic and operational diversification of procurement.

In the oil and gas sector, the introduction of predictive planning is particularly relevant due to:

- the high cost of supply disruptions (rig downtime, missed repair deadlines, contract penalties);
- dependence on imports of critical components;
- a high share of project-based supplies with long lead times and changing requirements;
- the need to factor in weather-related, geopolitical and technological risks.

5. Risks and limitations of implementation

Despite the high theoretical effectiveness of predictive planning in supply and risk management, its practical implementation is associated with a number of organizational and technological constraints. In the context of the transformation of the logistics model at *Uzbekneftegaz JSC*, these constraints may significantly affect the timing and depth of integration of predictive tools.

1. Limited and unstructured data

Predictive models require high-quality, complete and representative datasets. In the current document flow and reporting system, data are often:

- maintained in fragmented formats and systems (Excel, 1C, local databases);
- lacking a sufficient time horizon or indicators for seasonality analysis;
- not covering all risk categories (for example, contracts with new suppliers or risks of political instability in equipment-exporting countries).

This limits the applicability of machine learning and the development of robust forecasting models.

2. Low digital maturity of individual units

Despite automation initiatives (such as the implementation of MDM and the unified risk management system), many production and procurement units still operate within traditional paper-based processes. The absence of a unified IT infrastructure and integration between ERP systems reduces the effect of implementing AI algorithms and slows feedback on forecast results.

3. Shortage of competencies in analytics and risk management

Working with predictive tools requires specialists in data analytics, data science, applied mathematics and risk management. At the current stage, enterprises in the sector face:

- a shortage of qualified personnel;
- insufficient involvement of IT specialists in production processes;
- a lack of established cross-functional teams for implementing analytics in supply chains.

4. Organisational barriers and resistance to change

The transition from experience-based planning to predictive models is often perceived as a threat to stability or to managerial authority. Possible risks include:

- resistance from line managers and procurement staff;
- distrust of analytical results;
- delayed incorporation of model recommendations into managerial decisions.

5. Financial and regulatory constraints

Large-scale digitalisation requires investment in IT infrastructure, staff training and solution support. Under conditions of a limited budget and procurement procedures governed by the Law “On Public Procurement”:

- it is difficult to introduce modern SaaS solutions quickly;
- it is harder to respond flexibly to project needs (for example, to rapidly procure cloud capacity or data visualisation tools).

6. Risks of over-automation and model dependence

Despite the potential of AI, excessive reliance on automatic forecasts without expert validation may lead to erroneous decisions, especially in force majeure situations (sanctions, geopolitical shocks, pandemics, etc.). In addition, models lose accuracy over time without regular recalibration, which requires continuous monitoring and validation..

7. Legal and contractual risks related to suppliers

Predictive planning assumes the assessment of supplier risks. However, limited access to suppliers' internal data and the legal framework of contracts (for example, the absence of penalty clauses for delays) may prevent effective influence on non-compliant suppliers, even when the system identifies a high risk level. The

integration of predictive planning at *Uzbekneftegaz JSC* therefore requires not only technical modernisation but also organisational transformation. The most effective path is step-by-step implementation of pilot solutions followed by scaling, combined with active efforts to develop the digital competencies of personnel.

6. Conclusion and recommendations

Material and technical supply (MTS) in Uzbekistan's oil and gas sector is undergoing active transformation and simultaneously facing the challenges of digitalization, global logistics risks and the need for sustainable import substitution [Zagrebel'skaya, 2019]. The analysis of the current MTS system at *Uzbekneftegaz JSC* has revealed critical structural issues, ranging from fragmented data and dependence on external suppliers to weak integration of risk into planning and a shortage of digital competencies.

Predictive planning offers an effective response to these challenges. Unlike predictive analytics, which focuses on interpreting events that have already occurred, predictive planning makes it possible to construct forward-looking scenarios, estimate the probability of disruptions and rapidly adapt the supply strategy. The indices developed in this study – PIRSP, PESI and DLI – provide a practical pathway towards management based on predictive indicators by integrating risk assessment, supplier stability and digital maturity into a single decision-making framework.

IFRS-based financial data and operating performance indicators for 2021–2024 demonstrate the importance of shifting from a purely quantitative expansion of procurement to qualitative management of suppliers and risks. Substantial fluctuations in the share of local procurement, growth in inventories and the active use of diverse procurement procedures all underscore the need for more accurate, adaptive and digitally oriented tools.

To ensure supply chain resilience and achieve the strategic objectives of *Uzbekneftegaz JSC* through 2030, it is recommended to:

- implement a predictive planning system based on the PIRSP, PESI and DLI indices in a phased manner;
- integrate risk assessment results into procurement planning and safety stock formation;
- enhance suppliers' digital maturity through cooperation programs and obligations to integrate with MDM;
- introduce KPIs based on predictive indices for procurement units;
- invest in staff training in data analytics and digital risk management.

In this way, predictive planning becomes not only a tool for minimizing operational risks but also a catalyst for a sustainable, digitally oriented transformation of the entire MTS system in Uzbekistan's oil and gas industry.

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Digital servitisation strategy: Approaches to development and implementation

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Abstract

Digital servitisation is the integration of two innovative approaches that contribute to modern companies' competitive advantage creation: servitisation and digitalisation (digital transformation). The article reveals the essence of these approaches and describes various types of product-service systems (PSS), which are the foundation for forming a service strategy. A comparative analysis of approaches to the typology of servitisation strategies is carried out. The prerequisites and possibilities for the configuration approach in determining successful models of strategic behaviour are shown. The principles of developing a digital servitisation strategy are defined: equifinality, rational choice, relationality, ecosystem and strategic alignment. In accordance with the principle of strategic alignment, a generalised scheme for creating a servitisation strategy in a digital environment (digital servitisation strategy) is proposed, which is based on a coupled assessment and forecasting of current and target service levels and the company's digital maturity. Key areas for assessing the level of a company's servitisation have been highlighted. The possibilities of three types of service strategies for companies at different levels of digital maturity have been shown.

Keywords: service business models, configuration approach, strategic alignment, servitisation maturity model

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数字服务化战略：发展和实施的方法

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简介

数字服务化是两种创新方法的整合，有助于创造现代公司的竞争优势-服务化和数字化（数字转型）。本文揭示了这些方法的本质，描述了各种类型的产品服务系统(PSS)。作为形成服务战略的基础。对服务化战略类型学方法进行了比较分析，展示了确定战略行为成功模型的配置方法的先决条件和可能性。定义了数字服务化战略制定的原则为：平等性、理性选择、关系性、生态系统和战略调整。根据战略调整原则，提出了在数字环境中形成服务化战略（数字服务化战略）的广义方案，该方案基于对公司当前和目标服务水平和数字成熟度的综合评估和预测。确定了公司服务化水平评估的关键领域。展示了具有不同数字成熟度水平的公司的三种类型服务策略的可能性。

关键词: 服务业务模型、配置方法、战略调整、服务化成熟度模型

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Introduction

One of the first definitions of servitisation is considered to be the definition by S. Vandermerwe and H. Rada. According to this definition, servitisation refers to the expansion of product offerings in the direction of providing more comprehensive market packages (combinations of goods and services) tailored to the needs of customers in order to enhance the value of basic products [Vandermerwe, Rada, 1988]. The emergence and development of the servitisation concept is often seen as a response by industrial companies to changing market conditions. When the possibility of selling industrial products is reduced, and consumer demands for results are increased, this contributes to the growth of service companies [Minaya et al., 2023]. The main advantages of servitisation include increased sales and market share, due to increased customer satisfaction and loyalty, a reduced number of returns or product rejections, the attraction of new customers, a deeper understanding of consumers, their values and expectations, improved company image, and additional impetus for innovation [Tukker, 2015; Kamala et al., 2020; Favoretto et al., 2022; Minaya et al., 2023; 2024]. The work by [Georgievskiy, 2022] identifies the following groups of results that a company can achieve when moving from selling goods to providing ‘goods-services’: ensuring a strategic advantage, improving the financial condition, increasing organisational efficiency and developing relationships with customers. The positive impact of servitisation on the financial results and long-term financial stability of the company has been noted in works by [Martín-Peña et al., 2020; Dvoyanov, Kelchevskaya, 2021].

The relevance of further research in this area is determined by the following circumstances:

- the presence of certain problems and risks faced by companies that have embarked on the path of servitisation;
- expanding the opportunities of servitisation through the use of digital technologies and forming on this basis the concept of digital servitisation.

The challenges of moving from goods to services are fundamental and involve transforming a company’s value proposition and business model. As noted in [Foerster, 2023], such a shift in the value proposition is a complex task, as it involves shifting from unidirectional value delivery to collaborative value creation. Servitisation requires effective coordination between multiple stakeholders, which can lead to conflicts of interest between key stakeholders in a product company’s network. [Kohtamaki et al., 2019]. According to research [Kamala et al., 2020], implementing servitisation requires fundamental changes at all levels of the company. These changes include aligning the servitisation strategy with the corporate culture, marketing, and operating model. This also includes the competencies of individual

employees, which requires significant resources and time. As a result, the transition to a servitised business model can be challenging. Problems and risks can also arise from: a lack of necessary competencies and capabilities within the company, the need for specialised personnel, high costs of implementing services, prioritisation of sales of products due to higher returns, poor service culture, difficulties in adapting the offer to each client’s needs, lack of support from decision makers, resistance to change, and so on [Kohtamaki et al., 2019; Sholihah et al., 2020; Minaya et al., 2023].

Another potential danger is the so-called servitisation paradox, or service paradox, when an emphasis on new services undermines existing production capabilities, or when due to management differences (both at the planning and implementation stages) significant investments in expanding the service business lead to an increase in supply of services and higher costs, but do not generate expected and correspondingly higher profits [Gebauer et al., 2005; Sjödin et al., 2019; Kohtamaki et al., 2020]. While digital technologies offer additional opportunities for servitisation, they can also exacerbate the inherent challenges and contradictions of the process due to the existence of a ‘digitalisation paradox.’ [Gebauer et al., 2020; Sjödin et al., 2020; Galvani, Bocconcelli, 2022].

The realisation of potential opportunities and minimisation of risks, as follows from theory and practice of digital transformation, is ensured by forming a strategy [Gileva, 2023]. Therefore, the purpose of this article is to systematise approaches and develop recommendations for the formation of a servitisation strategy for companies operating in a digital environment.

1. Development of the concept of digital servitization: A theoretical review

As the analysis shows, there is no clear definition of the concept of servitisation. Moreover, there are several approaches to its essence that are complementary. Since servitisation is associated with changes in the value proposition and aims to create competitive advantages, it is most commonly considered as a strategy or business model. A third approach can be identified, which relates to the understanding of servitisation as a complex transformation process that ensures coordinated change not only in a company’s strategy and business model, but also ensures its connection with organisational culture and operational model, acquisition of necessary resources and competencies, including through expansion of ecosystem interactions and joint value creation. Let us give some of the most comprehensive definitions:

- servitisation is a strategic shift in an organisation’s capabilities, human and financial resources, and processes to offer comprehensive, integrated services using innovative technologies that add value to products [Kamala et al., 2020]:

- servitisation is a business strategy that focuses on providing services to customers. To do this, a company needs to understand what customers want from their products. This information can then be used to enhance the value of products by offering additional services that support their use and functionality [Minaya et al., 2023];
- servitisation is a transformational process in which a company moves from providing products to providing personalised solutions focused on satisfying customer needs through the creation of results [Georgievskiy, 2022];

These approaches to defining the concept of servitisation are also highlighted in the work [Georgievskiy, 2022], and it is noted that, in the analysed definitions, ‘strategy’ is the most frequently used specification, which is more than twice as common as the second most common specification ‘process’. However, despite frequent mentions of the term ‘strategy’ in relation to servitisation, most researchers focus on the strategic nature of transformations, while relatively few works are devoted to clarifying typologies of services or service-oriented strategies.

The next aspect that is actively being discussed today is the impact of digital technologies on the development of the concept of servitisation. As noted in [Dolgova, Nikitaeva, 2021; Favoretto et al., 2022], servitisation and digitalisation are two business model innovations that have had a significant impact on product companies. The convergence of these two trends has led to the emergence of a new concept called digital servitisation. Digital servitisation is:

- transformation processes, capabilities, and offerings in industrial firms and their associated ecosystems to progressively create and deliver increased service value arising from a wide range of enabling digital technologies [Sjödin et al., 2020];
- a transformation process, in which a product-based company changes its business model from a product-focused one to a service-oriented one, is enabled by digital technologies. This reconfigures its business processes, capabilities, products and services to enhance customer value and improve the company’s non-financial and financial performance [Favoretto et al., 2022];
- generating additional benefits and value for clients through the integration of industry 4.0 technologies into the service process [Minaya et al., 2024];
- the use of digital technologies to create new services and configure a value creation ecosystem consists of various resources and stakeholders, who, together, in an automated or non-automated form, create value and achieve certain results [Rabetino et al., 2024].

Additional benefits of using digital technologies in the context of servitisation include:

- improved personalisation and customer experience – thanks to the ability to collect and analyse large volumes of data;
- increased efficiency and proactivity in service delivery – technologies such as the Internet of Things and artificial intelligence enable remote monitoring and predictive maintenance, preventing problems before they occur and minimising downtime;
- developing new opportunities and business models where customers pay for results rather than the product itself provides greater value for customers;
- improving relationships between customers and suppliers through closer collaboration and joint value creation;
- continuous improvement of products and services based on continuous feedback from customers, monitoring and analysis of results and customer satisfaction [Martín-Peña et al., 2020; Minaya et al., 2023].

A more in-depth analysis of the potential of digital servitisation in comparison to traditional servitisation was conducted in the study by [Favoretto et al., 2022], which identified nine areas of change based on content analysis results (motivation, strategy, service offering, structure, culture, resources and capabilities, processes, performance, and ecosystem interactions), and provided descriptions of their characteristics.

One of the fundamental concepts that reflect the essence and dynamics of the servitisation process is the product-service system (PSS). According to A. Tukker, a PSS is a system consisting of both tangible products and intangible services that are developed and integrated in a way that can jointly satisfy specific customer needs [Tukker, 2004]. According to the PSS (Product-Service System) concept, service is seen not as a useful addition to a physical product, but rather as an integral part of a holistic value proposition [Sholihah et al., 2019].

Today, various types of product-service systems exist, but many are based on the typology proposed by Tukker as part of the continuum from creating tangible to intangible value for users - from a ‘pure product’ to a ‘pure service’ [Tukker, 2004]. The first main category of services is product-focused. Although the business model is primarily centered around selling products, some additional services are also offered. This version of servitisation is the most conservative and easiest to implement for traditional, product-focused companies. Within this category, there are two types of PSS: (1) actual services related to the product, such as a maintenance contract, supply of consumables, or a return agreement when the product reaches the end of its life, and (2) advice and consultancy, such as advice on

optimising logistics in a plant where the product is used as a production unit. The second category is usage-based services. In this category, the traditional product still has a central role, but the business model is not focused on selling the product itself. The product remains the property of the supplier, but it is provided in a different format and sometimes shared among multiple users. Within this category, there are several possible options:

- product leasing - the product does not become the customer's property. The supplier retains ownership and is often responsible for maintenance, repairs, and monitoring. The customer pays a regular fee for using the product and typically has unlimited and personalised access to it;
- rental - the product is also owned by the supplier, who is responsible for maintaining, repairing, etc., and receives payment for the use of the product. The main difference between this option and the previous one is that the user will not have unlimited and exclusive access to the product. Instead, the product will be shared among users, meaning that other people can also use it at the same time;
- product pooling - similar in many ways to the previous options, but it involves the simultaneous use of a product by multiple users.

The third category is services that focus on results. This includes:

- activity management (outsourcing) is the transfer of personnel and material costs from the client to the supplier, who makes a profit by more efficiently organising outsourced tasks using specialised knowledge.
- pay-per-use pricing - the basis is a product or service that is in high demand, but users do not purchase the product or service itself, but rather the results it provides. A well-known historical example of this is the sale of photocopies, rather than photocopy machines. In this case, the manufacturer of photocopying machines takes on all the responsibilities necessary to maintain the photocopying function in the workplace, including supplying paper and toner, providing technical support, and repairing or replacing the photocopy machine if needed;
- functional result – the supplier promises to provide a specific benefit to the customer, while having much more freedom in how they deliver it. There is less reliance on a specific product or technology. Examples of this type of PSS include companies that offer a 'pleasant working environment' instead of selling air conditioning units, or companies that guarantee minimal crop losses for farmers instead of selling pesticides.

A more detailed analysis of research on product-service systems is provided in the paper [Barravecchia et al., 2021]. The development of the PSS concept in a digital environment has resulted in the emergence of intelligent product-service systems, or Smart PSS, which combines intelligent, connected products with digital services to provide comprehensive solutions that address customer needs [Barravecchia et al., 2021]¹.

In conclusion, two points should be noted. Firstly, there is a close connection between the success of companies' innovative transformations, both in the areas of servitisation and digitalisation, and the presence of a unified strategy for implementing these transformations [Sholihah et al., 2019; Kamala et al., 2020; Gileva, 2023; Minaya et al., 2024]. Secondly, the typology of product-service systems often forms the basis for determining service strategies.

2. Methods and tools for developing and implementing strategies

The methodology and tools of strategic management are well-established, diverse, and constantly evolving. A major driver for development was the increased instability and uncertainty in the external environment, caused by the digital transformation of various aspects of life. At the same time, the methods of analysing the external environment are evolving in a certain direction: the range of factors being analysed is expanding, the importance of weak signal analysis, technological scanning, scenario analysis, and planning is growing, and the scope of industry analysis is broadening, extending far beyond specific industries [Gileva, Shkarupeta, 2022; Titov et al., 2025]. The demands for strategic flexibility are significantly increasing [Gileva, 2023]. A new analysis and management tool has emerged - a digital maturity assessment model [Gileva, 2021]. Initially, models for assessing the maturity of industries and individual companies were developed. Then, this toolkit evolved to include assessing the maturity of entire ecosystems and the service maturity of individual companies [Adrodegari, Sacconi, 2020; Kimita et al., 2022]. Business models play a crucial role in implementing strategies, especially in the area of servitisation [Gileva, 2016; Khachaturyan, 2022]. One of the most comprehensive approaches to understanding service business models is presented in the article [Kohtamäki et al., 2019].

At the same time, the logic behind developing both a digital strategy and a servitisation strategy remains largely traditional. This involves analysing the external and internal environment, taking into account the updating and development of strategic analysis methods, integrating the analysis results into a SWOT matrix (necessarily in its full version - with recommended action

¹ See also: Zheng P., Chen C.-Y., Wang Z. (2021). Smart product-service systems. Elsevier Inc. <https://www.sciencedirect.com/book/9780323852470/smart-product-service-systems#book-info>.

areas), setting goals, selecting strategies, and developing a trajectory for achieving them at different management levels (corporate, business unit, and functional). Monitoring implementation is also essential, often using the methodology and tools of a balanced scorecard to present and monitor strategy. Adjustments to goals, strategies, and plans are made based on monitoring results. This is the logic for forming a service strategy, with clarifications regarding the structure of a balanced scorecard, that is presented in this work [Sholihah et al., 2020].

However, it is worth noting that, in addition to the traditional approach to strategy development, a so-called configurational approach has gained popularity in recent years. At the same time, like with many scientific and practical approaches and concepts, there are different interpretations and applications of this idea. One of the pioneers of the configuration approach to strategic planning is D. Miller. Based on his analysis, he identified ten strategic archetypes, or models of company behaviour, depending on the dynamics and hostility of the external environment, as well as the heterogeneity of the environment and the company's size. These archetypes include six successful and four unsuccessful models [Miller, Friesen, 1978].

Currently, the development of the configuration approach is largely driven by the increasing instability and uncertainty in the external environment. Situations arise where basic scientific research is unable to provide answers to current management challenges. In such cases, a comprehensive analysis of successful companies' activities becomes essential to identify and systematise effective behavioural models, including different types of strategies. According to the configurational approach, strategic design is presented as a set of options depending on various combinations of factors that influence the success of the transformations being implemented [Greckhamer et al., 2018; Sjödin et al., 2019; Kamala et al., 2020; Soto Setzke et al., 2023; Paiola et al., 2024; Markova, Ovchinnikova, 2025]. However, the results of interest are rarely caused by a single factor, and these factors rarely act independently. Therefore, the same factors can have both positive and negative effects, depending on the other conditions involved. Thus, in the study by [Sjödin et al., 2019], the goal was to identify specific management conditions that lead to the successful implementation of servitisation strategies.

Configurational theory can help explain complex, multi-dimensional phenomena that tend to group together into archetypes or general patterns of consistent causes (e.g., management strategies) [Greckhamer et al., 2018]. An essential principle of the configurational approach is the recognition of the concept of equifinality. This means that different combinations of factors can lead to the

same optimal outcome, meaning that there are multiple paths to success [Sjödin et al., 2019].

The approaches considered (traditional and configurational) are not in contradiction, but rather complementary, which will be taken into account and used when developing recommendations for creating a company's servitisation strategy.

3. Servitisation strategies: typology and formation

As mentioned above, the term 'strategic' is often used when discussing the concept of servitisation. However, this is largely due to the nature of the process itself. It creates a wide range of additional competitive advantages, and requires a thorough review and restructuring of the strategic priorities, business models, processes, competencies, capabilities, and organisational culture of the company.

Creating value through servitisation requires a new approach, and the intention to move towards services should be clearly reflected in the company's strategy and changes to its business models [Soto Setzke et al., 2023]. As noted in [Minaya et al., 2024], digital servitisation represents a strategic shift that marks a fundamental turning point in the modern business landscape. This transformation involves not only a shift from a product-focused to a service-focused approach, but also the integration of advanced digital technologies deeply into the company's operations. In addition, servitisation involves collaboration across company boundaries and effective coordination between multiple stakeholders. This means that it not only affects the business models of individual companies, but also requires the alignment of the business models of all partners involved in creating value through PSS. Therefore, the implementation of the concept of digital servitisation is not possible without the creation of ecosystems and the use of digital platforms as their foundation [Kohtamäki et al., 2019; Favoretto et al., 2022; Trachuk, Linder, 2023; Rabetino et al., 2024].

As for the strategies themselves, their understanding generally corresponds to the traditional one. A servitisation strategy is seen as a comprehensive action plan designed to achieve a long-term business goal [Kamala et al., 2020]. In [Sholihah et al., 2020], a service-oriented strategy is described as a coordinated and integrated set of actions and commitments that a company makes in order to leverage its capabilities and achieve its goals, as well as gain a competitive advantage through improved service offerings. It should also be noted that digitalisation leads to a differentiation of services, whether they are product- or customer-focused, mainly due to an increase in customisation options [Favoretto et al., 2022]. Additionally, service strategies, or models

Table 1
Approaches to identifying servitisation strategies

Authors	Types of strategies	Features of the approach
[Kamala et al., 2020]	Five servitisation strategies have been identified: 1) product-focused; 2) integration-focused; 3) user-focused; 4) service-focused; 5) result-oriented	The strategies are identified through a systematic literature review. They are based on Tooke's typology of 'product-service' systems, which positions a company along the 'product-service' continuum.
[Cusumano et al., 2015; Foerster, 2023]	In the work [Cusumano et al., 2015] three strategies were identified, adapted in the work [Foerster, 2023] taking into account the characteristics of ecosystem interactions: – Product flattening strategy: additional services support the functionality of the product, but they are not fully integrated with it. This allows the service to be standardised and offered by the product manufacturer or by an independent service provider; – A product adaptation strategy involves customising a product based on the needs of the users. This enhances the product's functionality and makes it more relevant to the target audience. The service component is closely linked to the product, ensuring a seamless experience for the user; – The product replacement strategy aims to completely replace a product with a service, where customers primarily pay for use	The initial premise for creating the typology is that competitive advantages are created based on a value proposition. Therefore, strategies are differentiated according to the type of value proposition, reflecting the evolution of PSS from products to services. In [Foerster et al., 2023], these strategies are seen as a means for a company to succeed in the ecosystem during the renewal phase.
[Sjödin et al., 2019]	Three alternative management strategies have been identified that allow advanced service providers to maximise the value of their services: 1) Innovation management strategy (high service innovation, low attractiveness of alternatives, and low use of explicit contracts) - firms following this strategy consistently provide innovative service combinations that clearly differentiate them from competitors, without the need for formal contracts to capture the value of innovation. A firm's ability to generate effective service innovation allows them to freely manage their partner network, relying on their ability to innovate and respond quickly. The successful application of this strategy relies on the rapid commercialisation of innovations and a limited level of competition; 2) The relational management strategy, which is characterised by a high level of service innovation, high perceived switching costs, and low use of explicit contracts, is based on the establishment of longer-term relationships with partners and customers that are characterised by trust and openness. Trust replaces explicit contracts as a governance mechanism, allowing for the joint creation of value. This is possible due to the high switching costs associated with the significant interdependence between partners in the process of generating innovative value; 3) Market-based governance strategy - instead of relying on trust, this approach uses contractual mechanisms to manage and extract value from innovation. This strategy emphasises high levels of service innovation, low switching costs, and the attractiveness of alternative options, as well as extensive use of explicit contracts. According to the analysis, this configuration is least common and only works in certain market conditions. For instance, a greater focus on contracts may be suitable when client relationships are new or when there is a high risk of opportunistic behaviour from partners	The study employs a configurational approach that examines the impact of four key factors on company performance: innovation in the service industry, perceived switching costs for customers, the attractiveness of alternative service providers, and the use of explicit contracts. Empirical data from 50 Swedish companies providing advanced services was used to create analytical models and draw conclusions

Table 1 – ending

Authors	Types of strategies	Features of the approach
[Favoretto et al., 2022]	There are three types of digital servitisation strategies: 1) industrial servitisation - when digitalisation enhances the efficiency of a company's operations by allowing the provision of product-related services; 2) commercial servitisation - product companies use digital technologies to provide services that enhance customer processes; 3) a value-based servitisation strategy that combines digitalisation and service offerings to create value for both businesses and customers	The typology of strategies is part of a comprehensive study that analyses the impact of digitalisation on traditional service delivery and is considered one of the areas affected by this change. Another important aspect is the use of digital platforms
[Paiola et al., 2024]	Three equifinal configurations (models of strategic behaviour) have been identified: 1) small and medium-sized businesses with a relatively high level of digital maturity, no significant internal involvement in the project, and a correspondingly small number of new hires related to it. The implementation of local projects that do not require the involvement of the entire company, using existing resources and capabilities, without the need to hire competent specialists from outside; 2) large companies with a relatively high level of digital maturity and high levels of internal collaboration, as well as a small number of targeted hires, are the most common among the companies in the sample we studied; 3) large companies that are not fully prepared for digital transformation but have a high level of internal engagement in digital service projects and employ a large number of external specialists to implement them	The study used a configurational approach to examine the influence of four internal factors on the success of digital servitisation projects: firm size, level of digital readiness, degree of internal involvement, and acquisition of new competencies through external talent acquisition. The focus of this study is on Italian B2B manufacturing companies that are implementing digital servitisation projects in the area of knowledge-intensive business services (KIBS)

Source: compiled by the author.

of strategic behaviour, are increasingly being developed based on a configuration approach (see Table 1).

Based on the results of the analysis, several conclusions can be drawn.

Firstly, regarding approaches to the typology of service strategies.

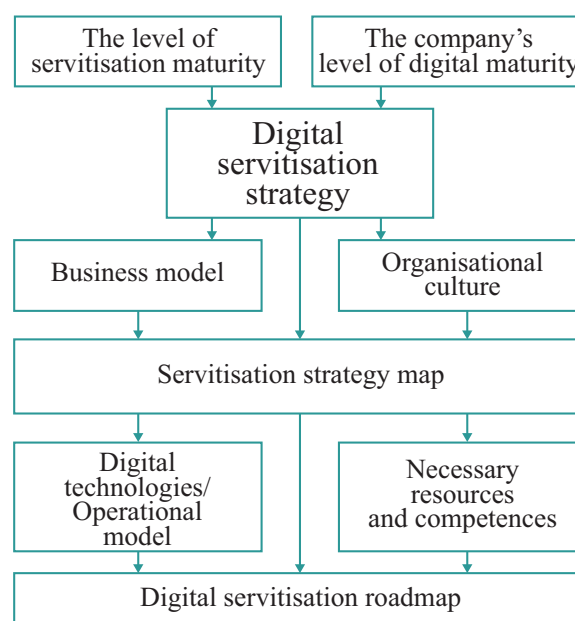
Here, we can broadly distinguish between two options:

- value typology - based on the type of value proposition within the PSS format, this approach is the most common within the 'product-service' continuum [Cusumano et al., 2015; Kamala et al., 2020; Favoretto et al., 2022; Foerster et al., 2023];
- configuration typology - in the form of various combinations of several factors that are key to the success of the service process [Sjödin et al., 2019; Soto Setzke et al., 2023; Paiola et al., 2024].

Secondly, in terms of defining the key principles for creating a servitisation strategy, these principles include:

- the principle of equifinality reflects the idea that strategic goals can be achieved through various means. This means that there are different configurations of key factors that can lead to the same desired result;

Fig. The generalised scheme for the formation of the servitisation strategy for a company in the digital environment



Source: compiled by the author.

Table 2
Key areas for assessing the company's level of servitisation

Directions	Components
Strategy and business-model	<p>Value proposition in PSS format, digital products and services</p> <p>Having a clear servitisation strategy</p> <p>Alignment of business models with the strategy of a service-oriented company</p> <p>Metrics (KPIs) that reflect the process and outcomes of servitisation, such as the share of revenue or profit generated from providing services within the company's overall revenue/profit, customer satisfaction levels, and return on investment in the service segment, among others</p>
Processes and technologies	<p>Ability to analyse the consumer and determine their requirements in order to formulate a value proposition that is tailored to the specific needs of the company</p> <p>Capability to deliver a value proposition that meets the needs of the business and is specifically tailored to the operations of the company</p> <p>Standardisation of processes and services to ensure consistent quality and high levels of service</p> <p>Service-oriented information technologies, including online marketing and analytics, customer-focused CRM systems, customer support systems, chatbots, omnichannel service support, the use of virtual and augmented reality technologies in customer services, and so on</p> <p>Cybersecurity</p> <p>Risk management</p>
Resources and competences	<p>Availability of necessary resources and competencies within the company (assessed taking into account the specifics of the services and the company)</p> <p>Allocation of resources between product- and service-oriented departments and projects</p> <p>Senior management support for servitisation investments</p> <p>Knowledge management in the company, including:</p> <ul style="list-style-type: none"> - collection and accumulation of knowledge about clients necessary for expanding the range and improving the quality of services; - collection and accumulation of data on partners' goals, resources, competencies and reliability, etc.
Partners and ecosystem	<p>Number and reliability of existing partners</p> <p>Availability of potential partners</p> <p>The nature of relationships with partners (contractual or relational – based on trust)</p> <p>Degree of dependence on ecosystem partners</p> <p>Participation of clients and other stakeholders in the development/creation of services</p>
Personnel and organisational culture	<p>Service-focused appraisal and motivation system</p> <p>Employee engagement drives customer-focused growth</p> <p>Customer service culture</p> <p>Leadership and talent management</p> <p>Motivating employees to learn and collaborate</p>

Source: compiled by the author.

Table 3
Features of servitisation strategies based on a company's digital maturity

Company's level of digital maturity	Product smoothing strategy (Product-oriented services)	Product adaptation strategy (Usage-driven services)	Product substitution strategy (Results-based services)
Low	Additional services that do not involve significant use of digital technologies are offered in addition to basic (material) products	Product sharing services are implemented using minimal digital technology	Providing the final result as a service with minimal digitalisation
Basic	The ability to monitor the quality and efficiency of product-service use is added to the product-service offering	The use of digital technologies can help reduce the time and cost of maintenance. This is because digital platforms offer a range of benefits, including the ability to attract and evaluate potential partners and clients more efficiently	Improving customer experience and efficiency through data analysis
Advanced	The share of digital products and services is growing, and the opportunities for customisation and scaling are significantly expanding	Developing our own digital platform, growing our customer base and increasing satisfaction levels by providing more customised services	Continuously improving our services in collaboration with our partners and clients, we are developing an ecosystem based on a digital platform

Source: compiled by the author.

- the principle of rational choice emphasises the need to justify both the selection of key success factors and the choice of a strategic behaviour model;
- the principle of relationality presupposes the need for the existence, consideration, and formation of a system of non-hierarchical relationships based on coordination of interests and trust between companies involved in creating an integrated value proposition in PSS format;
- the ecosystem principle describes the inter-company nature of the process of creating PSS and emphasises the importance of combining resources and skills in the process of jointly creating innovative value;
- the principle of strategic alignment reflects the need to align the chosen strategy with a set of business models, organisational structure, operating model, and corporate culture.

As mentioned earlier, the shift from a product-centric approach to a PSS-based value proposition involves significant changes not only to products, processes, technologies, and resources but also to the overall business model, management structure, and organisational culture. The need for strategic alignment between all aspects of a company's operations is identified by [Sholihah et al., 2019] as a crucial issue, without which it is impossible to successfully transition to a service-oriented business model. The principle of strategic alignment should be considered already at the planning stage, but its success is largely dependent on the process of implementing the strategy. Currently, the most common approach to addressing issues of strategy implementation, monitoring and evaluation is the balanced scorecard (hereinafter referred to as BSC). The features of creating a strategic map in the BSC format, considering the characteristics of the service process,

are discussed in the works by [Rabetino et al., 2017; Sholihah et al., 2020].

A servitisation maturity model is a valuable tool for developing a service strategy and addressing alignment issues. Various approaches to creating such models have been described in the literature [Adrodegari, Saccani, 2020; Kimita et al., 2022; Arioli et al., 2025]. Additional tools that can be used in the creation of servitisation models and the development of a strategic plan for the service strategy include PSS mapping tools, such as the PSS Board [Barravecchia et al., 2021].

A comprehensive diagram of the process of developing a service strategy for a digital business (digital servitisation strategy) is shown in Fig. 1. The diagram does not illustrate the stages of strategic analysis that lead up to the justification of the feasibility of transitioning to a service-oriented development model. General guidelines for conducting such analysis can be found in the literature [Sholihah et al., 2020; Gileva, Shkarupeta, 2022]. In this process of analysis, it is important to identify key success factors, which are a limited number of areas (internal or external conditions) that, if achieved, guarantee success in the competition. These factors are essential for the successful implementation of a strategy. For companies with a high level of digital maturity, it is recommended to analyse and identify these factors using big data analysis and artificial intelligence technologies. These factors can serve as parameters for creating successful configurations. For example, by focusing on them in maturity models and defining corresponding target values, as the choice of a digital servitisation strategy is largely determined by the balance between the servitisation maturity level and the company's digital maturity level (see Figure).

Today, a wide range of models for evaluating the digital maturity of businesses have been created [Gileva, 2021]. A generalised description of the key areas for assessing the level of service-orientation is presented in Table 2.

A servitisation strategy is chosen based on the current level of service maturity and its potential for growth. As can be seen from the analysis presented in Table 1, the most common and logical approach is to choose the appropriate position along the 'product-service' continuum. The basic guidelines are the PSS categories identified by Tukker and described above: (1) product-oriented services, (2) usage-oriented services and (3) result-oriented services [Tukker, 2004]. Additional recommendations for selecting the type of PSS are contained in the work by [Frederiksen et al., 2021]. Considering the different levels

of digital maturity, the capabilities of each identified strategy may vary (Table 3).

Like strategies, service business models are closely related to the type of PSS. Therefore, it is essential to identify business models that align with the chosen strategy. Alternatively, from the perspective of the service content, business models such as product supplier, industrialiser, solution provider, results provider, and platform provider could be used [Kohtamäki et al., 2019]. From the perspective of the format for providing IT services in the context of digital servitisation, we can consider the XaaS family of business models.

The issues of creating a service-oriented organisational culture are important, but they are beyond the scope of this study.

The logic of creating a strategic map allows us to expand the requirements for a PSS into a system of processes, technologies, resources, and competencies needed to create a company's operating model. This, in turn, leads to the development of a roadmap as a tool to implement the chosen strategy.

Conclusion

As numerous theoretical and empirical studies have shown, the transition of product-based companies to the provision of both products and services, known as servitisation, can lead to the creation of significant competitive advantages. The development of digital technologies presents a vast array of opportunities in this field, while also increasing the complexity of an already intricate process. To successfully overcome the challenges of servitisation and digitalisation, companies need to develop a clear strategy that aligns with other key components of their business, including their operating model, technologies, and organisational culture. This requires a comprehensive approach that takes into account the skills and expertise required to implement change.

The proposed framework for developing a company's service-oriented strategy in a digital environment provides an overall logical approach to the process. It includes additional guidelines for managers, such as a typology of service strategies that take into account different levels of digital maturity in companies, as well as key areas to assess a company's level of service orientation.

Since both servitisation and digital servitisation involve the collaboration of various companies, as well as customers, in the development of integrated products and services, it is important to understand the characteristics of ecosystems that enable the creation of result-oriented services. This area of research aims to analyse the formation, operation, and evolution of these ecosystems.

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Artificial Intelligence adoption: Drivers and barriers to development

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Abstract

The article explores the challenges to Russia's economic security caused by the development and implementation of artificial intelligence (AI) in the context of digital transformation and global technological competition. The purpose of the study is to identify the most significant threats to the country's economic security in the context of the popularisation of AI technologies and propose measures aimed at addressing them, taking into account the current situation. To achieve this goal, the authors analysed the dynamics of the Russian AI market, its structure by industry and growth rates, as well as the main external and internal risks associated with the use of AI technologies. Special attention is paid to the trends in the development of the AI market, cyber threats, economic and cyber espionage, proliferation of deepfakes, and problems of technological dependence on foreign suppliers and sanctions pressure. Internal challenges include staff shortages, polarisation of digitalisation in industries, concentration of resources in large companies, and lack of regulatory oversight. It is shown that these factors significantly limit the development potential of the domestic AI market and create prerequisites for economic and technological vulnerability in the country. The article suggests measures to minimise threats, including the development of domestic solutions, decentralisation of resources, annual monitoring of digital maturity and digital literacy in industries, the use of various mechanisms to support small and medium-sized businesses depending on the industry affiliation and the role of a company in a particular market. It also proposes improvement of the regulatory framework, relaxation of regulations, and provision of comfortable working conditions for IT specialists in Russia, as well as training of qualified personnel. The conclusion is drawn about the need for a comprehensive approach to ensuring Russia's economic security in the context of the rapid development of artificial intelligence. The results obtained can be applied both in the practical activities of organisations using AI technologies and in the activities of government authorities to develop strategic and other policy documents for the development of the AI market.

Keywords: cyber threats, cyberattacks, deepfakes, digital technologies, and technological security

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AI采用: 发展的驱动和障碍因素

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简介

本文研究了在数字化转型与国际技术竞争背景下, 人工智能 (AI) 的发展与应用对俄罗斯经济安全构成的威胁。本研究旨在识别人工智能 (AI) 技术应用背景下对国家经济安全构成的最重大威胁, 并制定相应的风险消减措施。

本文作者分析了俄罗斯人工智能 (AI) 市场的动态变化、行业结构及增长趋势, 并重点研究了与AI技术应用相关的主要外部和内部风险。研究特别关注AI市场的发展趋势、网络威胁、经济间谍与网络间谍活动、深度伪造 (Deepfake) 技术扩散, 以及对外国供应商的技术依赖问题和制裁压力等挑战。研究分析了内部挑战: 人才短缺、各行业数字化进程不均衡、资源向大型企业过度集中, 以及法规监管不足等问题。研究表明, 这些因素严重制约了俄罗斯国内人工智能 (AI) 市场的发展潜力, 并可能引发国家经济与技术层面的脆弱性。

文章提出了一系列风险消减措施, 包括: 发展本国解决方案, 推动资源去中心化、建立行业数字化成熟度与数字素养年度监测机制、根据企业所属行业及其在特定市场中的角色实施差异化中小企业扶持政策、完善法规体系、吸引海外人才回流, 以及为在俄境内工作的IT领域专家提供舒适工作条件并培养高素质专业人才。研究结论指出, 在人工智能 (AI) 迅猛发展的背景下, 必须采取综合措施保障俄罗斯经济安全。研究成果既可供应用AI技术的各类组织在实际工作中参考, 也能为政府部门在制定人工智能市场发展战略及其他规划文件时提供决策依据。

关键词: 网络威胁、网络攻击、深度伪造、数字技术、技术安全

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Introduction

As human society evolves, it creates and improves its methods of attack and defense. Similarly, the current development of artificial intelligence (AI) can be compared to the invention of the bow and arrow, which led to the creation of the long arm, significantly changing human life. The development of 'long arm' never stops and the evolution of offensive weaponry continues. While modern AI is still at the stage of choosing between a bow and an arrow, humanity is essentially developing its 'smart arms' or 'digital heads'. The future development of AI technologies and their potential consequences cannot be accurately predicted over the long term. However, it is crucial to address the issue of 'shielding', that is, protecting against the threats posed by AI now, as the current 'long arm' could potentially plunge the planet into chaos and destroy humanity.

To defend against AI threats, we need to take multiple approaches:

- Ensuring the stability of AI against external and internal threats, such as electronic worms, viruses, and Trojans;
- Detecting and preventing constitutional AI, implementing code insertions to prevent it from

committing illegal actions, and training it not to commit illegal acts when time limits or conditions are met;

- Technologies using AI as a countermeasure to prevent illegal actions that threaten human life and state security;
- Training, certifying, and approving AI technologies for market use in accordance with security requirements;
- Parity between national systems using AI and foreign ones.

The authors examine the threats to Russia's economic security associated with the active development and implementation of AI technologies in the country's economy. These threats are particularly significant at the current stage of digital transformation and ensuring technological sovereignty amid international competition in this area. The study aims to identify the most significant threats and propose measures to mitigate them given the current situation.

To achieve these goals, the authors consistently address tasks such as analysing the Russian AI market, identifying the main risks and challenges associated with the use of AI, and proposing measures to minimise identified threats.

In terms of methodology, a retrospective analysis of data characterising the state of AI market development in Russia and cyberattacks in Russia is conducted. Analysis of external and internal threats associated with implementation of AI at national level is performed. This made it possible to identify problems of developing ‘smart hand’ or ‘digital head’ and, based on application of synthesis, propose set of measures aimed at solving ‘shield’ problem.

1. Theoretical aspects of the study

Recent years have seen growing interest in research not only in the digital economy, but also in one of its key technologies, artificial intelligence. Given the multifaceted nature of this issue, we are interested in examining artificial intelligence specifically as a potential threat to Russia’s economic security. Therefore, this study focuses on the work of leading Russian scholars.

For example, A.S. Danchenko notes that ‘digitalisation has become the most important driver of the modern economy and a condition for ensuring economic security, determining the importance of technological and innovative solutions in all sectors of the national economy’ [Danchenko, 2024].

In his analysis of the technical aspects of AI, A.A. Balashov highlights the potential for increased unemployment due to technological advancements, as well as concerns regarding cybersecurity threats and the spread of misinformation. He also discusses the possibility of government agencies utilising ‘profiling,’ which raises questions about its safety and ethical implications [Balashov, 2023].

At the same time, ensuring economic security should include not only technical and information support, but also the digital competence of employees and management, as well as legal protection through improving existing legal norms [Mamontova, 2022].

Research into AI technologies for economic security reveals the transformation and increasing sophistication of crime methods driven by technological advances. At the same time, AI systems have significant potential to identify risks associated with ensuring a country’s economic security [Dyatlova, Svirina, 2024].

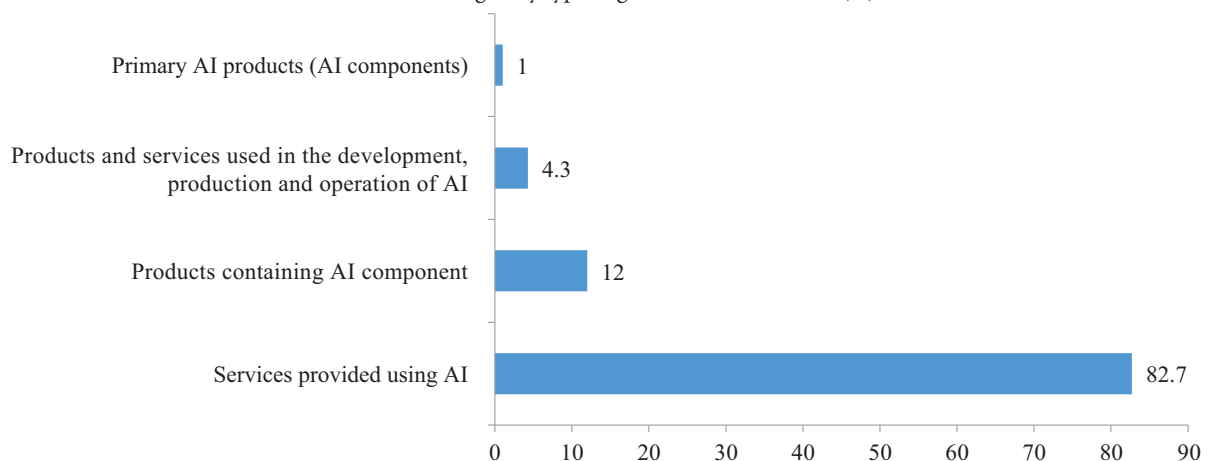
Aspects of AI, such as the digital shadow economy [Obukhova, Piyaltsev, 2021] and the use of AI technologies in assessing the level of economic security at the national level have also been studied [Balashov, 2024].

Based on the results of assessing the state’s economic security during large-scale implementation of neural networks in various sectors of the national economy, it was noted that there are threats related to the banking sector when working with artificial intelligence, such as AI malfunctions and damage to customers and the bank itself [Mankovsky, 2023].

I.N. Romanova, examining the risks and threats of AI technology implementation, notes that the main threats include: complete dependence on computers; errors and failures in intelligent information systems; the unpredictability of intelligent robots; the lack of security; threat to information privacy; impossibility of accountability; and creation of artificial superintelligence. As a response, she proposes closer cooperation between government and AI developers; socially responsible behavior by developers; involvement of top scientists and experts; application of best international security practices [Romanova, 2021].

A set of mechanisms have been identified through which AI technologies can contribute not only to reducing the level of risk but also to increasing the resilience of the economic system: forecasting based on neural networks, monitoring and optimisation of business processes, rationalisation of risk management systems,

Fig. 1. The structure of soled goods, works and services related to AI technologies by type of good and service, 2023 (%)



Source: [Artificial Intelligence..., 2025].

and modeling the dynamics of complex socio-economic systems [Barakin, Shailieva, 2023].

One cannot but agree that ‘one of the key areas for AI use in Russia’s economic security is its application to the analysis and forecasting of macroeconomic processes. Modern machine learning algorithms allow for processing vast volumes of data and identifying patterns that might escape human analysis’ [Smorodina et al., 2024].

In general, the main barriers to digitalisation of the Russian economy and implementation of AI include lack of investment resources, infrastructure limitations, insufficient legal regulations, shortage of specialised personnel, and fears and tensions in society caused by the expectation of possible structural unemployment [Elin et al., 2024].

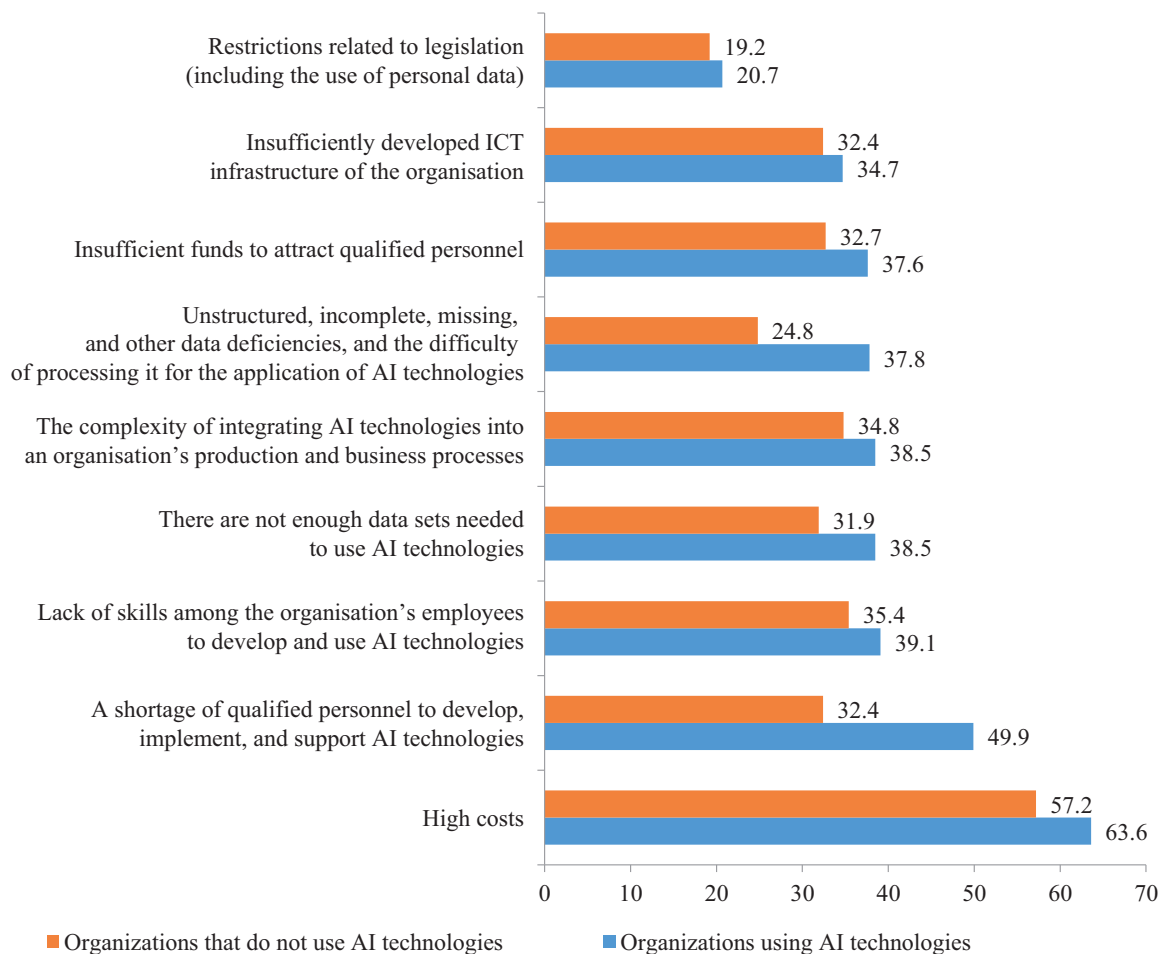
As can be seen from the results of the review of scientific papers conducted, there is still a gap in research on AI technologies with regard to national economic security.

2. The current state of demand for AI technologies in Russia

The Russian artificial intelligence market has shown steady and rapid growth in recent years. According to various analytical agencies, the market size was estimated at approximately 80-90 billion rubles in 2021, and by 2022 it had grown to 647 billion rubles, an 17% increase. In 2023, the market reached 900 billion rubles, with a year-on-year increase of 37%. Estimates of the Russian AI market size vary: the NTI Competence Center at MIPT estimates it at 130-160 billion rubles; Smart Ranking estimates it at about 305 billion rubles and TAdviser estimates around 320 billion. Meanwhile, investments in AI grew 36% in 2014, reaching 304 billion roubles [Borovkov et al., 2024].

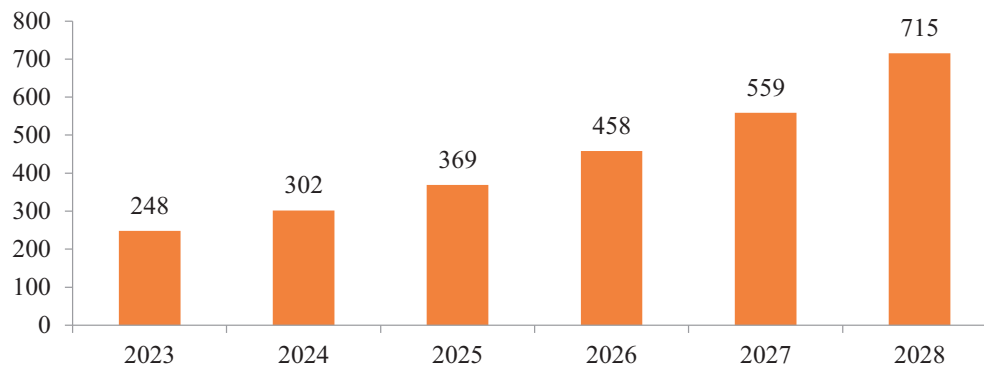
According to forecasts from experts at NTI Safenet and the NTI Competence Center, revenue from the Russian AI project market is expected to grow to 600-800 billion rubles by 2025, representing a two to three-fold increase compared to 2024. The contribution of

Fig. 2. Barriers to AI adoption by organisations, 2023
(% of respondents’ answers)



Source: [Artificial intelligence..., 2025].

Fig. 3. Forecast for the development of the Russian cybersecurity market (billion rubles)



Source: Forecast for the development of the cybersecurity market in the Russian Federation for 2024-2028. <https://www.csr.ru/upload/iblock/f14/bnl532lqmqd0u23s1ftuzw4n3ycm1to1.pdf>.

the AI sector to Russia's GDP could reach up to 2% [Borovkov et al., 2024].

Of interest is the structure of sales of goods, works, and services related to AI technologies (Figure 1), as well as barriers to the use of AI by organisations (Figure 2).

As Figure 1 shows, the AI market is growing based on AI-enabled services (82.7%). In turn, primary AI products as well as goods and services used in the development, production and operation of AI do not significantly impact market structure, accounting for 1% and 4.3% respectively.

Regarding barriers for companies using AI technologies, the most significant ones are: high costs (cited by 63.6% of respondents), a shortage of qualified

personnel to develop, implement and support the operation of AI technologies (49.9%), and a lack of skills among organisation's employees to develop and use AI technologies (39.1%).

For companies that do not use AI technologies, the most significant barriers include high costs (57.2%), lack of skills among organisation's employees to develop and use AI (35.4%) and difficulty integrating AI into production and business processes (34.8%).

Financial services lead the way in AI adoption by industry, with 95% of organisations already using it, followed by higher education (72%) and information and communication technology (70%). Manufacturing is lagging behind, with only 16% having adopted AI.

Table
Assessing the impact of factors on the growth of the cybersecurity market
(% changes based on current weighted average estimates from the expert community)

Factor	Year				
	2024	2025	2026	2027	2028
Rising cyberattacks	3	3	3	3	3
Departure of foreign vendors	3	3	3.5	3.1	3
Sanctions and related restrictions	0	0	0	0	0
Responsibility of top officials of organisations for ensuring information security	3	4	4	4	4
Ban on foreign software in critical information infrastructure facilities	3	3	4	5	5
Financial support measures	3.7	3.6	3.8	3.7	4.1
Non-financial support measures	2.3	2.4	2.5	2.6	2.8
Tightening of information security requirements	3.4	3.2	3.5	3.6	3.7
Total market growth (year-on-year)	21.4	22.3	24.3	25	24.8

Source: Forecast for the development of the cybersecurity market in the Russian Federation for 2024-2028. <https://www.csr.ru/upload/iblock/f14/bnl532lqmqd0u23s1ftuzw4n3ycm1to1.pdf>.

According to data presented at the 2025 St. Petersburg International Economic Forum¹, среди 100 крупнейших российских компаний внедрили 43% of the top 100 Russian companies have implemented AI in at least one business function, an increase of 23% compared to 2019. More than half of large companies (54%) are using generative AI.

At the same time, AI technologies provide certain competitive advantages for companies and industries, as well as the economy of the country as a whole. However, they also pose a number of threats that can be minimised through knowledge of these threats at the corporate, industrial, and national levels.

Let's look at the economic consequences and cybersecurity issues through the lens of cyberattacks, as a factor hindering the development and active implementation of AI technologies in various elements of the country's economic system.

In 2024, Russian businesses faced a sharp increase in cyber threats, many of which were created using artificial intelligence. Attackers actively used AI to develop sophisticated and effective attacks, using phishing campaigns, ransomware and deepfakes. This led to significant financial losses, destabilising corporate IT infrastructures and undermining the stability of corporate systems. Companies had to significantly increase their cybersecurity budgets and reduce user trust in digital services as a result.

Companies operating in the financial, telecommunications, and retail sectors remain particularly vulnerable to cyber threats due to the high level of digitalisation and vulnerability of their IT systems. Active integration of artificial intelligence into fraudulent schemes and automated attacks complicates the defense process significantly, necessitating the use of innovative information security methods. Measures are being discussed in response to these threats, including criminal liability for the use of AI in fraudulent schemes [Gashi et al., 2024].

The economic impact of the misuse of artificial intelligence technologies includes both direct losses from ransomware (which increased by 44% in 2024) and indirect losses due to data breaches, damage to companies' reputations, and system recovery costs. The introduction of AI into cyberattacks creates new types of threats - intelligent malware that adapts to defense systems, requiring continuous improvements in cybersecurity methods.

In this regard, as previously noted, an important component of ensuring economic security is the identification and prohibition of malicious AI containing various types of backdoors in the code and training

for committing illegal actions when certain times or conditions occur.

Figure 3 shows the forecasted values of the national cybersecurity market from 2023 to 2028.

The data presented in Figure 3 suggests that the Russian cybersecurity market is expected to grow significantly by 188.3% in 2028 compared to 2023, according to forecasts from the Center for Strategic Research, which predicts annual growth of 22-28%. Therefore, it is of interest to study the results of a survey conducted among representatives of key market players in Russia, including vendors and distributors, to assess the impact of various factors on the growth of the cybersecurity market.

As can be seen from the data presented in Table, the importance of banning foreign software on critical information infrastructure facilities is increasing, followed by a decrease in the importance of financial support measures, tighter information security requirements, and an increase in the number of cyberattacks, according to experts.

3. External threats to economic security associated with AI

One of the key external threats to Russia in the AI sector is technological dependence on foreign suppliers of hardware and software.

Sanction restrictions significantly hinder access to advanced computing power, specialised processors, and software platforms necessary for training and operating neural networks. This hinders the development of domestic AI technologies, reduces the competitiveness of Russian companies in the global market, and increases the risk of technological backwardness [Tulunbasova, 2024]. Under sanctions pressure, Russia is forced to actively develop its own solutions and infrastructure. Creating a fully-fledged, closed AI ecosystem, however, requires time and significant investment. Technological dependence, at the same time, creates vulnerabilities that could be exploited by external actors to restrict access to critical resources and technologies.

External threats to economic security also include cyber espionage, economic espionage and AI-enabled data leaks.

Cyberespionage and economic espionage are interconnected and complementary threats that take on new dimensions and complexity through the use of AI. Attackers use automated AI tools to conduct reconnaissance attacks, significantly lowering the barrier to entry and increasing the speed and effectiveness of cyberespionage [Varavva, 2023].

According to Bi.Zone², the share of intelligence attacks on Russian companies' web resources has increased by 220% in Russia in the second half of 2024

¹ <https://forums.spb.com/programme/business-programme/145548/>.

² <https://bi.zone/news/dolya-razvedyvatelnykh-atak-s-tselyu-poiska-uyazvimostey-saytov-vyroslo-na-220/>.

compared to the first half. AI-enabled cyberattacks aim to obtain strategically valuable information, including trade secrets, technological innovations, and economic data. Attackers can use AI to quickly process large amounts of data and identify vulnerabilities in digital systems. They can also automate unauthorised access and data leaks.

The use of AI in economic espionage is becoming a key threat to national security. Foreign entities are gaining tools to quickly analyse the economic situation in Russia, identify vulnerabilities, and then use the resulting information to strengthen their own market positions. In this context, Russian companies and government organisations must strengthen data protection measures, implement advanced cybersecurity solutions, and refine strategies to counter new types of digital threats.

At the current stage of AI development and implementation, one of the main threats to information security is deepfakes - fake audio and video materials created using AI. Voices and appearances of famous people are imitated to spread false information, claims, and even 'evidence' of non-existent events.

There has been a significant increase in the use of deepfakes in information attacks. From 2023 to 2024, the number of such cases increased by 150%. This figure could triple by 2026. At the 2025 St Petersburg International Economic Forum, it was noted that deepfakes have the potential to manipulate public opinion and undermine trust in government institutions. They could also destabilise the political situation and create fertile ground for the spread of fake news, which could lead to mass protests and social conflicts. This could even lead to interference in the internal affairs of states.

To counter this threat, a comprehensive approach is needed. It includes the development and implementation of advanced methods for automatic detection and verification of digital content. Modern AI-powered algorithms can analyse video and audio recordings with up to 95% accuracy, identifying signs of forgery. However, technological measures alone are not enough. A strengthened legal framework for liability for creation and distribution of deepfakes, as well as international cooperation to share experiences and coordinate efforts, are also needed.

With AI technologies rapidly advancing and cyber threats growing, countering deepfakes has become a priority for ensuring information security and maintaining social stability in Russia and around the world.

4. Internal threats to economic security associated with AI

To ensure the country's economic security, one of the main internal barriers to AI development in Russia is the acute shortage of qualified personnel in this field. This hinders large-scale implementation of technologies and creates dependence on foreign specialists.

By 2030, the shortage of qualified AI specialists in Russia could reach critical proportions. According to estimates from the Digital Economy non-profit, the demand for AI developers will exceed 70,000 people, while the annual university graduation rate is only around 4,500 specialists. In certain industries such as metallurgy and mechanical engineering, there is a shortage of personnel with AI skills reaching 55-65%. This is forcing industrial companies to compete with IT giants such as Sberbank and Yandex, which offer higher salaries, for talent [Akaev et al., 2024].

Due to a shortage of specialists, many IT initiatives at industrial enterprises remain at the pilot stage and are not systematically implemented, hindering digitalisation and optimisation of production processes. In 2023, due to personnel shortages, financial barriers and insufficient digital infrastructure, only 25% of manufacturing companies used AI technologies³.

There is also a severe shortage of information security experts, which complicates the development and implementation of secure AI systems. Without reliable protection, AI technologies remain vulnerable, creating additional risks for businesses and governments.

The talent shortage is exacerbated by the emigration of IT specialists after 2022, while the influx of young talent is slow and fails to compensate for the loss. Furthermore, sanctions and Russia's technological isolation limit access to advanced computing power and modern processors, further hindering AI development. This leads to the country's technological backwardness and dependence on foreign technologies and specialists.

One of the national approaches to ensuring the availability of skilled labor is to increase the number of state-funded places at leading universities in the country, which have undergone a competitive selection process and received government support for implementing top-tier education programmes. Universities are required to admit a sufficiently large number of students each year, which will significantly increase the number of qualified graduates.

Close attention is also paid to the development of cyber schools offering free and accessible courses in programming, AI-powered technology development, and related fields. These initiatives aim to make training in modern technology more accessible to a wider audience. Partnerships with leading IT companies play a key role

³ <https://forumspb.com/programme/business-programme/145548/>.

in creating relevant curricula, providing internships, and grant support, ensuring a high level of training and the competitiveness of graduates.

The shortage of personnel in the fields of AI and information security is a key factor slowing Russia's technological development and large-scale implementation of AI, and requires urgent and systematic measures from government and business.

The implementation of AI in the Russian economy is highly polarised. The uneven adoption of digital technologies and automation across various sectors of the Russian economy creates internal contradictions, reduces overall productivity and competitiveness. While IT, telecommunications and some energy sectors actively embrace digital solutions and implement AI, manufacturing, a key sector of the economy, significantly lags behind. As noted in [Matyushkina, Seregina, 2023], in 2022, the manufacturing industry recorded a low level of AI implementation (approximately 16%). This is explained by high costs, worn-out equipment, personnel shortages, and insufficient government funding for digitalisation. These factors have led to polarisation in efficiency and innovation development between different industries.

The backwardness of traditional sectors, which accounts for a significant share of GDP and employment, negatively impacts overall labour productivity and the economy's innovative potential. This limits Russia's ability to enter new markets and maintain international competitiveness. The technological gap leads to uneven development across regions and industries, which in turn exacerbates socioeconomic inequality. More digitally advanced companies and regions gain competitive advantages, while those lagging behind face the risk of stagnation and job losses [Ibragimov, Dushenin, 2021].

To improve competitiveness and ensure the sustainable development of the Russian economy, it is essential to close the gap in artificial intelligence (AI) adoption across industries. This can be accomplished through annual monitoring of digital maturity and digital literacy in industries, followed by the development and implementation of a series of government measures. The monitoring process will enable us to track trends in specific industries and, in certain cases, take targeted measures to address identified issues. Overall, enhancing competitiveness and ensuring the sustainable development of the national economy require comprehensive measures: modernisation of production, investment in digital infrastructure, training of qualified personnel, and stimulation of innovation in traditional sectors. Together, these measures will create a balanced and efficient economy capable of competing successfully in the global market.

A negative aspect that poses a significant threat to Russia's economic security is the concentration of

resources in large corporations for the development of new technologies. As of 2024, there were approximately 540 companies working on AI in the country, with a significant number located in Moscow. This has led to regions that are not among the leaders suffering from a lack of investment, qualified specialists and necessary infrastructure. This hinders their digital transformation and economic growth.

Small and medium-sized enterprises (SMEs) face significant barriers to using advanced AI technologies. The high development and implementation costs of such solutions prevent them from automating processes, increasing productivity, and expanding their operations [Kondrashov et al., 2025]. This also exacerbates economic inequality and weakens the competitiveness and stability of the economy as a whole.

Of particular importance is the more equitable distribution of limited resources among regions and companies through the use of various support mechanisms, depending on the industry and the role of the company in the market. Large businesses undoubtedly provide significant revenue streams for budgets at various levels, but small and medium-sized businesses face oligopolisation and even monopolisation of certain markets. This leads to restrictions for them, as well as a deterioration in consumers' positions in the market, due to narrowing their choice of goods and services they can purchase.

Another challenge facing AI development in Russia in 2025 is the lack of a clear and comprehensive regulatory framework. This creates multiple risks and slows down digital transformation in key economic sectors.

A major challenge is the absence of a clear definition for artificial intelligence (AI) in Russian legislation at the federal level. Despite the fact that the concept of AI has been enshrined in the decree of the President of the Russian Federation and the national strategy for the development of AI until 2030, there is no legal definition for AI in the Civil Code of Russia, which creates uncertainty and hinders effective regulation.

Experts note that we talk a lot about AI, but there is no legislative regulation, confirming that the legal framework seriously lags behind technological developments in this area. This lack of clarity has led to confusion and uncertainty among stakeholders, including businesses, government agencies, and researchers [Kondrashov et al., 2025].

Currently, gaps in the regulation of personal data protection when using AI exacerbate privacy concerns. Existing personal data legislation does not take into account the specifics of processing by machine learning systems, creating legal uncertainty for companies implementing such solutions. Although work is currently underway to create a standard for personal data for AI

systems, it must be acknowledged that this process is progressing rather slowly.

The lack of effective measures to prevent AI abuse is creating opportunities for cybercriminals. The increasing number of cyberattacks using AI, such as deepfakes and automated fraud, demands urgent legislative action. The Russian Ministry of Digital Development has proposed introducing criminal responsibility for AI-related crimes in 2025. However, experts warn of the risk of unfair prosecution due to a lack of clear criteria for determining malicious AI behaviour.

5. Measures to minimise threats

A priority area for ensuring Russia's economic security is the development of domestic AI solutions.

To stimulate innovation and the development of competitive technologies, the state supports the creation of research centers. Currently, 12 centers are operating, focusing on cutting-edge developments in the field of strong, ethical and industry-specific AI. This facilitates the formation of a sustainable ecosystem of domestic AI solutions, reducing dependence on foreign technologies and mitigating the risk of technological backwardness.

The use of domestic software is aimed not only at ensuring the stability of AI, but also at identifying and prohibiting malicious AI.

State grants and support programs for AI startups help small and medium-sized businesses to implement innovations, facilitating market diversification and the development of regional centers of excellence. The development of domestic AI platforms and solutions becomes a key tool for minimising internal threats and enhancing the country's economic security.

The next area of AI threat mitigation is personnel training. In Russia, personnel training is considered one of the key measures to minimise the risks associated with the development of IT and AI in the country. Thus, the Russian Ministry of Digital Development, Communications and Mass Media has initiated new training programmes (Top-IT and Top-AI), effective September 1st, 2025. These programs are aimed at training developers of IT solutions and specialists in AI.

Another important area of focus in terms of human resources is the return of relocated workers and the provision of comfortable working conditions for IT specialists working in Russia.

To successfully develop and implement modern technologies, it is essential to establish a government oversight system. This system should include regulations for the safe use of AI technologies, ethical standards, and certification procedures for Russian systems. By doing so, we can ensure the reliability and transparency of these technologies, as well as eliminate potential risks and increase trust among economic actors. At SPIEF

2025, a proposal was made to mandate the labeling of AI-generated content. This initiative aims to promote greater transparency and accountability in the digital space. By providing clear information about the origin of content, users can make informed decisions about whether to trust it.

A key component of state policy in this area is the federal project 'Artificial Intelligence', implemented as part of the national project 'Digital Economy'. As of 2024, 839 grants have been awarded for AI technology development under this project and 857 startups have received state support. This demonstrates widespread support for innovative initiatives. Between 2019 and 2023, 19.4 billion rubles have been allocated for the development of artificial intelligence. These funds have created conditions for industry growth and implementation of advanced solutions in various economic sectors [Kondrashov et al., 2025].

It is advisable to conduct annual monitoring of digital maturity and digital literacy in industries. This measure will allow for prompt response to challenges within a particular industry.

As noted previously, there are a number of gaps in the legal framework, further reinforcing the importance of improving the regulatory framework. This includes with regard to AI-enabled technological solutions used to commit illegal acts. Collectively, these gaps exacerbate existing threats to human life, the security of the state and infrastructure, as well as the functioning of various systems, territories and enterprises.

Various mechanisms must be applied to support small and medium-sized businesses in implementing and applying AI technologies in their operations. These mechanisms will vary depending on the industry of the company and its role in the market.

Together, these measures form the foundation for the safe, ethical, and responsible development of artificial intelligence in Russia, ensuring economic stability and sustainable digital growth.

We also emphasise international partnership in the field of AI as a means to ensure Russia's economic security. The free flow of information contributes to economic and social development, education, and democratic governance. Significant progress in information technology and telecommunications development and implementation has also created new opportunities for illegal activities, particularly criminal misuse of information technology [Larionova, 2024]. To mitigate the risks associated with AI development and use, it is essential to support international cooperation in security for new technologies. Despite the sanctions imposed on Russia in 2022, cooperation with friendly countries enables the exchange of advanced knowledge, successful approaches, and new technologies to protect countries.

For example, the Shanghai Cooperation Organisation (SCO) serves as an important platform for coordinating efforts in the field of information security. Its members have signed an agreement on cooperation in international information security, which entered into force in 2011. Russia, China, Kazakhstan, and Tajikistan have ratified this agreement, creating a legal basis for the prompt exchange of information on cyber threats. The SCO plans to sign a roadmap for developing cooperation with the CSTO and the CIS by the end of 2025, which will strengthen regional coordination in combating cybercrime.

In December 2024, Russian President Vladimir Putin announced the creation of the international AI Alliance Network to unite specialists from friendly countries. In January 2025, the president instructed the government to establish closer cooperation with China in the field of artificial intelligence. China is becoming a key partner for Russia in technology exchange, joint development of AI projects, and overcoming technological limitations.

Today, it is essential to align approaches towards ethical norms and standards in the field of AI technology. This will create a stable and secure environment for all economic actors and ensure the global application of these technologies. A global partnership in AI security will not only protect Russian digital systems, but also strengthen trust between states, essential for stable technological development and economic security.

Conclusion

An analysis of the state of artificial intelligence development and its impact on Russia's economic security reveals a complex and multifaceted picture of contemporary challenges and opportunities. The Russian AI market is demonstrating impressive growth dynamics. In 2024, growth was 22.8% compared to 2023, and by 2025 it is projected to reach 22.2%. Subsequent projected annual growth rates range from 22.1% to 27.9%. At the same time, the development of this industry is accompanied by serious internal and external threats to the country's economic security, requiring a comprehensive and systematic approach to mitigate them.

External threats related to technological dependence on foreign suppliers and sanctions pressure remain a key risk factor. Restricted access to advanced computing power and specialized equipment creates long-term obstacles to Russia's integration into global technological chains. Of particular concern are AI-enabled cyberattacks, which reached a record 1.8 billion cases in 2024, and deepfake fraud, which increased 2.3-fold compared to the previous year.

Internal threats are no less critical, and include an acute shortage of skilled labour. This could reach 2-3 million specialists in industry by 2030. The uneven adoption of AI across industries (only 16% of manufacturing companies used AI technologies in 2022, and 25% used them in 2023) creates imbalances in the economy. The concentration of resources in large companies, particularly in the Moscow region, where 68% of Russian AI companies are located, exacerbates regional disparities, and hinders the formation of a coherent innovation ecosystem.

To minimise the identified threats, Russia is implementing a range of measures, including the development of domestic solutions. A priority is training personnel through new 'Top-IT' and 'Top-AI' programs that will launch in 2026 to address the shortage of specialists. Regulations in this area include the development of a first bill on voice privacy and mandatory labeling of AI content to ensure the safe development of these technologies.

Thus, the proposed set of measures aims to address the 'shield' problem. In order to ensure sustainable economic growth for the Russian Federation during the era of digital transformation, it is necessary to wisely use the potential of artificial intelligence, while simultaneously minimising associated risks. Technological independence and economic security in the field of AI can only be achieved through comprehensive development of domestic research, training of qualified specialists, establishment of clear legal regulations and expansion of international cooperation. The ability of Russia to quickly and effectively respond to challenges associated with AI development will determine its competitiveness and long-term economic well-being.

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Typologies of small venture enterprises within the institutional framework: Implications for improving efficiency

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Abstract

The Federal Law of the Russian Federation ‘On the Development of Small and Medium-sized Enterprises in the Russian Federation’ contains a contradiction between the goals of administering the small enterprises. To resolve this contradiction, it is necessary to investigate the core signs in order to institutionally guide small enterprises. The article’s urgency is to find a scientifically sound criterion to classify the diversity of small venture enterprises based on the resource-based approach. Due to the Scopus scientometric analysis, a two-pronged criterion has been determined: the way a small enterprise achieves economic sustainability depends on its degree of resource specialisation; the possibility of external interference affects a small enterprise dramatically. The content analysis of scientific literature reveals that market regulation is insufficient to achieve the goals of small-scale venture enterprises development. The practical conclusion is that enterprises should be distinguished according to the degree of specialisation in their resources, in order to be objects of active state-institutional industrial policy.

Keywords: management, institutional theory, specialised resources

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制度框架内小型企业类型：提高效率影响

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简介

俄罗斯联邦《中小企业发展法》中存在小微企业治理目标矛盾问题。为化解这一矛盾，需深入研究小微企业制度性监管的核心特征。本文的研究意义在于从资源导向视角出发，为小型风险企业多样性分类寻找科学依据标准。根据Scopus文献计量分析结果，确定了一个双重标准：小型企业的经济可持续性取决于其资源专业化程度；而资源专业化水平又显著影响外部制度干预的可能性。内容分析显示，现行市场规制体系尚不足以实现小型风险企业的发展目标。实践结论表明，若要使小型风险企业成为国家-制度性产业政策的重点扶持对象，必须根据其资源专业化程度对其进行分类。

关键词: 制度理论、小型风险企业、专业化资源

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1. Relevance and purpose of the study

The risk of encountering conflicting demands from the institutional environment is particularly high for small venture enterprises (hereinafter referred to as SVEs). In the face of limited resources, meeting some needs inevitably means ignoring others [De Massis et al., 2017]. First and foremost, the Federal Law ‘On the Development of Small and Medium-sized Entrepreneurship in the Russian Federation’ contains fundamental contradictions¹. The main goals of state policy in the area of small business development in the Russian Federation include:

- on the one hand, the social impact is to ensure employment for the population and promote self-employment;
- on the other hand, there is an increase in the share of taxes paid by small and medium-sized businesses in tax revenues from the federal budget, constituent entity budgets of the Russian Federation, and local budgets.

The solution to the first issue requires an increase in the company’s wage budget, which in turn leads to an increase in the overall cost of its products. To solve the second issue, the company needs to increase its profit as a taxable basis, and therefore, reduce its specific costs. Finding a balanced solution to both issues simultaneously is a challenging task that requires institutional and managerial expertise.

Key stakeholders in the institution disagree on whether maximising profits is a legitimate goal for SVEs [De Massis et al., 2017]. Some investors, particularly in the financial markets, view large profits as desirable because they attract more outside investment. Others argue that socially responsible actions must be taken in order to clearly communicate to the small workforce decisions regarding the workload of employees and the provision of a socially acceptable level of wages.

It is highly likely that SVEs do not have their own management resources or competencies to assess risks and independently manage conflicting requirements, which could lead to the paralysis or collapse of the organisation [Snihur, Zott, 2020].

Global management practices have noted that the increasing costs and risks faced by SVEs have led them to return to their conglomerate forms, as exemplified by Alphabet and Alibaba. These companies have acquired the ability to strategically identify, acquire, and integrate startups in order to reduce their risks and increase their chances of success. As the influence of these syndicates increases, it becomes more difficult to implement socially responsible public policies [Loon, Chik, 2019].

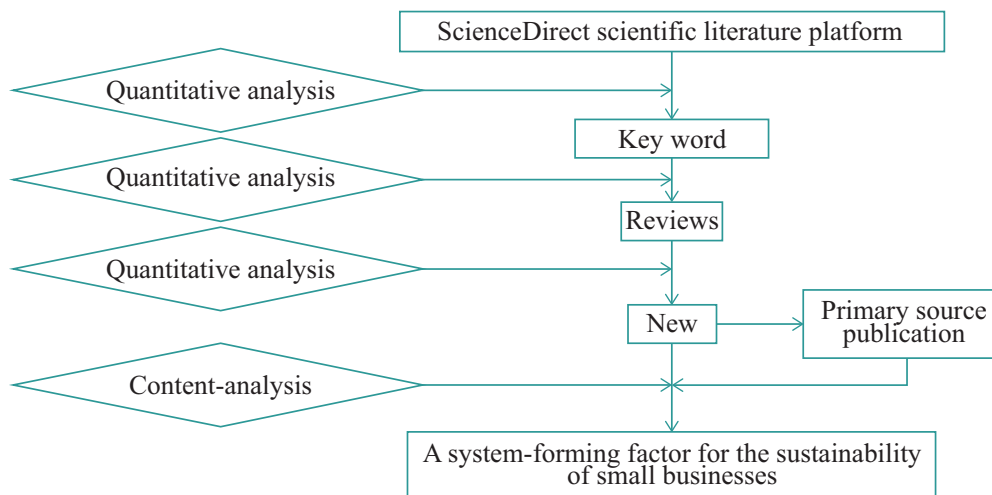
Therefore, a methodology for evaluating the activities of SVEs by regional government agencies is necessary for sustainable development, as a complement to corporate management of mergers and acquisitions.

2. Method

The study provides a comprehensive review of scientifically significant concepts in the field of small business management and the relevant literature on the ScienceDirect platform (Fig.1). The criterion for relevance in this study was the publication date of the review. The author of this article assumes that the new study includes an analysis of a larger body of scientific literature. Thus, a scientifically-based classification of small venture enterprises will be conducted based on the findings of those publications that served as the foundation for the development of significant concepts in the field of institutional management of SVEs. We will then verify the results using these concepts as a basis.

Formulating the search query is a challenging task. A direct translation of the keyword ‘small venture enterprise’

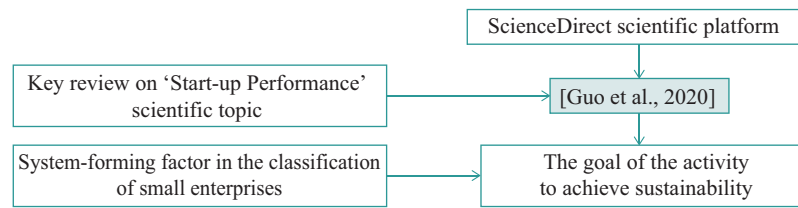
Fig. 1. Scientometric search algorithm



Source: compiled by the author.

¹ The Federal Law of July 24, 2007, No. 209-FZ, ‘On the Development of Small and Medium-sized Entrepreneurship in the Russian Federation’. <http://www.kremlin.ru/acts/bank/25971>.

Fig. 2. A current review summarising primary sources in the scientific field of Start-up Performance according to the criterion of novelty



Source: [Guo et al., 2020].

into English doesn't accurately reflect the meaning of the task at hand. The focus of this study is not the size of the business, but rather the proactive nature of entrepreneurship, which requires targeted investment. Therefore, the key phrase used is 'Start-up Performance'².

3. Results

3.1. The system-forming factor for the stability of SVEs

As a result of our scientometric search, using the algorithm shown in Fig. 1, we identified a review of publications in the field of 'venture enterprise activities' [Guo et al., 2020] (Fig. 2).

The researchers conclude that SVEs, as objects of external investment, should be grouped strictly according to their purpose.

The common goal for all SVEs is to ensure the sustainability of economic growth [Guo et al., 2020: 360]. However, since sustainability can be achieved in various ways, it is essential to establish criteria that help a company identify key factors for achieving a successful economic trajectory. Depending on the importance of achieving the goal, different factors for the sustainability of SVEs may have completely different values.

For example, high-tech companies that focus on consumer demand purposefully strive to maintain their customer base. Radical innovation in new products or services can lead to irreversible losses, so it's important for these companies to

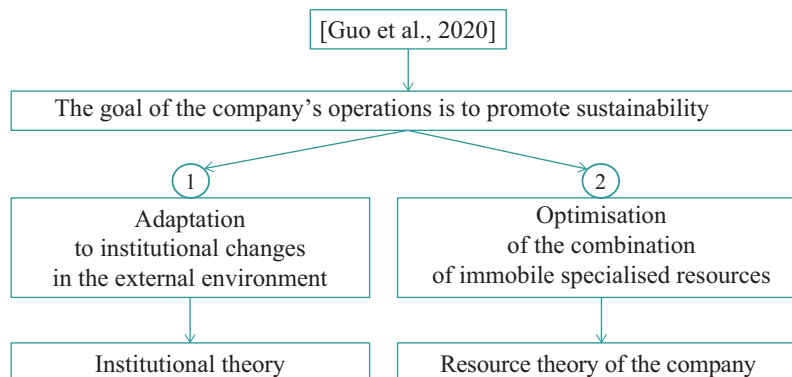
carefully consider the impact of any changes they make. Firstly, there will undoubtedly be losses in the established production logistics [Eckhardt et al., 2018]. Secondly, the consumer, lacking full information about new technological advances, will not be able to assess the capacity of their production facilities or the technical and operational specifications of the new products (services) that are part of the package [Eckhardt et al., 2018].

Therefore, SVEs that are focused on consumers need to strive to standardise their products and manufacturing processes in accordance with internal quality standards, often disregarding indicators of technological innovation and advancement. Conversely, a high-tech company focused on implementing an innovative project needs to be aware of the risk of illiquidity for its internal specialised resources. If the project fails commercially, it will not be possible to recover investment losses by selling fixed assets or work-in-progress inventory [McDonald, Eisenhardt, 2020].

After reviewing the results of 63 studies, a group of scientists have identified a comprehensive set of external risks associated with high-risk medical care:

- institutional uncertainty - assessment of the consistency of the main policy of SVEs and changes in the policies of state institutions in various areas of social and economic interactions;
- technological turbulence - assessment of the level of technological changes in the industry of SVEs activities.

Fig. 3. Classification of target factors affecting the sustainability of small businesses



Source: [Guo et al., 2020].

² The Oxford English dictionary (1991). Vol. XV: Ser - Soosy. Oxford, Clarendon.

Then, based on the proposed classification of factors for the sustainability of SVEs, the researchers integrated various assumptions about the risks and motivations of SVEs in overcoming external constraints into two subsets [Guo et al., 2020] (Fig. 3).

The first subset is a group of consumer-focused SVEs. A key feature of the success of this group is their ability to adapt to changes in the industry. They must undoubtedly structure their activities around sales and financial functions, and their production must depend on the functioning of external, institutionalised structures. Therefore, the arguments for the sustainability of businesses in this group are supported by the institutional theory of the firm.

The second group of companies is made up of SVEs that focus on the implementation of new technologies. These companies have specialised resources, the value of which is determined by their complementarity, or co-specialisation. A key characteristic of the stability of companies in this group is their ability to optimally combine their diverse assets, which are individually illiquid on the open market, into a cohesive whole. Therefore, resource management at these companies is explored within the context of the resource-based theory of the firm.

The principles of self-organisation within SVEs stem from their resistance to external pressures. Both institutional and resource-based theories suggest that organisations seek to achieve stability and legitimacy. However, the formulations and factors of stability in the two theories differ significantly. Differences in the abilities and methods of achieving SVE stability should not only determine the strategies of companies, but also their behavior within the external institutional and economic environment.

In order to achieve a balanced interaction between an organisation as a subject and external agents, the motivational factors will be further explored in the context of institutional theory for the first category of SVEs, and resource theory for the second category.

3.2. Publications - primary sources of stability factors of SVEs

Institutional theory

Institutional theory focuses on the pressures and constraints that agents in the external environment face in relation to the enterprise. These agents can be enterprises, government institutions, investors, or creditors.

In this theory, stability and power are generally attributed to the external institutional environment, rather than to SVEs [Kondra, Hurst, 2009]. The company simply selects a set of responses when faced with conflicting organisational requirements (Fig. 4) [Oliver, 1991].

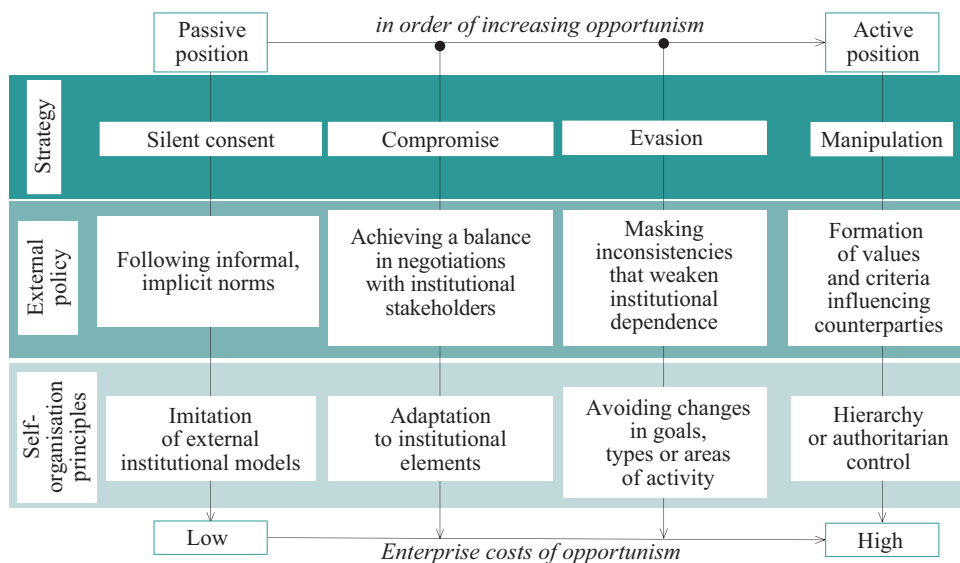
The choice of a SVE's strategy is influenced by two main factors [Kondra, Hurst, 2009]:

- 1) The costs of implementing SVE's opportunism increase disproportionately faster than its self-organisational degree does;
- 2) SVEs are permanently experiencing a shortage of working capital, as they do not have the ability to efficiently manage their resources due to their small size.

Therefore, classical institutional theory, until the 2010s, emphasised the primary importance of an organisation's conformity to external cultural and social norms. The integrating principle in institutional theory for enterprises as objects of management is conformity, and for institutional management as a subject - forced isomorphism [DiMaggio, Powell, 1983]. The authors of this important work on the institutional theory of the firm were the first to study the phenomenon of isomorphism, which is an example of a coercive institutional order. In their framework, the stability of a company is ensured not by competitive advantage or exclusive monopoly control, but by its ability to adapt to its surrounding institutional and business environment [Kondra, Hurst, 2009].

Then, in the late 2010s, a new stage in the development of institutional theory began, with the emergence of a fundamental new idea about the need for external regulation

Fig. 4. Enterprise strategies and tactics, in order of ascending their active organisational resistance



Source: [Oliver, 1991].

in relation to business [Loon and Chik, 2019]. This idea fundamentally contradicted the idea of the open market being the engine of scientific and technological progress, which had been the dominant paradigm until then.

Most obviously, regulatory bodies can create obstacles to entry. Additionally, in many cases, local or regional governments' industrial policies often favour smaller businesses over larger ones, which significantly hinders the development of economies of scale [Bogatyreva et al., 2022]. Indeed, institutions can influence the economy in various ways. For example, they can do so through scale, such as through antitrust laws and local tax laws. They can also influence the economy by promoting product differentiation, such as by protecting trademarks and patents. Additionally, institutions can shape the cost structure of industries through labour laws, and they can even influence the skills of the labour force through political and media incentives [Ahuja et al., 2018].

The article by [Eesley et al., 2018] examines the conflict between formal and informal institutions and its impact on entrepreneurial activity's economic performance. The authors argue that there is a complex or random relationship between formal and informal institutions, and that informal institutions tend to dominate in situations of conflict [Eesley et al., 2018: 403].

Thus, the role of formal institutions is changing significantly. They now need to less dominate enterprises as independent economic entities and more to facilitate and structure their informal institutional environment. Contemporary research today presents institutional subjects not as a random collection, but as an organised 'framework' of the SVE. The institutional framework can be defined as the set of formal and informal organisations that govern, facilitate, and regulate organisational activities and practices. It also includes the norms and regulations that these organisations support in order to achieve their goals [Ahuja et al., 2018].

At least two key theoretical innovations in institutional theory deserve attention. First, the role of external actors has changed significantly. In addition to achieving specific goals for individual institutions, institutions and their activities also serve a broader purpose: to maintain social and economic order [Eesley et al., 2018].

Secondly, today, the institutional meta-order is replacing the market paradigm of industrial regulation. This institutional meta-order reduces uncertainty and transaction costs for businesses, facilitating their ability to achieve their specific goals. Therefore, the effectiveness of the institutional environment is an integral part of the success of SVEs. [Eesley et al., 2018].

The authors of the article, [Oberholzer-Gee, Yao, 2018], also propose a comprehensive strategic approach to the goals of institutional activities. Their conceptual basis is that market imperfections, which can lead to random speculative gains, present a fundamental threat to society and necessitate the intervention of regulatory bodies in the public interest. Therefore, any public policy intended to create social value requires active regulation.

It is essential to support the active formation of trade associations and consortiums of SVEs, which can not only

advocate for public policies, but also create new formal institutions that regulate the industry and foster the development of various informal institutions [Waguespack et al., 2018]. Codes of conduct, industry standards, and trademarks, as well as social and sponsorship programmes, are some of the ways that industry players can shape their environment and foster healthy competition. These dense social networks within an industry provide a platform for rational management of economic transactions among network participants, rather than relying on impersonal and unpredictable market laws. The norms of social behaviour created by economically successful SVEs serve as important control mechanisms that help ensure the success of healthy commercial activity.

Resource-based theory of an enterprise

In 1984, B. Wernerfelt introduced the concept of the imperfect market, which states that the sustainability of a business does not depend fundamentally on external factors. Instead, it has the ability to develop strategies for actively shaping its environmental business environment [Wernerfelt, 1984: 173]. To systematise the second group of SVEs, it is necessary to utilise the findings of the resource-based theory of the firm. Key publications on resource-based theory, such as those by [Wernerfelt, 1984; Barney, 1991] establish that, in order to achieve sustainable development, organisations must exercise active control over their internal resources. The focus of the search for sustainable development of high-tech companies lies in their organisational capabilities to achieve the optimal combination of internal resources. As scientific and technological specialisations continue to deepen, pricing as a means of evaluating a company's products in the external market has ceased to function as an 'automatic mechanism' [Wernerfelt, 1984]. Measuring and analysing the usability of individual resources is unreliable. A key work in the 1990s, by [Prahalad, Hamel, 1994], argued that the value of each resource arises only when they are used together. The value of each individual resource outside the enterprise is insignificant. Therefore, the main focus of resource theory is on resolving the system-forming contradiction between the low liquidity of these resources and the highly dynamic changes in the technological structures of the external environment.

After summarising the results of their scientific and practical work, the scientists have proved that for the creation of radically new products, it is not just measurable material components that are crucial, but rather a unique combination of skills, experience, and knowledge of a team of specialists at a company, through which diverse material components are combined [Kraaijenbrink et al., 2010]. In knowledge-intensive industries, specialists play a significant role in managing material assets proactively. As a result, the concept of an enterprise's proactive role is evolving and becoming more prominent within resource-based theories.

In 2004, scientists at the University of Michigan introduced the concept of collaboration between an organisation and external partners (co-creation view) [Prahalad, Ramaswamy, 2004: 11]. The new perspective on the business, according to researchers, is that 'companies are actively thinking about

how to manage relationships with “the right” customers.’ The company is actively working to engage with its target consumers. As a result, they are becoming more informed and proactive in expressing their own interests as well as socially significant issues. This is more than just a new public relations strategy. The values and philosophy of the SVE organisation are evolving, and managers must invest in building the external information infrastructure to create opportunities. In 2007, [Teece, 2007: 1319] clarified the conditions under which a company not only adapts to a business environment, but also shapes it. According to the author, the importance of a high-tech company’s ability to integrate heterogeneous components into the global economy is growing exponentially. A company’s most valuable asset is its ability to combine not only its existing capabilities, but also its future potential. Since many of the most valuable assets within a high-tech firm are related to knowledge, a well-developed ability to specialise its own resources goes beyond the company’s boundaries and can be used to create intra- and inter-industry information and logistics networks.

In 2013, a survey of the top 1,000 companies in Taiwan was conducted [Lin, Wu, 2014]. Scientists have developed and statistically confirmed the hypothesis that the ability to manage diverse resources increases the efficiency of a business, regardless of its industry. Intra-industry differences

in profits exceed inter-industry differences [Lin, Wu, 2014: 408]. Evidence has also shown that the ability to identify and create new opportunities is sometimes more crucial for the success of SVEs than government support or any other external assistance.

3.3. Factors of sustainable interaction between institutional actors and SVEs within the framework of the resource-based approach

Traditionally, institutional theory has developed the concept of a contradiction between the institutions of the external environment and industrial enterprises. Accordingly, enterprise economic strategies were based on balancing the costs of opportunism with external pressures. In contrast to the institutional theory, the resource-based theory of SVEs emphasises the importance of managing internal resources within an organisation (Table).

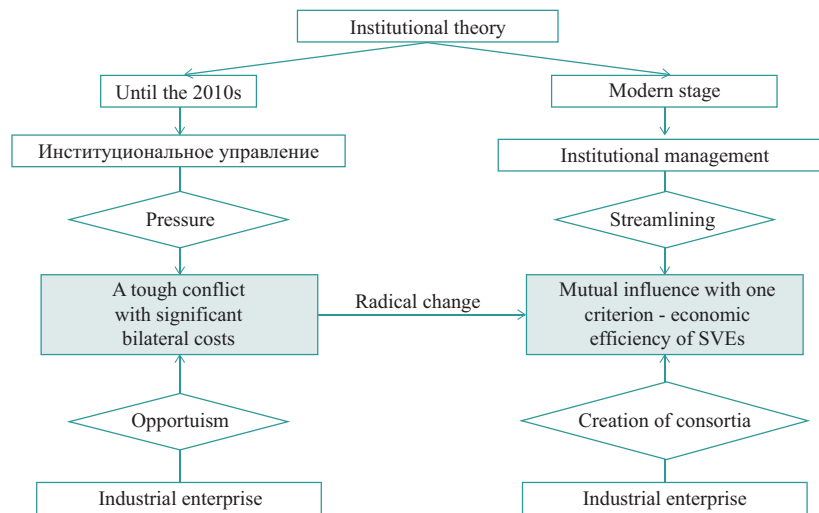
Currently, institutional theory emphasises the multi-directionality of vectors and the diverse forces of influence from external agents on an enterprise. This influence often lacks a clear structure and therefore cannot be easily changed through administrative measures. To strengthen this influence, formal institutions should be involved that can utilise the power of cloud-based services. The effectiveness of these various external factors is determined by their

Table
Classification and scientific-based factors of external institutions vs. effective interaction small venture enterprises

The main feature of SVE classification	The nature of the internal resources within the enterprise		
SVE grouping	Predominantly universal and homogeneous internal resources		Predominantly specialised and heterogeneous internal resources
Factor	Institutional		Resource
	Classical stage	Modern stage	
	General		
SVE goals	Sustainability and legitimacy		
	Differences		
SVE strategy	Passive	Active	Active
Power is generally attributed to:	institutional external environment, not the enterprise	unions and consortia	an enterprise with valuable and specialised capacities
The development of the enterprise is determined by:	state or social regulation	balance of external institutions and economic goals of SVEs	integration of internal heterogeneous capacities into a single complex
The main limitation	Forced isomorphism of external influence on SVEs	Disorder of the vectors of influence from external institutions	Limited and illiquid resources
Organisational structure of the enterprise	Imitates institutions in the external environment	Unique, subject to internal factors of economic sustainability	Heterogeneous in accordance with the internal structure of heterogeneous powers

Source: developed by the author.

Fig 5. Revolutionary change in the subject of study in institutional theory



Source: developed by the author.

consistency with the company’s active self-organising strategy.

In this concept, the unresolvable contradiction between external institutional pressure and the opportunistic behaviour of SVEs is transformed into a space of bilateral counter-influence (Fig. 5). Because the SVE, by avoiding the strategy of opportunism and its associated significant costs, can not only attempt to influence fragments of the external environment within the institutional framework, but also actively create new institutions of its own.

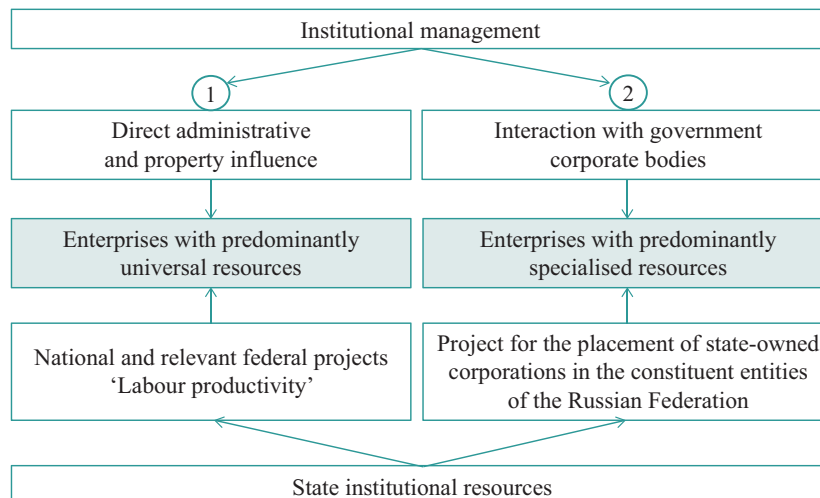
For SVEs with predominantly universal resources (the first group in our classification), changes in institutional theory are organic and undoubtedly positive. However, for SVEs in the second group, although the achievements of institutional theory (Fig. 5) are necessary, they are not sufficient. SVEs in this group can only thrive within a specific industry environment to maintain their innovative activity for the following reasons:

- specialised resources are key for them;
- specialised resources are not traded on the open market, as they have value only when they are combined in a specific way and complement each other within the SVE;
- individual technologies are developed within a specific technological paradigm. The life cycle of this paradigm extends far beyond that of the SVE [Teece, 2018].

4. Conclusions for the practical application of the research findings

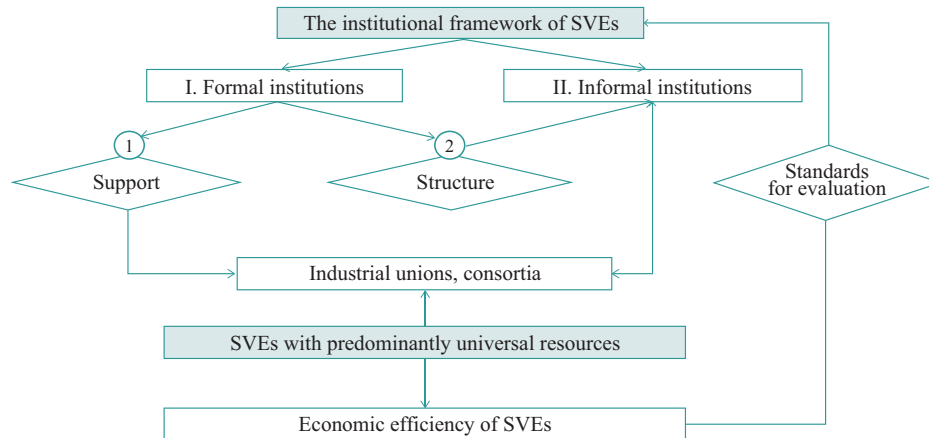
For external institutions, one indicator of the SVE practical differentiation could reasonably be considered to be the degree of specialisation and uniqueness of an enterprise’s internal resources. An example of a system of state support for a full diversity of SVEs by external institutions is shown in Fig. 6.

Fig. 6. An example of targeted allocation of government institutional resources



Source: developed by the author.

Fig. 7. Modern concept of institutional theory



Source: developed by the author.

The distribution scheme for institutional investment resources in Fig. 6 is based on the target affiliation of SVEs. In the proposed scheme, the classification criterion for SVEs is the nature of their internal resources. The universal resources of SVEs enable greater unification of governance by government institutions. It is suggested that SVEs with specialised resources be grouped separately and mechanisms for interaction between government and corporate governance bodies be explored.

The fundamental requirements for sustainable conditions for SVEs are also changing. These businesses must create and maintain channels for dialogue with external stakeholders. External customers need access to information in order to evaluate the prospects for collaboration.

The second group of SVEs, which are part of industrial corporate structures, can actively participate in the creation and operation of formal and informal institutions, such as consortiums and industry associations in local government areas. In this case, they receive additional government funding for their development programs (see Fig. 6 and 7) and institutional media support. In turn, the institutional environment receives clear and significant guidance for enhancing the cultural and professional growth of society.

The SVEs of both groups can thus actively contribute to the establishment of external order, working together with formal institutions to fill the gaps in the informal institutional framework.

The main conclusion of this study is that, as early as 1983, the fundamental work on institutional theory established that the management of SVEs does not rely on the principles of competition or the market paradigm [DiMaggio, Powell, 1983]. Regardless of the classification of high-tech medical care, active and systematic intervention by government institutions is essential. The effectiveness of these institutions

can be assessed quantitatively using the high-tech medical care economic efficiency indicator (Fig. 7).

5. Future research directions

The author has identified the possibility of evaluating state-institutional management based on the economic efficiency of SVEs operating within the relevant institutional framework.

The challenge lies in the fact that the indicator of economic efficiency for SVEs with specialised resources (second group in the classification) reflects not only the effectiveness of institutional support, but also the level of highly specialised technological expertise. Therefore, it is essential to identify and scientifically justify the criteria for the optimal ‘density’ of the institutional framework, depending on the level of industry specialisation in SVEs. The more specialised the industry, the less flexibility SVEs have to adapt their resource mix. Additionally, strong institutional pressures clearly inhibit innovative activity. The negative consequences of insufficient institutional pressure, or the low ‘density’ of the institutional framework, may not be immediately apparent, but they can be more dangerous in the long run. In an environment that lacks formalisation but is saturated with informal norms and rules, which can lead to disorder, conflicts of interest and violations of social justice become inevitable. If this institutional uncertainty is superimposed on the uncertainty of changing industry technological paradigms [Teece, 2018], then it is fundamentally impossible to create a rational economic strategy for SVEs.

The nature of the criteria for the need and sufficiency of formal and informal institutions for the innovation activity of SVEs should be explored at the intersection of institutional and resource theories.

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Organisational capabilities and the effectiveness of digital product innovations

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Abstract

This paper aims to analyse what specific high-level capabilities are considered by scholars to be the most important for the organisation to develop in order to facilitate innovation. Precisely, the paper explores what is the perceived effect of these capabilities on digital product innovation metrics 'time-to-market' and return on invested capital. The statistical method used in the research is PLS-SEM, with data gathered from middle and top management of Russian companies in different industries using a 5-point Likert-type questionnaire. The results showed a significant and relatively large effect of seizing and transformation capabilities on such metrics as time-to-market and return on investment, whereas the sensing capability only showed a considerable effect on the time-to-market metrics and a moderately small effect on the second metric.

Keywords: firm resources and capabilities, dynamic capabilities, product innovations, digital transformation, strategic analysis, PLS-SEM

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组织能力与数字产品创新的效率

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简介

本文旨在分析在组织中推动创新实施所需的高水平能力中哪些具体能力最为关键。文章探讨高阶组织能力对数字产品创新绩效的影响, 聚焦以下两项核心指标: 市场推出时间和投资资本回报率。该研究采用偏最小二乘结构方程模型 (PLS-SEM), 基于对俄罗斯多行业企业中高层管理者的问卷调查数据进行分析。数据采集工具为5点李克特量表 (Likert Scale), 覆盖企业数字化转型、组织能力等核心变量。研究结果表明, "机会捕捉能力" (seizing capability) 和转型能力 (transformation capability) 对产品上市时间和投资资本回报率这两个指标均产生了显著且相对较大的影响。相比之下, "感知能力" (sensing capability) 仅对产品上市时间这一指标表现出明显影响, 而对第二个指标 (投资资本回报率) 的影响则相对较弱。

关键词: 资源与组织能力、动态能力、数字化转型、战略分析、PLS-SEM

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Introduction

The study of issues related to building capabilities and implementing digital product innovations is highly relevant for both business and society as a whole.

It opens up opportunities for sustainable growth, strengthens market positions, and meets current consumer needs. The ability to create and successfully launch innovative products has become a crucial factor for success in today's market. Those companies that are the first to come up with unique solutions gain a significant advantage over their competitors. They capture market share, build a loyal customer base, and set high quality standards. Certain capabilities help companies organise their innovation processes in a way that makes them as efficient and sustainable as possible.

Today, research into organisational capabilities is quite extensive. Thus, the most modern discourse is the concept of dynamic capabilities. The dynamic capabilities concept is very suitable for the context of product innovation, since the process of creating new products and services is driven by changes in the environment and market. Therefore, it is crucial to identify specific capabilities that can help to increase the effectiveness of digital product innovations.

Originally, the capabilities theory originated from the 'Resource-based view (RBV)' and the 'core competences' theory [Hamel, Prahalad, 1989; Barney, 1991]. The theory of dynamic abilities does not contradict the classical theories, but rather builds upon them. Identifying the company's ability to adapt its 'core competencies' to the current business environment and economic conditions is the next step the dynamic capabilities theory aims to achieve. In 1997, D. Teece defined dynamic capabilities as a company's ability to adapt, integrate, and reconfigure its internal and external organisational skills, resources and functional competencies according to changes in the business environment and economic conditions [Teece et al., 1997]. However, there are certain limitations to the original concept of Teece. One of the main drawbacks is that it was not practical from the beginning and it did not provide a clear path for how to implement it.

Responding to critics of the original concept of dynamic capabilities, Teece clarifies his theory for practical purposes. At this stage of the development of the concept of dynamic capabilities, three main categories of organisational abilities are identified: 'sensing', 'seizing' and 'transforming' [Teece, 2007]. These are essential activities for organisations and management if they want to understand where markets and technologies are going, develop strategies to take advantage of this, and transform the organisation to achieve their goals. Additional clarifications that have taken place regarding the concept of dynamic capabilities include clarifications about the role of managers in companies and their 'entrepreneurial' actions and qualities. To have strong dynamic capabilities, leadership must be entrepreneurial. This means that managers need to be involved in the process of developing and verifying assumptions about new technological and market trends, creating and improving new business models, and

managing the necessary resources within the organisation [Teece, 2007].

We highlight the introduction of these high-level organisational capabilities in the context of digital transformation as the most advanced stage in the development of dynamic capabilities. According to one definition, digital transformation is the process of creating digital products that provide a platform for seller and buyer to interact. Regardless of whether the transformation is based on a platform, one of the main goals is to develop and implement a new business model. A business model, according to D. Teece's definition, should include a comprehensive process of creating value, delivering it to consumers, and generating revenue from this model.

The process of creating a new business model starts with 'sensing' and identifying opportunities related to new or emerging technologies and how they can meet customer needs. Digital technologies allow for quick and inexpensive testing and adjustment of hypotheses about customers and technologies, which is essential for the process of product innovation.

The ability of a company to 'seize an opportunity' is crucial for the creation of a profitable business model. A sustainable business model should have a digital solution that meets customer needs, while maintaining a price that covers costs and generates profits that will allow the company to grow. This 'seizing' capability also involves sharing and communicating knowledge within the organisation, as well as implementing digital transformation.

Eventually, the 'transformation' capability is activated, which is essential for the implementation of digital product solutions and innovations, as well as for making key strategic decisions. This ability to transform allows us to identify gaps in other company's abilities that can be filled through internal development, acquisition of other companies, or creation of partnerships.

In today's digital transformation context, we see capabilities not as processes, operations or routines within an organisation. Instead, we view them as higher-level abilities that are defined by management and permeate throughout the organisation's human resources. These abilities enable rapid and effective innovation in the company's digital products.

To improve the practicality of these top-level capabilities, we need to take a closer look at their impact on innovation effectiveness, particularly product innovation. As previously defined, innovation is the application of knowledge to create new knowledge [Drucker, 1993]. Furthermore, since this paper discusses digital transformation, a category of technological innovations has been identified. Therefore, the definition of a digital product innovation involves the creation or development of technological products and/or platforms.

However, there is a lack of empirical research on the mechanisms used to implement the necessary capabilities and increase the effectiveness of product innovation. Furthermore, various hypotheses have been proposed and tested in an effort to fill this gap.

1. Hypothesis development

To establish the hypothesis regarding the impact of high-level organisational skills on the success of product innovation, let's discuss these skills in more detail to gain a better understanding of their significance.

1.1. Sensing capability

The activities defined by Teece as a sensing capability are scanning, searching, and exploring opportunities for innovation [Teece, 2007]. It involves investment in research and exploration of technological possibilities. Previous studies have identified that information and resources available externally influence innovation activities and the development of a company [Yam et al., 2011]. Additionally, studies have shown that experienced organisations are likely to have search tactics to improve organisational innovation [Nelson, Winter, 1982]. Sensing also involves understanding demand, the evolution of markets, and the responses of competitors. Therefore, when opportunities arise, companies with sensing capabilities can understand which technologies to explore and which market segments to target [Teece et al., 1997]. Therefore, based on this reasoning, it is possible that a stronger sensing capability possibly could lead to more effective product innovations. This is the hypothesis that needs to be tested.

1.2. Seizing capability

This capability focuses on the efficient and effective transfer of knowledge among employees within an organisation engaged in technological innovation. It provides opportunities for learning and sharing best practices and expertise [Teece, 2014]. The seizing capability involves not only internal communication, but also the ability to integrate external resources. For example, external seizing activities involve integrating customer and/or market knowledge, as well as knowledge of emerging technologies, etc. [Iansiti, Clark, 1994]. In a way, seizing allows for the conversion of resources and knowledge into innovation [Dutta et al., 2005]. Research has found that the effective integration of internal and external knowledge about technology and the market increases a company's chances of incorporating successful features into new products [Marsh, Stock, 2006]. Based on this, good seizing capabilities allow for effective product innovation – the second hypothesis to be tested.

1.3. Transformation capability

The transformation capability helps an organisation maintain its fitness over time and provides the opportunity to avoid unfavorable path dependencies, if necessary [Teece, 2007]. It includes activities through which companies acquire, merge or sell resources or business units [Karim, Capron, 2016]. Considering technological innovation, internal organisational knowledge exchange could be stimulated and distributed in the firm if human resources were properly redeployed and business units were restructured [Nonaka, 1994]. Those employees who hold key knowledge but are not appropriately deployed may be hesitant to make

necessary decisions and contribute to the company's progress [Wang et al., 2007]. Therefore, the resource of loyal and engaged personnel is crucial, as well as the ability to grant some level of autonomy to business units in their decision-making process during innovation. The third hypothesis to be tested is that transformation capability also enhances the effectiveness of digital product innovation.

2. Methodology

2.1. Measurement

For this study, all of the variables were measured using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). As [Daneels, 2016] pointed out, 'as a relatively new area of strategic management research, there are currently no generally accepted approaches for measuring in the field of dynamic capabilities.' To identify relevant items, an extensive search of the literature was conducted. Therefore, Teece's and other researchers' microfoundations of the described capabilities were used as items to ensure content validity.

To measure the sensing capability the items chosen were adopted from [Teece, 2007; O'Reilly, Tushman, 2008]. The items are: research on technological solutions (sen_1), research on customer needs and demands (sen_2), and investigation of customer segments (sen_3). The measurement of the seizing capability consisted of several factors, including: processes for sharing and communicating knowledge within the organisation (seize_1), efforts to implement new technological solutions for product innovation (seize_2), and the selection of target market segments that the company can or cannot reach with the product (seize_3). These items were adopted from previous research of [Zollo, Winter, 2002; Teece, 2007]. Finally, the transformation capability measurement items were also adopted from [Teece, 2007] and include: autonomy and decentralisation of product innovation teams (tr_1), involvement and loyalty of key employees (tr_2), and building innovation partnerships (tr_3).

To measure the effectiveness of product management, two dependent variables were used: time-to-market and Return on Invested Capital (ROIC). Time-to-market is the speed at which an innovation moves from the idea stage to becoming available to real clients. ROIC represents the ratio of returns gained from the commercialisation of a product compared to the costs spent on its discovery, development, and deployment.

Following the research practice, an analysis was conducted controlling for firm size. According to [Schumpeter, 1942], firm size can influence innovation activities. Therefore, data were collected from companies with similar sizes, measured by the number of employees.

2.2. Data collection

Standard questionnaires were used to collect data for the research. Data was collected from various companies in Russia, mainly located in Moscow and Tyumen. The business sectors in which these companies operate

were chosen based on the the industry's susceptibility to rapidly changing business conditions. Thus, the industries covered in the data include commercial civil aviation, telecommunications, software development, and daily banking and brokerage (investments). In each company, questionnaires were distributed to middle and top management who are directly or indirectly involved in product innovation activities. The most common roles represented were product and project managers, financial planners, marketing managers, market and customer researchers, and vice-presidents of commerce and product development. In some companies, data was gathered from CEOs. A total of 197 completed questionnaires were collected, excluding those with incomplete data.

To avoid common method bias, we used an approach of reversing some questions to reduce the possibility of respondents anticipating the connection between them. Additionally, since using a single respondent as the source of data for both independent and dependent variables can lead to common method bias [Podsakoff et al., 2003], we obtained data for the variables from different sources to prevent self-report bias, consistency effects, and illusory correlation problems. This means that two or more respondents from each company answered only questions related to the dependent variables or only questions about the independent variable. Additionally, all respondents were reassured that the purpose of the study was purely academic and that there were no 'right' or 'wrong' answers. The intention was for respondents to give honest answers without worrying about what they perceived as the best answer.

2.3. Data analysis

For the analysis the method of Possible Least Squares Structural Equation Modeling (PLS-SEM) was used. It allows for the analysis of multiple variables and equations simultaneously. PLS estimation process is an ordinary least squares regression-based method that works well with small

sample sizes (up to 200). It does not make any assumptions about the underlying data [Hair et al., 2011]. All of the variables in the dataset had multiple items, as described in part 2.1. PLS can weight the item loadings for a variable within the context of a theoretical model.

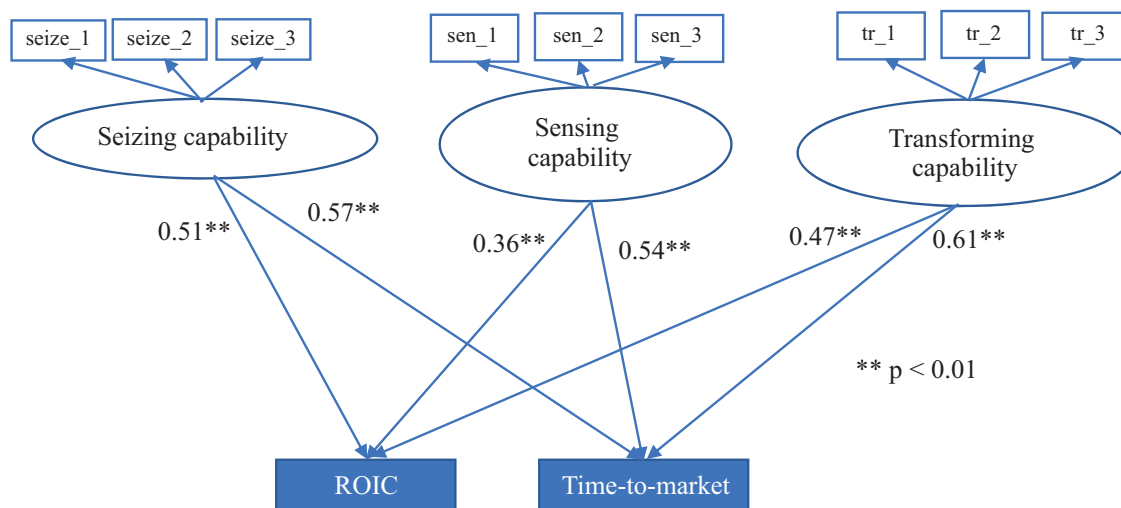
To ensure the validity and reliability of our theoretical framework, we evaluated the criteria for internal consistency, indicator reliability, convergent validity, and discriminant validity for the variables. All of the Cronbach's α values for internal consistency were greater than 0.8 for all the variables ('sensing', 'seizing', and 'transformation'). Good indicator reliability was also achieved, as all indicator loadings were greater than 0.7. All AVE (average variance extracted) scores were > 0.6 , so the convergent validity was achieved. All variables showed good discriminant validity, as the outer loadings of the indicators on their own items were higher than the cross loadings with other items. The square root of the AVE for each construct was higher than its highest correlation with any other construct in the model, indicating good discriminant validity [Fornell, Larcker, 1981].

To evaluate the structural model of the theoretical framework, we conducted an examination of collinearity and calculated the determination coefficient (R^2). We also determined the significance of path coefficients and direct effects. All of the R^2 scores were above the required 0.1 threshold. For variable collinearity, all of the variance inflation factors (VIF) were below 5, as expected. This indicates that multicollinearity is not an issue in the data set. A bootstrapping method was used to calculate the significance of the path coefficients in a two-tailed test. Finally, the results and significance values can be seen in Figure.

3. Results and discussion

In total, six flow paths were analysed: (1) from seizing capability to time-to-market, (2) from seizing capability to

Fig. Theoretical framework and analysis results



Source: author analysis results.

return on invested capital, (3) from sensing capability to time-to-market, (4) from sensing capability to return on invested capital, (5) from transforming capability to time-to-market, (6) from transforming capability to return on invested capital. The direct relationships between all the independent variables and the metrics of product innovation efficiency were significant. The standardised regression weights for the flow paths can be seen in Figure 1 again.

It is interesting to note that the theory was strongly supported by the analysis. The seizing capability had a significant impact on both tested metrics, which makes sense considering the nature of the construct. As we discussed previously, activities such as knowledge sharing within an organisation and finding ways to implement modern technological solutions in product innovations have an effect on a logical level on the speed at which a product reaches the commercialisation phase and the return on investment. Additionally, it should be noted that the transformation capability has a significant impact on time-to-market. Innovation partnerships, the autonomy of product teams, and the loyalty of key employees all contribute to the effectiveness of product innovation as part of the transformation capability.

In summary, this study contributes to literature on capabilities and innovation. This paper provides a more nuanced understanding of how certain capabilities, specifically dynamic capabilities, influence corporate innovation, and specifically, digital product innovation.

Although, this piece does not cover dynamic capabilities as a whole, it rather breaks them down into more specific capabilities in order to help practitioners better understand them. Having discussed the components, activities, and resources that make up the capabilities of sensing, seizing, and transforming, managers involved in product innovation within their companies can gain an insight into what to focus on.

The issue of whether dynamic capabilities influence company performance in innovation as a whole is still a subject of debate and research. This article proposes an approach to measuring certain impacts empirically, drawing on insights from marketing research. The most obvious next step in the presented research would be to add more testable metrics to the study, in addition to those already included. For example, the author could measure customer base growth and market share changes. He hopes that this paper will inspire further empirical studies on dynamic capabilities and their impact on organisational innovation.

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