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CONTENT

Maria Gheorghița, Ina Gumeniuc, Alina Stratila, Rina Turcan	*The influence of foreign direct investment on economic development: the case of the Republic of Moldova*	*6*
Federico Verri	*Digital governance and trust in Moldova's eu accession process*	*23*
Igor Rotaru, Aliona Dodu	*Strategic directions for the development of Chisinau municipality public transport system*	*36*
Nina Garștea	*Harmonisation of road freight transport entrepreneurship regulation through the EU-Moldova agreement*	*46*
Beauty Zindi	*Digital transformation in public procurement: opportunities and challenges in South African municipalities*	*62*
Afeez Babatunde Siyanbola, Nathaniel Oluwaseun Ogunseye, Chikodi Daberechi Alaka	*Investigating experiential graphic user interface of smart city-enabled transportation system in Lagos, Nigeria*	*77*
John Mbambu Pasiyikala	*Home-based preparation as a mediating mechanism between confidence in autonomy and engagement in the flipped classroom*	*89*
Sabiu Lawali Tsafe, Abdulhakeem Ibrahim, Armayau Saadu	*Comparative assessment of alphanumeric and graphical password authentication methods*	*100*
Corina Caușan, Ghenadie Radu	*The role of family medicine in strengthening public health and sustainable development*	*108*
Vitalie Jitariuc	*Conceptual foundations, general characterization and psychological particularities of examination as a criminal investigative procedural act*	*120*
Angela Munteanu, Tatiana Filipski	*The department of Architecture on the 60th anniversary of its activity within the Technical University of Moldova*	*130*

CONTENT

Maria Gheorghița, Ina Gumeniuc, Alina Stratila, Rina Turcan	*Influența investițiilor străine directe asupra dezvoltării economice: cazul Republicii Moldova*	*6*
Federico Verri	*Guvernanță digitală și încrederea în procesul de aderare la UE în Republica Moldova*	*23*
Igor Rotaru, Aliona Dodu	*Direcții strategice pentru dezvoltarea sistemului de transport public al municipalității Chișinău*	*36*
Nina Garștea	*Armonizarea reglementării privind antreprenoriatul în transportul rutier de mărfuri prin acordul UE-Moldova*	*46*
Beauty Zindi	*Transformarea digitală în achizițiile publice: oportunități și provocări în municipalitățile din Africa de Sud*	*62*
Afeez Babatunde Siyanbola, Nathaniel Oluwaseun Ogunseye, Chikodi Daberechi Alaka	*Investigarea interfeței grafice experiențiale de utilizator a sistemului de transport activat de orașe inteligente din Lagos, Nigeria*	*77*
John Mbambu Pasiyikala	*Pregătirea la domiciliu ca mecanism de mediere între încrederea în autonomie și implicarea în clasa inversată*	*89*
Sabiu Lawali Tsafe, Abdulhakeem Ibrahim, Armayau Saadu	*Evaluarea comparată a metodelor de autenticare a parolei alfanumerice și grafice*	*100*
Corina Caușan, Ghenadie Radu	*Rolul medicinei de familie în consolidarea sănătății publice și a dezvoltării durabile*	*108*
Vitalie Jitariuc	*Fundamente conceptuale, caracterizare generală și particularități psihologice ale examinării ca act procesual de investigație penală*	*120*
Angela Munteanu, Tatiana Filipski	*Departamentul de Arhitectură la a 60 a aniversare a activității în cadrul Universității Tehnice a Moldovei*	*130*

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THE INFLUENCE OF FOREIGN DIRECT INVESTMENT ON ECONOMIC DEVELOPMENT: THE CASE OF THE REPUBLIC OF MOLDOVA

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Abstract. This study examines the relationship between foreign direct investment and the economic development of the Republic of Moldova by integrating a theoretical perspective with empirical analysis. Based on official statistical data and public institutional sources, it evaluates the dynamics of the main macroeconomic and investment indicators, the economic performance of enterprises with foreign participation, and their association with the evolution of GDP per capita. For the period 2015–2024, a multifactor econometric model is estimated in which the growth rate of GDP per capita is analysed in relation to a set of indicators reflecting the dynamics of foreign direct investment and several related economic variables relevant to assessing the relationship between foreign capital and economic growth. The results highlight the existence of positive relationships among the variables examined. Overall, the study suggests that foreign direct investment may constitute a relevant factor in supporting economic growth, provided that its effects are leveraged within a favourable investment and institutional environment.

Keywords: *foreign direct investment; economic growth; GDP per capita; labour productivity; foreign capital; investment in fixed assets; Republic of Moldova.*

Rezumat. Acest studiu examinează relația dintre investițiile străine directe și dezvoltarea economică a Republicii Moldova prin integrarea unei perspective teoretice cu analiza empirică. Pe baza datelor statistice oficiale și a surselor instituționale publice sunt evaluate dinamica principalilor indicatori macroeconomici și investiționali, performanța economică a întreprinderilor cu participare străină și asocierea acestora cu evoluția PIB-ului pe cap de locuitor. Pentru perioada 2015–2024, este estimat un model econometric multifactorial. Rata de creștere a PIB-ului pe cap de locuitor este analizată în raport cu un set de indicatori, care reflectă dinamica investițiilor străine directe și variabilele economice conexe, relevante pentru evaluarea relației dintre capitalul străin și creșterea economică. Rezultatele evidențiază existența unor relații pozitive între variabilele examinate. Per total, studiul sugerează că investițiile străine directe pot constitui un factor relevant în susținerea creșterii

economice. Condiția principală este ca efectele acestora să fie valorificate într-un mediu investițional și instituțional favorabil.

Cuvinte cheie: *investiții străine directe; creștere economică; PIB pe cap de locuitor; productivitatea muncii; capital străin; investiții în active fixe; Republica Moldova.*

1. Introduction

Foreign direct investment (FDI) represents one of the most important and complex forms of international economic interconnection and today constitutes far more than mere capital flows crossing national borders. It is a fundamental mechanism through which capital, technology, innovation, managerial know-how, and modern organisational practices are transferred from one economy to another, directly influencing the structure and performance of both productive and service sectors and thereby contributing to the development of the national economy as a whole. As globalisation has intensified, FDI has become not only an instrument used by multinational firms to expand their operations, but also a driver of economic transformation, capable of stimulating industrial modernisation, structural diversification, and countries' integration into global value chains.

In the last three decades, FDI has acquired strategic importance in both developed and emerging economies, albeit for different reasons. In advanced economies, FDI is used to strengthen technological advantages, optimise costs, and maintain global competitiveness in a context marked by intense competition. It helps preserve dominant positions in key technological and industrial sectors through international acquisitions, partnerships, and the expansion of value chains. It also compensates for demographic stagnation and population ageing, which constrain the potential for domestic economic growth. Thus, the expansion of capital abroad remains a means of sustaining profitability. At the same time, in emerging or transition economies, such as the Republic of Moldova, its role is essential: it compensates for the insufficiency of domestic capital, facilitates technological modernisation, stimulates job creation, contributes to professional training and productivity growth, and thereby generates long-term structural transformations. FDI supports the integration of emerging economies into global value chains, enabling them to become active participants in international trade and to attract additional investment. It also enhances international credibility, as the presence of major investors signals stability and reduces risk perception. FDI constitutes a bridge between advanced and developing economies, fostering economic convergence and accelerating reform processes, while also serving as an indispensable pillar of economic growth and sustainable development.

At the same time, the strategic role of FDI is explained by the fact that it no longer consists solely of financial flows, but rather of complex vehicles of technological transfer, economic integration, geopolitical repositioning, and structural modernisation, directly influencing the long-term performance of both developed and emerging economies [1]. Thus, at present, the attraction and effective management of FDI has become a central objective of the economic policies of most states, being perceived as an essential lever for strengthening economic resilience and adapting to the rapid transformations of the global economy.

2. Materials and Methods

This research is based on a quantitative approach, supported by a synthesis of the relevant literature and by the use of official statistical data and public institutional sources, with a view to examining the relationship between foreign direct investment and the

economic development of the Republic of Moldova. The descriptive component relies primarily on data for the period 2019–2024, which are relevant for capturing the recent dynamics of the main macroeconomic and investment indicators, whereas the econometric component extends the period of analysis to 2015–2024 in order to enable the assessment of statistical relationships within a broader temporal framework.

From a methodological perspective, the study combines dynamic and structural analysis, statistical comparison, and the generalisation of indicators with the estimation of a multifactor linear regression model. The dependent variable is the growth rate of GDP per capita, while the explanatory variables refer to the dynamics of net direct investment, investment in fixed assets under foreign ownership, foreign funds, labour productivity in FDI enterprises, and the time trend; data processing was carried out using QM for Windows and RStudio.

3. Results and Discussion

3.1 Literature review on foreign direct investment flows and their role in economic development

Academic interest in foreign direct investment is not a recent phenomenon. As early as the 1950s and 1960s, economists sought to explain the nature, logic, and implications of these flows for economic development. The first major contributions, such as the works of John H. Dunning, paved the way for robust theories regarding the formation, location, and internalisation of firms' international activities (the OLI Paradigm). According to this theory, foreign investment arises when three conditions are met:

- Ownership advantages – technology, know-how, capital;
- Location advantages – lower costs, natural resources, market opportunities;
- Internalization advantages – the efficiency of organising activities within the firm.

The OLI Paradigm is now regarded as one of the most influential theories of foreign direct investment [2, 3].

Over the following decades, alongside the surge in cross-border investment during the 1980s and 1990s, the literature became more diversified and refined, incorporating perspectives from international trade theory, the theory of the firm, institutional economics, and studies on globalisation and development. Today, FDI is analysed through a multidimensional lens encompassing economic, political, technological, and even geopolitical factors.

The historical transformations of FDI, evident in the shift from investments primarily oriented towards natural resources or local markets to investments integrated into global production chains, provide a solid basis for a comprehensive analysis of their evolution and of the ways in which they influence national economies. These dynamics become all the more relevant in the case of states that have undergone the transition from a centrally planned economy to a market economy. Countries such as the Republic of Moldova, which after 1990 faced major challenges related to privatisation, restructuring, technological modernisation, institution-building, and European integration, provide compelling examples of how FDI can contribute to the profound transformation of an economy.

In this context, the study of FDI can no longer be reduced to a simple assessment of capital flows or to the analysis of statistical indicators alone. It requires a theoretical and historical approach based on an understanding of the evolutionary stages of FDI, the theories that explain them, and the way in which they have influenced the economic trajectories of

different states. Such an analysis makes it possible to understand not only the role of FDI in contemporary economic development, but also the complex relationship between globalisation, structural transformation, national competitiveness, and sustainable development.

In the 1970s, interest in FDI increased significantly, especially in the United States, where the intensification of foreign investment generated numerous academic studies. The analysis conducted by Arpan, Flowers, and Ricks (1970s) shows that this period represented a peak in FDI research, in response, on the one hand, to the rapid growth of investment in the United States and, on the other hand, to global economic tensions. Foreign direct investment in the United States became more diversified, expanding beyond traditional industries into new fields. Changes in the economy, oil prices, and international policies influenced capital flows. Thus, both FDI and foreign investors had a broader impact on the American economy than had previously been assumed [4].

As Graham and Krugman (1993) show, the 1980s witnessed an unprecedented acceleration of FDI, driven by financial liberalisation, the globalisation of production, and the growth of multinational corporations. Between 1985 and 1989, global flows grew exponentially, far outpacing the growth of trade and global GDP [5].

Furthermore, the 1990s brought significant changes in states' attitudes towards foreign direct investment. According to the 2005 UNCTAD (United Nations Conference on Trade and Development) report, governments began to liberalise their legislation in order to encourage the attraction of FDI after the periods of scepticism that had characterised the 1970s and 1980s. The report notes that the state-directed and inward-looking economic strategies dominant during the 1970s and 1980s were abandoned, giving way to market acceptance and integration into the world economy; between 1992 and 2001, 95% of legislative changes concerning FDI were in the direction of liberalisation. Thus, economic sectors were gradually opened, restrictions were removed, and incentives for attracting FDI were introduced [6].

The period following the 2008 financial crisis brought about a major transformation in studies on FDI. The literature highlights profound changes in the mechanisms, motivations, theoretical models, and implications of FDI for both developed and emerging economies. After the 2008 financial crisis, FDI flows became volatile owing to financial turbulence and global uncertainty. According to Mohapatra and Gopalaswamy (2016), the 2008 crisis significantly reduced FDI inflows into emerging economies. At the same time, FDI continued to stimulate domestic investment through crowding-in effects, thereby contributing to economic development. The long-term relationship between incoming and outgoing foreign direct investment and domestic investment was confirmed through cointegration analysis using a Vector Error Correction Model. [7]

Up to the year 2000, the specialised literature described predominantly the effects of FDI at the macroeconomic level across different economies. Beginning in the 2000s, emerging economies - especially BRICS (Brazil, Russia, India, China, and South Africa), ASEAN (Southeast Asia), Sub-Saharan Africa, Latin America, and Eastern Europe—attracted increasing volumes of FDI due to economic liberalisation, market expansion, and growing institutional capacity. This conclusion is detailed in a comprehensive review of FDI in emerging markets (2000-2024) conducted by Dr J. Rama Devi and Mrs J. Ganga Devi [8].

During this period, the BRICS countries attracted increasingly large volumes of investment owing to the size of their economies, structural reforms, investment liberalisation,

and competitive labour forces. From 2000 inwards, the FDI inflows to BRICS have increased remarkably from USD 77,127 million to USD 330,644 million in 2024 [25].

By contrast, the ASEAN countries proved attractive to FDI due to regional integration, macroeconomic stability, expanding infrastructure, and investment in digitalisation. ASEAN countries played a particularly important role in absorbing global FDI, which contributed to structural modernisation through productivity growth, technology transfer, and capital and trade effects [8].

The outbreak of the Russia–Ukraine war in 2022 introduced a new wave of geopolitical uncertainty, with far-reaching implications for global energy markets. The imposition of sanctions against Russia, coupled with disruptions in European energy supply chains, compelled multinational corporations to reassess their regional investment portfolios. Simultaneously, the intensification of U.S.–China tensions, particularly in the domains of trade, technology, and national security, manifested through tariffs, export restrictions, and regulatory controls, has reshaped the global investment landscape. Consequently, American and other Western firms have reevaluated their operations in China, increasingly considering alternative locations in Southeast Asia, South Asia, and Latin America.

Foreign direct investment has also contributed to the financial development of emerging economies. The study by Deqing Wang, Qian Huang, Tianzhi Ye, and Sihua Tian indicates that FDI plays an ambivalent role but, overall, stimulates financial development, particularly in the eastern regions of China [9].

In the context of the 2020s, it is first necessary to mention the influence of the COVID-19 pandemic, which generated one of the most severe disruptions to international investment flows in recent decades. According to UNCTAD, 2020 witnessed a global collapse in FDI of 42%, with investment falling from USD 1.5 trillion in 2019 to approximately USD 859 billion, the lowest level since the early 1990s. This decline even exceeded the impact of the 2008-2009 financial crisis. UNCTAD emphasises that health-related uncertainty and restrictive measures led investors to adopt a markedly cautious stance, postponing or cancelling major international projects. The decline was most pronounced in developed economies, where FDI fell by 69%, particularly affecting North America and Europe amid a sharp reduction in cross-border mergers and acquisitions and the suspension of greenfield projects. In parallel, emerging economies recorded more moderate declines but remained more resilient than developed ones [10].

According to the Oesterreichische Nationalbank, represented the second most severe decline in the history of foreign direct investment statistics after 2001, with global flows contracting by 35% and investors displaying considerable reluctance in the context of fears of a global recession, political uncertainty (Brexit, the US elections), trade risks, and financial volatility [11].

OECD analyses confirm the same phenomenon: public health measures, mobility restrictions, and disruptions to global supply chains led to the suspension of numerous investment projects, while multinational firms significantly reduced their expansion plans [12].

A detailed academic assessment by Moosa and Merza shows that the pandemic affected FDI through three main channels: the macroeconomic shock represented by the contraction of output and trade, the reassessment of risk within FDI theories, and the systemic effects of global crises on capital flows. The same study notes that structural changes in the economy, such as accelerated digitalisation and the reconfiguration of production, will redirect FDI flows over the long term [13].

After the dramatic declines of 2020 up to USD 648,576 million, preliminary data from UNCTAD and OeNB indicate that FDI experienced a strong recovery in 2021 and constituted USD 1914,441 million. However, this recovery remains rather fragile owing to new global risks. The specialised literature convergently underlines that geopolitical uncertainties have become a major determinant of international investment decisions, affecting both inbound and outbound foreign direct investment flows. Geopolitical tensions, including military confrontations, trade disputes, economic sanctions, and technological rivalries, have significantly reduced investors' appetite for cross-border projects. FDI flows declined to USD 1,568,613 million in 2022 and continued their downward trend in 2023, reaching USD 1,556,106 million. A modest recovery was observed only in 2024, when FDI increased slightly to USD 1,608,874 million [25].

Yu and Wang show that geopolitical risks have a significantly negative impact on FDI inflows, diminishing host countries' capacity to attract foreign capital and generating an investment climate marked by uncertainty and volatility [14].

Within the OECD area, the study conducted by Ashutosh Chandra Dwivedi & Arpita Chandra shows that geopolitical risk has a robust negative effect on foreign direct investment inflows, and that its impact becomes more pronounced in the context of major conflicts. The authors demonstrate that European states are particularly vulnerable to such external shocks, as integrated economic and financial relationships amplify the transmission of risks across the region [15].

The synthesis of the literature on foreign direct investment flows and their role in economic development demonstrates that they contribute to GDP growth, stimulate productivity, strengthen the balance of payments, and accelerate economic modernisation. An analysis carried out by Tituleasa and Mititean highlights the central role of FDI in infrastructure modernisation, the reduction of regional disparities, and integration into global value chains [16].

In the post-Soviet period (1991-2000), the Republic of Moldova had an acute need for foreign capital for reindustrialisation, technological modernisation, and economic reconstruction. Studies by ASEM show that the lack of domestic capital and the low technological level made FDI indispensable for development [17]. Analyses by Expert-Grup confirm the contribution of foreign direct investment to export growth, improved efficiency of Moldovan firms, job creation, and the modernisation of industrial sectors [18].

Although Moldova continues to lag behind other Eastern Partnership states, the progress achieved after 2014, following the Association Agreement, has been significant. During the period 2016-2019, foreign investment followed a trajectory of moderate growth, supported by closer economic ties with the EU, the expansion of free economic zones, the development of export-oriented industrial sectors such as automotive, textiles, and agro-food processing, and the intensification of trade relations in the context of the Association Agreement. The role of the EU as the principal investor increased significantly, although vulnerability to geopolitical shocks remained evident. The year 2020 generated a severe shock to foreign investment, in line with global trends.

The post-2020 period became a crucial moment of transformation for foreign direct investment in the Republic of Moldova. Although the COVID-19 pandemic, regional crises, and the war in Ukraine created heightened risks, Moldova displayed investment behaviour atypical of an emerging state, recording significant increases in FDI during certain periods,

driven by reinvested earnings and by the repositioning of foreign investors seeking proximity to the European market [19].

3.2 The impact of foreign direct investment on the economy of the Republic of Moldova

The dynamics of aggregated macroeconomic indicators make it possible to identify the general contours of Moldova's economic trajectory in the period 2019-2024 and to determine the macroeconomic environment within which the role of foreign direct investment should subsequently be examined. Before analysing the investment mechanisms and channels through which FDI exerts its effects, it is necessary to show how the overall scale of the economy, the real dynamics of output, the inflationary environment, and the level of income per capita evolved over this period (Table 1).

In the period 2019-2024, the macroeconomic dynamics of the Republic of Moldova unfolded under conditions of a changing growth regime: the pre-crisis base of 2019 was interrupted by the pandemic-induced downturn, after which the economy moved into an unstable recovery followed by a weakening of the pace of expansion. Although nominal GDP and GDP per capita increased markedly over the period under review, this trend was not accompanied by equally sustained growth in real terms.

Table 1

Main macroeconomic indicators of the Republic of Moldova, 2019-2024

Indicators	2019	2020	2021	2022	2023	2024
GDP, current prices, billion lei	206.3	199.7	242.1	274.5	303.6	323.9
Index of the physical volume of GDP, previous year=100, %	103.6	91.7	113.9	95.4	101.2	100.3
Deflator-index of GDP, %	105.4	105.6	106.4	118.9	109.3	106.4
GDP per capita, current prices, lei	77417	75797	93257	108551	123507	134842
Index of the physical volume of GDP per capita compared to the previous year, %	105.2	92.7	115.7	97.9	104.1	102.6

Source: compiled by the authors based on [20].

What is particularly important is that the recovery impulse following the 2020 downturn did not generate a consistent trajectory of expansion. Real indicators point to an alternation between phases of contraction and recovery, while by the end of the period economic dynamics had shifted into the zone of weak positive growth. This suggests that the post-crisis development of the national economy was not linear but rather cyclically fragmented, with the nominal expansion of the scale of the economy coexisting with limited sustainability of real output.

In Moldova, the post-crisis recovery relied less on the expansion of the industrial and construction core and more on activities sensitive to domestic turnover, logistics, digitalisation, and service intermediation.

Over the period under review, the structure of GDP use in the Republic of Moldova evolved under conditions of a weakening capital formation component, accompanied by a simultaneous increase in external trade dependence (Table 2).

Table 2

GDP use components of the Republic of Moldova, current prices, 2019-2024, million lei

	2019	2020	2021	2022	2023	2024
Gross Domestic Product	206256.2	199733.7	242078.6	274488.1	303554.0	323932.5
Gross Fixed Capital Formation	48251.3	49810.3	58312.8	60701.6	59000.3	66460.5
Export	64333.6	55754.3	74194.2	113161.7	106585.7	102258.4
Import	116413.4	102566.0	139974.9	194587.9	178738.8	185693.1

Source: compiled by the authors based on [21].

Despite the persistence of positive dynamics in several aggregated indicators, the internal configuration of GDP use did not point to the formation of a sustainable investment-based growth foundation.

Particularly noteworthy is the decline in the share of gross fixed capital formation in GDP by the end of the period under review. This indicates that the post-crisis recovery was not accompanied by a commensurate strengthening of the investment component and, therefore, did not provide a sufficient basis for the sustained expansion of the economy's capital base.

At the same time, the external sector continued to exert a significant influence on macroeconomic dynamics, albeit in an asymmetric form: the expansion of external economic turnover was accompanied by a persistent excess of imports over exports. Consequently, the growth of aggregate demand relied to a considerable extent on external supplies, while the structural dependence on imports remained high. This suggests that part of the economic activity associated with the recovery of domestic demand was not transformed into a corresponding expansion of the national production and investment base.

Under these conditions, analytical attention shifts to the institutional structure of investment in long-term assets (Table 3).

Table 3

Investments in non-current assets by form of ownership, current prices, 2019-2024, million lei

Indicators	2019	2020	2021	2022	2023	2024
Total	31253.2	30089.6	35411.2	37107.5	38367.5	42103.6
Private	15467.4	15380.7	19747.7	20509.6	20709.5	24846.9
Foreign	3013.6	2471.0	2927.7	3940.4	2730.4	2991.3
Joint ventures	3873.8	2280.2	2730.7	2347.7	2773.0	2665.8

Source: compiled by the authors based on [22].

In the period 2019-2024, the expansion of investment in long-term assets was accompanied by a shift in the institutional structure in favour of the domestic private sector. The growth in the total volume of investment was driven primarily by private ownership, indicating the strengthening of domestic private capital as the principal carrier of investment activity in the post-crisis period.

Against this background, the segments associated with foreign capital displayed a weaker and less stable trajectory. Investment by foreign-owned enterprises as a whole did

not establish a comparable upward trend, while the investment activity of joint ventures declined, ultimately leading to a reduction in their combined share in the overall structure of investment. Thus, the institutional configuration of the investment process shifted towards domestic sources of capital accumulation, alongside a relative weakening of the externally oriented component.

Foreign direct investment is regarded as a key external stimulus influencing the possibilities for modernisation and the expansion of the capital base of the Republic of Moldova. The dynamics of foreign direct investment are presented in Figure 1.

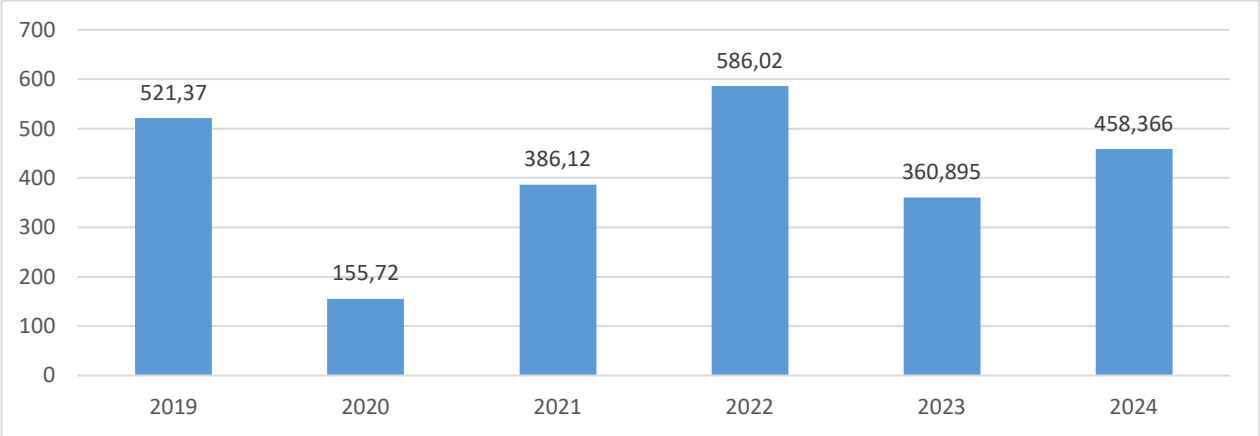

Figure 1. Foreign direct investment, net inflows, 2019-2024, million USD.
Source: compiled by the authors based on [23].

The COVID-19 pandemic significantly affected the level of foreign direct investment in the Republic of Moldova. Thus, 2020 was a year of severe shock. FDI amounted to only USD 155.7 million, declining by more than 70% compared with 2019. In the years following the pandemic, a positive upward trend in FDI was recorded, reaching a value of more than USD 586 million in 2022. In 2023, a correction occurred, followed by a recovery in 2024. Although 2024 did not return to the level recorded in 2019 or to the 2022 peak, the baseline level in 2022-2024 was clearly higher than in the period 2019-2021 (+33%).

The dynamics of the year-end stock of foreign direct investment over the period 2019–2024 are presented in Figure 2.

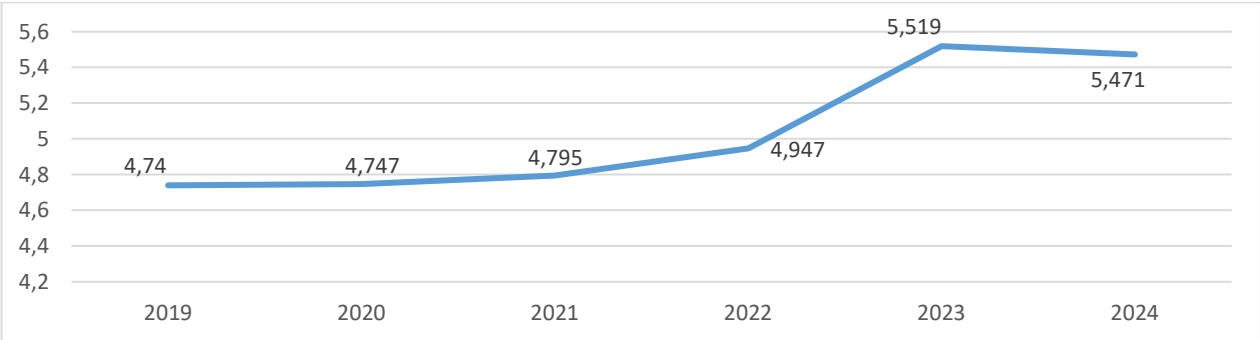

Figure 2. Foreign direct investment stock at the end of the year, 2019-2024, USD billion.
Source: compiled by the authors based on [24].

The total stock of liabilities in the form of direct investment at year-end followed an upward trend, increasing from USD 4.74 billion in 2019 to USD 5.471 billion in 2024. As of 31 December 2024, the total stock of direct investment liabilities stood at USD 5.471 billion,

representing a marginal decrease of 0.9% compared with the level recorded at the end of 2023. This decline does not reflect capital withdrawals, but is explained primarily by revaluation effects. The main contribution to the downward adjustment came from the depreciation of the Moldovan leu against the US dollar, which amounted to -6.2% over the course of the year. It is important to emphasise that, in the absence of these factors, the stock of direct investment would have recorded positive dynamics in 2024.

The share of foreign direct investment in gross domestic product is a relevant indicator for assessing the involvement of foreign capital in the development of the economy of the Republic of Moldova. In 2024, net FDI flows reached USD 458.4 million, equivalent to 2.52% of GDP, marking a moderate increase compared with 2023 (2.16%).

Comparing the stock of foreign direct investment (FDI) with gross domestic product (GDP) constitutes an essential analytical tool for assessing the degree of integration of foreign capital into the structure of the national economy. In 2024, the share of the FDI stock in GDP reached 30.1%, indicating a moderate presence of foreign capital in the Republic of Moldova (Figure 3).

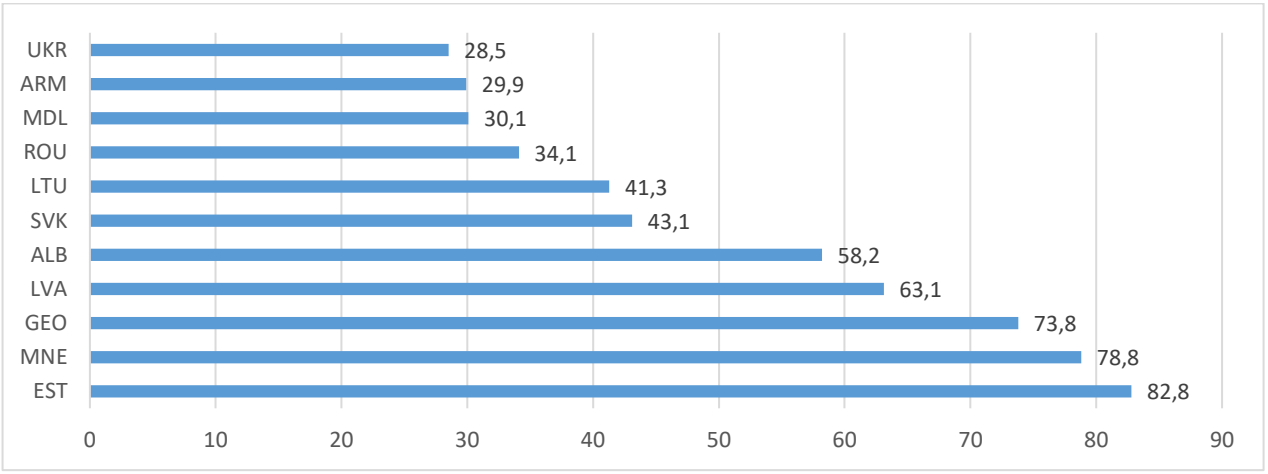

Figure 3. Share of the FDI stock in GDP: Moldova vs. comparator countries, 2024, %.
Source: compiled by the authors based on [25].

In comparative terms, many economies in Central and Eastern Europe—particularly the Baltic states, Slovakia, and several countries in the Balkan Peninsula—record substantially higher ratios. These higher levels reflect deeper integration into international value chains, stronger investment attractiveness, and a more advanced capacity to attract complex investment projects, including in sectors with high added value. Accordingly, the observed disparities highlight the need to accelerate structural modernisation and improve the investment framework in the Republic of Moldova in order to enhance competitiveness and stimulate long-term capital flows.

Cumulative foreign direct investment inflows per capita represent an essential indicator for assessing the intensity of foreign capital attraction relative to the size of the population. In the case of the Republic of Moldova, the cumulative value for the period 2019–2024 amounted to USD 758.6 per capita, whereas Romania recorded USD 2,548.5 per capita over the same period, approximately 3.6 times higher. This disparity points to the persistence of significant untapped potential in terms of attracting FDI to the Republic of Moldova. The relatively low level of this indicator is shaped by structural factors such as the limited size of the domestic market, the economy's vulnerability to regional shocks, the moderate degree of industrial sophistication, and the gradual pace of institutional and economic modernisation.

In the Republic of Moldova, foreign investment flows are channelled through FDI enterprises, foreign-owned enterprises, and joint ventures.

The post-pandemic dynamics in the number of these enterprises are presented in Table 4.

Table 4

Evolution in the number of enterprises with FDI, foreign-owned enterprises, and joint ventures, 2019-2024

Type of enterprise	2019	2020	2021	2022	2023	2024
Enterprises with FDI	4243	4092	3966	3908	3794	2889
Foreign-owned enterprises	2622	2536	2505	2504	2530	2668
Joint ventures	1521	1556	1461	1404	1254	1221
Total	8386	8184	7932	7816	7578	6778

Source: compiled by the authors based on [26].

In the post-pandemic period, the dynamics of enterprises with direct foreign participation revealed a clear downward trend. The number of enterprises with FDI declined from 4,243 in 2019 to 2,889 in 2024, equivalent to a decrease of approximately 32%. Over the same interval, joint ventures recorded a decline of about 20%, indicating a gradual withdrawal of foreign investors from shared ownership structures. It is worth noting that only the segment of foreign-owned enterprises (with wholly foreign capital) displayed a different pattern: after a slight decline until 2022, their number began to increase, and by 2024 it had exceeded the level recorded in the pre-pandemic period. This evolution suggests a reorientation of investors towards more firmly established forms of economic presence and a stronger preference for full control over operations conducted on the market of the Republic of Moldova [19].

Overall, enterprises with foreign direct investment - particularly those with wholly foreign capital - continue to represent a strategic employer in the economy of the Republic of Moldova, contributing substantially to the modernisation of the employment structure, the integration of the economy into global value chains, and the development of human capital. In 2024, companies with FDI employed 13.7% of the total workforce, of which 9.9% were employed in wholly foreign-owned enterprises and 3.8% in joint ventures [19].

In 2024, enterprises with foreign direct investment generated 23.3% of the total revenues of the economy of the Republic of Moldova, of which 15.0% was attributable to wholly foreign-owned companies and 8.2% to joint ventures [19].

These entities continue to stand out through higher levels of productivity compared with private enterprises with domestic capital, which confirms their role as pillars of economic performance (Table 5).

The evolution of revenue per employee shows that foreign direct investment has a major structural impact on the economic competitiveness of the Republic of Moldova. Enterprises with FDI, especially joint ventures and wholly foreign-owned enterprises, consistently outperform local private firms, suggesting that their higher productivity is driven by access to capital, technology, managerial know-how, and integration into global value chains.

Enterprises with FDI - namely wholly foreign-owned enterprises and joint ventures - also make a substantial contribution to profit generation. In 2024, they accounted for 19.5% of total profit, of which 12.2% was generated by wholly foreign-owned companies and 7.3% by joint ventures [19].

Table 5

Labour productivity in enterprises with different forms of ownership, 2019–2024 (thousand lei per employee)

Type of enterprise	2019	2020	2021	2022	2023	2024
Enterprises with FDI	1380	1380	1755	2116	2061	2085
Foreign-owned enterprises	1322	1322	2116	1755	1734	1869
Joint ventures	1442	1442	3042	3047	2922	2643
Private enterprises	867	921	1113	1113	1127	1199

Source: compiled by the authors based on [19].

Through their disproportionate contribution to job creation, the maintenance of high levels of productivity, and profit generation, enterprises with FDI, wholly foreign-owned enterprises, and joint ventures remain essential for modernising the productive structure, stimulating competitiveness, and strengthening the technological capacities of the Republic of Moldova.

3.3 Correlation and regression analysis of the relationship between economic growth and foreign direct investment in the Republic of Moldova

Based on the descriptive analysis presented above, it can be observed that foreign direct investment and the indicators associated with it are in a meaningful relationship with the economic dynamics of the Republic of Moldova. However, in order to move beyond the level of descriptive observations and to assess more rigorously the direction and intensity of the relationship between economic growth and the selected investment variables, a multifactor econometric model was applied. For this purpose, a linear regression model is estimated below, making it possible to examine the relationship between the growth rate of GDP per capita and a set of factors reflecting the evolution of foreign direct investment, investment in fixed assets under foreign ownership, foreign funds, labour productivity in enterprises with FDI, as well as the effect of the time trend. The period under examination is extended to 2015–2024 in order to capture statistical relationships over a broader time horizon than that covered by the post-pandemic dynamics alone.

3.3.1 Specification of the econometric model and description of the variables

The initial data for the baseline model are presented in Table 6.

Following the analysis of the data for the period 2015 - 2024, a multifactor linear regression econometric model was estimated, with the growth rate of GDP per capita as the dependent variable and, as explanatory variables, the growth rate of net direct investment, the growth rate of investment in fixed assets under foreign ownership, the growth rate of foreign funds, the growth rate of labour productivity in enterprises with foreign direct investment, as well as the time factor. The estimation yielded the following regression model [27]:

$$Y = 6.197 + 0.031*X1 + 0.095*X2 + 0.174*X3 + 0.154*X4 + 0.336*t$$

The verification and processing of the model were carried out using QM for Windows and RStudio, which made it possible to assess the relationship between the dependent variable and the explanatory factors included in the analysis. The estimated model highlights the existence of a direct relationship between the growth rate of GDP per capita and the explanatory variables considered, thereby providing an analytical basis for assessing the influence of foreign investment and labour productivity in enterprises with FDI on the dynamics of economic growth.

Table 6

Initial data for the econometric model, 2015-2024

Year	Growth rate of GDP per capita, %	Growth rate of net direct investment, %	Growth rate of investment in fixed assets under foreign ownership, %	Growth rate of foreign funds, %	Growth rate of labour productivity in enterprises with FDI, %	Time
	Y	X1	X2	X3	X4	t
2015	12.05145	-28.2747	19.3344	17.70924	6.442308	1
2016	9.630474	-65.6098	30.45884	-4.80499	-1.17435	2
2017	12.61701	91.35358	3.461423	4.822246	0.639854	3
2018	9.321875	87.72541	16.23535	-3.35796	0.817439	4
2019	10.85385	77.86596	7.352522	24.45448	13.15315	5
2020	-2.09256	-68.3202	-18.005	-29.5717	9.872611	6
2021	23.03521	144.7443	18.4824	-1.68873	27.17391	7
2022	16.39984	45.50882	34.59029	-5.30645	20.5698	8
2023	13.77786	-36.8665	-30.7075	24.88503	-2.59924	9
2024	9.177617	-28.6279	9.555377	14.01391	1.164483	10

Source: compiled by the authors.

3.3.2 Estimation results and interpretation of the identified relationships

The model estimation results reveal the existence of a direct relationship between the growth rate of GDP per capita and the explanatory variables included in the analysis. The regression coefficient associated with variable X1 (b1 = 0.031) shows that a 1 percentage point increase in the growth rate of net direct investment leads, on average, to a 0.031 percentage point increase in the growth rate of GDP per capita, holding all other factors constant. The positive sign of the coefficient indicates a direct relationship between net direct investment and GDP per capita growth. In other words, an intensification of direct investment flows generally contributes to supporting economic growth. However, the numerical value of the coefficient is relatively small, suggesting that the influence of foreign direct investment on the economy is manifested not only directly, but also indirectly through fixed capital, productivity, technology, organisation, exports, and other channels.

The regression coefficient associated with variable X2 (b2 = 0.095) indicates that a 1 percentage point increase in the growth rate of investment in fixed assets under foreign ownership leads, on average, to a 0.095 percentage point increase in the growth rate of GDP per capita, holding all other factors constant. This indicates that foreign investment directed towards fixed capital exerts a positive and relatively more pronounced influence on the dynamics of economic growth. This result has important economic significance, since investment in fixed assets reflects the allocation of resources to the material base of the economy: machinery, equipment, buildings, production infrastructure, and other components of fixed capital. Under normal conditions, such investment contributes to the expansion of production capacity, technological modernisation, and improved economic efficiency.

In the case of variable X3, the regression coefficient (b3 = 0.174) shows that a 1 percentage point increase in the growth rate of foreign funds leads, on average, to a 0.174 percentage point increase in the growth rate of GDP per capita, holding all other factors constant. This is the highest regression coefficient among the economic factors included in

the model, highlighting the significant role of external financing in stimulating economic growth.

The coefficient associated with variable X4 (b4 = 0.154) indicates that a 1 percentage point increase in the growth rate of labour productivity in enterprises with FDI leads, on average, to a 0.154 percentage point increase in the growth rate of GDP per capita, holding all other factors constant. Therefore, labour productivity constitutes an important channel through which the positive effects of foreign investment are transmitted to economic growth. In other words, not only the volume of investment matters, but also the efficiency with which that investment is transformed into productive outcomes.

The regression coefficient associated with the time variable (b5 = 0.336) reveals the existence of a positive linear trend, which means that, holding all other factors constant, the growth rate of GDP per capita increases, on average, by 0.336 percentage points from one year to the next. This result suggests that the dependent variable is also influenced by other general time-related factors that are not directly captured by the variables included in the model.

The multiple correlation coefficient, R = 0.828, indicates the existence of a relatively strong relationship between the growth rate of GDP per capita and the set of factors included in the model. The proximity of the multiple correlation coefficient to unity suggests that the model has a relatively high level of explanatory credibility and may be considered sufficiently reliable for interpreting the general relationships among the indicators analysed.

The coefficient of determination, R^2 = 0.685, shows that 68.5% of the variation in the growth rate of GDP per capita is explained by the explanatory variables included in the model, while 31.5% is attributable to other factors not captured by the regression equation or to random influences [28].

The regression model estimation was verified by applying the Fisher test, which makes it possible to assess the significance of the equation as a whole. The calculations yielded Fcalc = 1.73981, for df1 = 5 and df2 = 4 degrees of freedom, while the associated probability level was p = 0.3058 [27]. On this basis, the model may be regarded as a useful econometric instrument for analysing the relationships between the growth rate of GDP per capita and the explanatory factors included, providing a relevant picture of the direction of their influence and of their relative contribution to the variation of the dependent indicator.

The individual estimation of the regression coefficients was assessed using the Student's t-test. The results show that the highest t-statistic among the explanatory variables is associated with the coefficient for foreign funds (t = 1.492), which indicates relatively stronger support for this variable compared with the other factors included in the model. Overall, the values of the Student statistic indicate a moderate level of individual confirmation of the coefficients, which supports emphasising the general direction of the factors' influence on the dependent variable.

4. Conclusions

The research results show that foreign direct investment occupies an important place in the dynamics of the economy of the Republic of Moldova; however, its contribution is not manifested uniformly and cannot be interpreted outside the macroeconomic and institutional context in which it evolves. The descriptive analysis indicates that, although investment flows were affected by major external shocks and followed a volatile trajectory, foreign capital maintained its importance in the national economy through its contribution to employment,

revenues, profitability, and productivity. At the same time, the international comparisons and relative indicators used in the study suggest that the Republic of Moldova still has insufficiently exploited potential in terms of attracting and leveraging FDI.

At the structural level, enterprises with foreign participation stand out through superior economic performance compared with a substantial share of domestic enterprises, particularly with regard to labour productivity and their contribution to aggregate economic results. This supports the idea that the effects of FDI are not limited to the mere provision of capital, but also include qualitative dimensions associated with the transfer of technologies, managerial practices, and integration into more competitive economic circuits. At the same time, the reduction in the number of certain categories of enterprises with foreign participation suggests that the relevance of FDI should be assessed not only in terms of quantitative expansion, but also in terms of their actual capacity to generate economic value.

The results of the correlation and regression model indicate the existence of positive associations between the growth rate of GDP per capita and the investment variables included in the analysis, especially those related to investment directed towards the productive base, foreign funds, and labour productivity in enterprises with FDI. The level of statistical confirmation of the model and of the individual coefficients makes it possible to identify probable relationships and the general direction of the associations among the variables analysed.

Overall, the study supports the view that foreign direct investment may represent an important mechanism for sustaining economic growth in the Republic of Moldova, with effects transmitted through productivity, investment in fixed capital, and enterprise performance. However, the more consistent transformation of this potential into sustainable economic development depends on strengthening the investment framework, enhancing the absorption capacity of the economy, and reducing the structural vulnerabilities that limit the impact of investment on long-term growth.

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DIGITAL GOVERNANCE AND TRUST IN MOLDOVA'S EU ACCESSION PROCESS

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Abstract. This article examines the relationship between digital governance, institutional trust and accession readiness in the Republic of Moldova. It addresses a specific problem in accession monitoring: legal alignment, platform availability and service counts may be recorded without showing whether digital public services improve administrative experience. The purpose is to derive a trust-sensitive analytical model for Moldova rather than to test a statistical hypothesis. The study uses qualitative policy-document analysis and conceptual synthesis on a corpus of 24 source items, including Moldovan policy documents, European Commission enlargement documents, multilateral administrative assessments, interoperability and cybersecurity sources, election-observation materials and scholarly literature. Manual deductive coding applied five categories: strategic alignment, service quality, accountability, institutional capacity and inclusion. The findings show that Moldova's digital agenda is increasingly embedded in accession-related state-building, while evidence remains stronger for service availability and infrastructure than for user experience, complaint resolution or segmented satisfaction. The article proposes a trust-through-service-quality model and argues that assisted access and cyber-resilience should be treated as constitutive dimensions of public service quality. The contribution is conceptual and measurement-oriented, and requires future empirical testing.

Keywords: *administrative capacity, assisted access, citizen-centred services, cyber-resilience, e-government, interoperability, public administration reform, service delivery.*

Rezumat. Articolul examinează relația dintre guvernanța digitală, încrederea instituțională și pregătirea pentru aderare în Republica Moldova. Acesta abordează o problemă specifică în monitorizarea aderării: alinierea legislativă, disponibilitatea platformelor și numărul de servicii care pot fi înregistrate fără a demonstra, dacă serviciile publice digitale îmbunătățesc experiența administrativă. Scopul este de a obține un model analitic sensibil la încredere pentru Moldova, mai degrabă decât de a testa o ipoteză statistică. Studiul utilizează analiza calitativă a documentelor de politici și sinteza conceptuală pe un corpus de 24 de elemente sursă, inclusiv documente de politici moldovenești, documente privind extinderea Comisiei Europene, evaluări administrative multilaterale, surse de interoperabilitate și securitate cibernetică, materiale de observare a alegerilor și literatură științifică. Codificarea deductivă manuală a aplicat cinci categorii: aliniere strategică, calitatea serviciilor, responsabilitate, capacitate instituțională și incluziune. Constatările arată că agenda digitală a Moldovei este

din ce în ce mai integrată în construirea statului legată de aderare, în timp ce dovezile rămân mai puternice pentru disponibilitatea serviciilor și infrastructură decât pentru experiența utilizatorului, soluționarea reclamațiilor sau satisfacția segmentată. Articolul propune un model de încredere pentru calitatea serviciilor și susține că accesul asistat și reziliența cibernetică ar trebui tratate ca dimensiuni constitutive ale calității serviciilor publice. Contribuția este conceptuală și orientată spre măsurare și necesită teste empirice viitoare.

Cuvinte cheie: *capacitate administrativă, acces asistat, servicii centrate pe cetățean, reziliență cibernetică, e-guvernare, interoperabilitate, reformă a administrației publice, furnizare de servicii*.

Abbreviations

CUPS – Unified Service Delivery Centres (Centrele Unificate de Prestare a Serviciilor).
EC – European Commission.
EU – European Union.
GTMI – GovTech Maturity Index.
ICT – information and communication technology.
MPass – Government electronic authentication and access-control service.
MConnect – Government interoperability and data-exchange platform.
NPA – National Programme for the Accession of the Republic of Moldova to the European Union.
ODIHR – Office for Democratic Institutions and Human Rights.
PAR – public administration reform.
SIGMA – Support for Improvement in Governance and Management.
SWD – Commission Staff Working Document.

1. Introduction

Digital governance has become part of the administrative infrastructure through which candidate states demonstrate readiness for European Union membership. In the Republic of Moldova, this relationship is particularly visible because accession reforms, public administration reform and the digital transformation agenda now operate in the same institutional space. The 2025 Moldova Report and the wider 2025 Enlargement Package assess Moldova under the fundamentals logic of the enlargement process, while the National Programme for Accession 2025–2029 and the Digital Transformation Strategy 2023–2030 place service delivery, interoperability and digital public infrastructure inside a broader administrative-modernisation agenda [1–4].

This article uses the term digitization for the conversion of analogue information or procedures into digital form, digitalization for the redesign of administrative processes through digital tools, digital transformation for wider organisational and institutional change, e-government for the digital provision of public services, and GovTech for whole-of-government public-sector modernisation using digital technologies. The distinction is not only terminological. A document can be digitized without a procedure being simplified, and a portal can be available without the underlying administration becoming more predictable, accountable or inclusive.

The scholarly literature supports this distinction. Digital transformation is not reducible to the introduction of information and communication technology; it changes organisational routines, institutional roles and service relationships [5, 6]. Public value

research similarly argues that public-sector ICT should be assessed against citizen-centred outcomes rather than only efficiency or transactional volume [7, 10, 11]. The trust literature adds a second caution: transparency and e-government can support trust when they improve legibility, fairness and responsiveness, but disclosure or service availability alone does not necessarily produce confidence in institutions [8, 9]. Comparative work on critical citizens reinforces this point: where confidence in public institutions has eroded, the driver tends to be perceived government performance and responsiveness rather than the presence or absence of communication channels [13]. For a candidate state, this distinction matters directly, because it locates the trust-relevant variable in the quality of the administrative encounter rather than in the count of services placed online.

The unresolved issue is sharper in candidate-state contexts. Accession monitoring necessarily evaluates legal alignment, institutional capacity and progress in reform implementation. However, the lived administrative experience of citizens is not identical to the presence of online services or the formal transposition of acquis-related commitments. The gap addressed here is therefore specific: previous digital-government and trust studies explain why service experience may matter, and accession documents explain what Moldova must align, but the relationship between digital public service quality, cyber-resilience and trust-sensitive accession readiness remains insufficiently specified for Moldova as a candidate state.

The article does not claim to measure public trust directly. It does not use survey data, interviews, experiments or administrative microdata on individual users. Instead, it examines how trust-relevant mechanisms appear in the documentary architecture of Moldova's accession and digital-governance reforms and develops a conceptual model for later empirical testing. The research question is: how are digital governance, public service quality and cyber-resilience framed in Moldova's accession-related reform documents, and what model can be derived for trust-sensitive accession monitoring? The working analytical proposition is that digital governance can support institutional trust only when it is translated into service quality, assisted access, accountable feedback and resilient public infrastructure. This proposition structures the qualitative analysis; it is not treated as a statistically tested hypothesis.

The article makes three contributions. First, it clarifies the Moldova-specific mechanisms through which digital reform may become administratively meaningful for citizens. Second, it integrates cyber-resilience into the analysis of public service quality, rather than treating it as a separate security appendix. Third, it proposes a measurement-oriented model that distinguishes documentary findings from policy recommendations and identifies indicators for future empirical validation.

2. Materials and Methods

The study applies qualitative policy-document analysis with conceptual synthesis. This design is appropriate because the research object is the reform architecture of a candidate state rather than individual attitudes or behavioural outcomes. The method allows the article to analyse how official documents, multilateral assessments and scholarly concepts define the relationship between digital public services, administrative capacity and trust-relevant governance mechanisms.

The corpus consisted of 24 source items collected and checked between June 2025 and June 2026. The institutional component included Moldovan policy documents, European

Commission enlargement materials, multilateral administrative assessments, World Bank project evidence, interoperability materials and election-observation sources. The scholarly component included peer-reviewed and foundational works on digital government, public value, transparency, trust and street-level bureaucracy. Table 1 gives the complete declared corpus and the purpose for which each item was used; no source is used as analytical evidence without being identified in the reference list.

For verifiability, each quantitative and contextual statement was tied to a numbered corpus item. The reference list contains all 24 items used in the analysis. Official URLs and DOI links were checked on 17 June 2026. Where a source provided both a landing page and a downloadable report, the cited reference identifies the official source page or the stable report file. Scholarly sources [5-13] are used for conceptual framing, while Moldova-specific documentary findings are derived from institutional, multilateral and election-observation sources [1-4, 14-24].

Table 1

Analytical corpus used in the qualitative policy-document analysis (source: author's classification based on references [1–24])

Source band	Ref.	Source item	Purpose in the analysis
Policy / accession	[1]	European Commission, Moldova Report 2025, SWD(2025) 758 final	Accession assessment; public administration reform; hybrid-threat context
Policy / accession	[2]	European Commission, 2025 Communication on EU enlargement policy	Regional enlargement frame and fundamentals logic
Policy / accession	[3]	National Programme for the Accession of the Republic of Moldova to the EU, 2025–2029	National reform sequencing and chapter structure
Policy / digital strategy	[4]	Digital Transformation Strategy of the Republic of Moldova, 2023–2030	Digital-state objectives, service-delivery ambitions and interoperability agenda
Administrative evidence	[14]	Electronic Governance Agency, review of public-service modernisation	Official service-digitalization counts and implementation narrative
Administrative evidence	[15]	Electronic Governance Agency, MConnect Events information	Interoperability infrastructure and data-exchange scale
Administrative evidence	[16]	World Bank, From queues to clicks: digitalization transforms Moldova's public services	Service use, World Bank-supported digitisation and service-efficiency evidence
Administrative evidence	[17]	World Bank, Modernization of Government Services Project implementation report	CUPS, training, service redesign and project indicators
GovTech assessment	[18]	World Bank, GovTech Maturity Index 2025	Comparative GovTech maturity frame
Administrative assessment	[19]	OECD/SIGMA, Public Administration in the Republic of Moldova	PAR capacity assessment and service-delivery conditions
Election / resilience	[20]	OSCE/ODIHR preliminary findings on 28 September 2025 parliamentary elections	Cyber-attacks, disinformation and illicit-financing context
Election / resilience	[21]	OSCE/ODIHR final report on 2025 parliamentary elections	Confirmed election-administration and interference assessment

Continuation Table 1

Interoperability	[22]	Interoperable Europe, Moldova 2025 monitoring supporting document	Interoperability, MPass and digital public infrastructure context
Cyber-resilience	[23]	UNDP Moldova, advancing digital transformation in Moldova	Digital resilience and EU Cybersecurity Reserve context
Policy monitoring	[24]	Annual implementation report of Moldova Digital Transformation Strategy	Implementation progress and monitoring frame
Academic	[5]	Mergel, Edelmann and Haug, digital transformation definition	Conceptual distinction between technology adoption and institutional change
Academic	[6]	Janowski, digital government evolution	Transformation and contextualisation framework
Academic	[7]	Twizeyimana and Andersson, public value of e-government	Public-value benchmark for digital services
Academic	[8]	Tolbert and Mossberger, e-government and trust	Link between e-government experience and trust
Academic	[9]	Grimmelikhuijsen et al., transparency and trust	Limits of transparency as a trust mechanism
Academic	[10]	Bannister and Connolly, ICT and public values	Public-value critique of efficiency-led ICT reform
Academic	[11]	Cordella and Bonina, public-value perspective	Public-sector reform and ICT value creation
Academic	[12]	Lipsky, street-level bureaucracy	Human mediation and discretion in service delivery
Academic	[13]	Norris, critical citizens	Trust, democratic performance and institutional legitimacy

Selection followed four inclusion criteria: direct relevance to Moldova's digital governance, accession process or administrative reform; authoritative provenance, defined as an official institution, multilateral organisation or peer-reviewed scholarly source; availability in English or in an official English translation; and relevance to at least one of the five coding categories. Sources were excluded when they were journalistic commentary, duplicated factual claims already available in official documents, or offered only general regional background without specific analytical value for the research question.

Coding was deductive. Five categories were used: strategic alignment, public service quality, transparency and accountability, institutional capacity, and inclusion. Each document was read manually and coded in a structured spreadsheet, with one row per source item and columns for source identifier, document type, coded excerpt or analytical paraphrase, coding category, interpretation and relevance to the research question. Where page numbers or stable sections were available, they were recorded in the spreadsheet. The coding procedure was repeated after seven days. Discrepancies were resolved by re-reading the relevant passage and checking whether a second corpus source supported the classification. The most frequent discrepancy concerned the boundary between strategic alignment and institutional capacity, because accession documents often present capacity-building commitments as alignment tasks. Table 2 reports the codebook and coding examples; the examples are analytical paraphrases of coded evidence, not additional empirical claims.

No statistical processing was performed because the study did not generate or analyse a numerical dataset. Descriptive numerical statements are used only when reported in official or multilateral documents, and they are treated as contextual documentary evidence rather

than as independently verified measurements. The article does not generalise from documents to citizen attitudes. Claims about rural users, older users, disabled users, diaspora users or territorially constrained populations are therefore framed as monitoring gaps or inclusion categories, not as measured behavioural findings. No software-based text mining, machine learning classification or inferential statistics were used. The method is reproducible at the level of corpus, codebook and interpretive procedure, but it does not provide inter-coder reliability statistics. This is a methodological limitation and is addressed in the discussion.

Table 2

Coding framework and examples (source: author's methodological design derived from the corpus [1–24])

Category	Operational meaning	Coding example from the corpus	Analytical function
Strategic alignment	Digital reform is linked to accession obligations, chapter commitments, PAR and interoperability requirements.	NPA commitments linked with digital service delivery and PAR; Moldova Report assesses capacity under fundamentals.	Tests whether digital governance is accession infrastructure or a parallel ICT agenda.
Public service quality	References to simplification, completion, processing time, visit reduction, life-event design or user satisfaction.	World Bank-supported services report reduced red tape and increased use of online services; MGSP report records service redesign and CUPS indicators.	Tests whether reform is experienced as service improvement rather than only online availability.
Transparency and accountability	Visibility of rules, deadlines, responsible bodies, complaint channels, feedback and public reporting.	Documents provide strategic transparency but less systematic publication of completion, complaint and segmented satisfaction indicators.	Tests whether digital systems reduce opacity or simply publish administrative information.
Institutional capacity	Interoperability, staffing, coordination, legal absorption, cybersecurity and operational continuity.	MConnect, MPass, CUPS and SIGMA capacity findings show that back-office integration and staff capacity remain decisive.	Tests whether digital reform can be sustained across agencies and under hybrid-pressure conditions.
Inclusion	Assisted access, rural users, older users, disabled users, diaspora users and territorially excluded populations.	CUPS and mobile-first digital-service narratives appear as inclusion mechanisms, while diaspora and territorial gaps remain less operationally specified.	Tests whether digitalization widens access or creates new barriers for marginal users.

3. Results

The results reported in this section are documentary findings produced by the coding procedure. They describe how the corpus frames digital governance, service quality, capacity and inclusion. They do not report citizen perceptions, do not infer measured changes in institutional trust and do not present policy recommendations; interpretation and recommendations are reserved for the discussion.

3.1. Digital governance is increasingly positioned as accession infrastructure

The first documentary finding is that digital governance in Moldova is no longer framed only as a sectoral ICT programme. The NPA 2025–2029 and the Digital Transformation Strategy connect digitalization with institutional alignment, administrative service delivery, data exchange and public-sector modernisation [3, 4]. This is reinforced by

European Commission and SIGMA materials, which assess Moldova's administrative capacity through the fundamentals logic of enlargement and treat public administration reform as a condition of accession credibility [1, 2, 19].

This alignment is analytically important because it changes the status of digital public services. They become evidence of implementation capacity, not only technical deliverables. A functioning digital service can demonstrate that legal alignment, back-office procedures, staff capacity and user-facing delivery have been connected. Conversely, a service that is available online but still dependent on fragmented registries, unclear rules or repeated physical verification demonstrates the limits of formal alignment.

The corpus also shows a tension between strategic ambition and implementation conditions. Strategy documents define broad 2030 objectives, while administrative assessments emphasise absorption capacity, agency coordination and continuity of service delivery. The relevant analytical issue is therefore the extent to which digital platforms are converted into consistent service quality across agencies and territories.

3.2. Service availability is better documented than service quality

The second finding concerns measurement. Official and multilateral sources provide evidence of expanding digital service availability and platform use. The Electronic Governance Agency reports that 303 out of 648 public services were fully digitalized in 2025 [14]. The World Bank reports that more than 87 critical public services were digitalized with its support and that the share of people using online public services increased from 25% in 2018 to 54.7% [16]. MConnect materials report larg e-scale data exchange, including more than 2.5 million messages processed daily through the MConnect ecosystem [15].

These indicators are relevant, but they do not by themselves measure trust. They record availability, use or infrastructure activity. The documentary corpus contains less systematic evidence on completion rates by user segment, complaint resolution, failed transactions, assisted-access outcomes or satisfaction disaggregated by rural users, older users, disabled users and diaspora users. The result is a measurement asymmetry: digital progress is visible in service counts and platform statistics, while trust-relevant service experience is less visible in comparable public indicators. Comparative benchmarking does not resolve this asymmetry; it reproduces it. The 2025 GovTech Maturity Index places Moldova in Group A, its highest maturity band, on the strength of core government systems, online service portals, digital citizen engagement and institutional enablers [18]. The World Bank, however, states that the index is not a ranking and is not meant to evaluate an economy’s GovTech readiness or performance. A top-band classification therefore scores the presence and design of platforms, not whether citizens complete services and experience them as reliable. The asymmetry is structural to how digital governance is currently assessed, not merely a gap in Moldovan reporting.

This does not invalidate Moldova's digital reform. It specifies what the available evidence can and cannot support. The documents can support a claim that Moldova has expanded digital public infrastructure and service availability. They cannot, without additional empirical data, support a direct claim that institutional trust has increased because of those services.

3.3. Assisted access is a core condition of inclusive digital governance

The third finding is that assisted access appears as a necessary part of Moldova's digital-governance architecture. The World Bank implementation evidence records the

establishment and operation of CUPS service-delivery centres and the training of staff involved in citizen-centred administrative service delivery [17]. In methodological terms, this matters because assisted access changes the interpretation of digitalization statistics. A digital service accessed through a trained service centre is still part of digital governance, but its inclusion effect depends on human mediation, not only on online availability.

The importance of assisted access is consistent with street-level bureaucracy theory. Digitalization changes where discretion and mediation occur; it does not remove them [12]. In Moldova's case, the service centre, the authentication platform, the registry interface and the civil servant form a combined delivery system. A purely portal-centred measurement approach would therefore understate the role of assisted access and overstate the inclusiveness of digital service availability.

The corpus identifies inclusion as a boundary condition rather than a fully resolved achievement. Rural access, disability access, older users, diaspora users and populations outside effective central administrative control are present in the policy problem but less consistently operationalised as measurable service-quality categories. This is a limitation of the current monitoring frame.

3.4. Cyber-resilience is trust-relevant but not always integrated into service-quality assessment

The fourth finding is that cyber-resilience should be treated as part of service-quality assessment. The 2025 electoral context illustrates the relevance of this point. OSCE/ODIHR materials reported a competitive election process affected by foreign interference, illicit financing, cyber-attacks and disinformation [20, 21]. UNDP also records that Moldova became the first EU candidate country to benefit from deployment of the EU Cybersecurity Reserve Unit in September 2025, in the context of protecting critical infrastructure before parliamentary elections [23].

For digital governance, this evidence has a direct implication. Identity, payment, notification and registry systems are public infrastructure directly relevant to institutional confidence. A disruption, data breach or manipulated public narrative about digital-service failure can affect both technical continuity and confidence in accession-oriented reform. Cyber-resilience should therefore be coded as part of institutional capacity and public service quality, not only as a separate cybersecurity topic.

Table 3

Summary of documentary findings from manual coding (source: author's coding of references [1–4, 14–24])

Analytical area	Strength of documentary evidence	Main finding	Interpretive implication
Strategic alignment	Strong	Digital governance is embedded in accession and PAR documents.	Implementation capacity, not legal alignment alone, becomes the key assessment criterion.
Service availability	Strong	Service counts, platform functions and usage statistics are documented.	These indicators do not directly measure completion quality or institutional trust.
Service quality	Moderate	Some evidence on time, access and user satisfaction exists in project documents.	Comparable public reporting by service and user segment remains under-developed.

Continuation Table 3

Assisted access	Moderate to strong	CUPS and staff training show that assisted delivery is part of the architecture.	Assisted access should be treated as core digital infrastructure, not an exception.
Accountability feedback	Weak to moderate	Complaint, feedback and dashboard logic appear less systematically than service availability.	Trust-sensitive monitoring requires completion, complaint and resolution indicators.
Cyber-resilience	Moderate	Election and digital-resilience sources show that cyber risk is politically salient.	Cybersecurity must be integrated into service-quality and trust measurement.
Inclusion	Moderate	Inclusion is recognised, but marginal-user categories are unevenly operationalised.	Rural, disabled, older, diaspora and territorially constrained users require separate indicators.

The documentary evidence suggests that Moldova's digital ecosystem contains significant reusable platforms, including MPass, MConnect and related interoperability services [4, 15, 22]. The same evidence also indicates a monitoring requirement: as service delivery becomes more dependent on integrated digital infrastructure, operational security, redundancy, auditability and public communication become part of the service-quality mechanism. Table 3 summarises the coded documentary findings by analytical area.

4. Discussion

The results support a conceptual, not empirical, claim. Moldova's documentary architecture makes it plausible that digital governance can contribute to institutional trust, but only through intermediate mechanisms: service completion, procedural predictability, assisted access, accountability feedback and resilient infrastructure. The available documents do not demonstrate that trust has already increased. They show that the conditions for trust-sensitive digital governance are present but unevenly measured. The discussion therefore interprets the coded findings and derives a model; it does not convert documentary evidence into direct claims about citizen attitudes.

The proposed trust-through-service-quality model therefore treats digital infrastructure as an input, not an outcome. The model has five stages. Digital platforms, legal alignment and interoperability standards create technical and regulatory conditions. Service mechanisms then translate these inputs into user-facing experience through simplification, visibility, interoperability, assisted access and feedback. Institutional mechanisms determine whether these improvements are sustained inside agencies through coordination, staffing, back-office integration and cyber-resilience. Trust outcomes depend on predictability, fairness, accessibility and responsiveness. Accession outcomes depend on whether implementation capacity is credible beyond formal transposition. Table 4 presents this conceptual synthesis.

This model differs from a service-count approach. The number of online services is a useful input indicator, but it cannot establish whether citizens experience the state as more reliable. A more trust-sensitive measurement frame would report completion rate, processing time, complaint resolution time, assisted-access use, interoperability failures, service-specific satisfaction, cybersecurity incidents affecting service continuity and segmentation by vulnerable user categories. These indicators would make accession monitoring more sensitive

to administrative experience without requiring the Commission or the Moldovan government to abandon existing legal-alignment measures.

Table 4

Trust-through-service-quality model for Moldova (source: author's conceptual synthesis based on results and references [5–13])

Stage	Core element	Expected effect	Indicative empirical measure
Input	Platforms, legal alignment, interoperability standards, accession commitments, cyber baseline	Creates technical and regulatory conditions for reform	Re-engineered procedures; platform uptime; interoperability compliance; cyber baseline coverage
Service mechanism	Simplification, visibility, interoperability, assisted access, feedback	Converts infrastructure into citizen-facing administrative experience	Completion rate; processing time; assisted-access uptake; complaint resolution time
Institutional mechanism	Coordination, staffing, back-office integration, performance use, cyber-resilience	Converts tools into durable administrative capacity	Cross-agency data exchange; staff training coverage; service-level agreement compliance; incident response time
Trust outcome	Predictability, fairness, accessibility, responsiveness	Creates conditions for public confidence in administrative performance	Service-specific confidence; satisfaction by user segment; perceived fairness; repeat-use intention
Accession outcome	Implementation capacity across accession-relevant PAR and digital commitments	Supports accession credibility beyond formal transposition	Commission reporting; SIGMA indicators; chapter milestones; reform-agenda completion

The policy implications are recommendations derived from documentary analysis, not empirical findings. They concern service-quality indicators in Cluster 1 reporting, process redesign before online deployment, CUPS as digital infrastructure, cyber-resilience for identity, payment and registry systems, and dashboards that distinguish availability, completion and satisfaction. Table 5 presents the rationale for each recommendation.

Table 5

Policy-use implications for accession monitoring and future research (source: author's policy synthesis based on results and references [1–24])

Area	Recommended use	Rationale
Accession monitoring	Embed service-quality indicators in Cluster 1 public administration reporting.	This would show implementation capacity rather than only legal transposition.
Service design	Apply a 'no portal before process' rule for high-volume services.	Digitising unreformed procedures transfers administrative friction into the interface.
Inclusion	Treat CUPS and other assisted-access routes as permanent digital infrastructure.	Digital inclusion depends on mediated access for users who cannot complete services independently online.
Trust measurement	Publish service-level dashboards for completion, complaints and satisfaction by segment.	Trust-relevant performance must be observable by service, not only aggregated at platform level.
Cyber-resilience	Classify identity, payment and registry systems as infrastructure directly relevant to institutional confidence.	A cyber incident affecting core public services is also a legitimacy risk.
Future evidence	Combine administrative data, surveys and intercept interviews in a mixed-method evaluation.	The conceptual model requires empirical testing against citizen experience.

The article distinguishes between two unsupported interpretations. One interpretation would treat growth in portals and platform use as sufficient evidence of reform. That interpretation is not supported because service availability is not equivalent to service quality. A second interpretation would treat Moldova's capacity constraints as evidence that digital reform cannot produce meaningful gains. That interpretation is also insufficient because the corpus records platform development, service redesign and assisted-access infrastructure. The more defensible interpretation is conditional: Moldova has made documented digital-governance progress, but the trust value of that progress depends on more precise service-quality measurement and stronger integration of cyber-resilience and inclusion.

The main limitation is the single-coder qualitative design. The coding procedure is transparent and reproducible, but it does not provide inter-coder reliability statistics. The second limitation is evidentiary: the study uses public documents, official statistics and multilateral reports, not primary citizen-experience data. It therefore cannot independently validate institutional claims or measure changes in public trust. The third limitation is temporal: Moldova's accession process and digital infrastructure are evolving rapidly, and some 2025-2026 evidence may be revised or superseded. Future research should test the model using mixed methods: administrative service-level data, a citizen survey stratified by region and user segment, and intercept interviews at service centres and consular access points. The model would be weakened if service availability increased without corresponding improvements in completion, satisfaction, complaint resolution or confidence among marginal users.

5. Conclusions

This article advances a limited and defensible claim. It does not show that digital services have already increased institutional trust in Moldova. It shows that Moldova's accession-related documentary architecture contains a plausible trust pathway, but that the pathway depends on service quality, assisted access, accountable feedback and cyber-resilience.

The main finding is a measurement gap. Moldova's progress is more visible in service availability, platform development and interoperability infrastructure than in public indicators of completion, complaint resolution, marginal-user experience and service-specific confidence. This gap matters because accession readiness is not only a matter of formal alignment; it is also a question of whether the state can implement reforms in ways that citizens experience as predictable, accessible and fair.

The article's contribution is the trust-through-service-quality model. The model gives future research a falsifiable structure: if service quality and cyber-resilience improve without any corresponding improvement in citizen confidence, the proposed pathway is weak; if service availability grows while user completion and satisfaction remain uneven, claims about digital transformation are insufficiently supported. For Moldova and for other small candidate states, the implication is precise: digital governance should be assessed not by the number of services placed online, but by the quality, security and inclusiveness of the administrative experience it produces.

Research Data Availability Statement: No new datasets were generated. The study is based on publicly available policy documents, official communications, multilateral reports, election-observation materials and scholarly literature listed in the references. The coding

spreadsheet records source identifiers, document type, coding category, coded excerpt or analytical paraphrase, interpretation and relevance to the research question. It can be made available by the author on reasonable request, subject to the requirements of the journal's peer-review procedure.

Ethics Statement: The study did not involve human participants, interviews, surveys, experiments, personal data or administrative microdata. Ethical approval was not required.

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STRATEGIC DIRECTIONS FOR THE DEVELOPMENT OF CHISINAU MUNICIPALITY PUBLIC TRANSPORT SYSTEM

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Abstract. The assessment of the current state of the public transport system in Chisinau highlights the existence of an extensive urban and suburban transport network as well as the significant increase in the volume of passengers transported during the analyzed period. The analysis of statistical data demonstrates the consolidation of the role of electric transport in urban mobility and the partial modernization of the fleet by introducing new trolleybuses and buses. At the same time, multiple deficiencies related to the overlapping of routes, traffic congestion, the state of road infrastructure, reduced accessibility for people with reduced mobility and the insufficient level of digitalization and operational coordination were identified. The study of the activity of the public transport system in Chisinau aimed at applying SWOT analysis and examining modern public transport development strategies in order to substantiate efficient, sustainable strategic directions adapted to the needs of the municipality.

Keywords: *SWOT analysis, population mobility, infrastructure, public authorities, public transport, costs, efficiency.*

Rezumat. Evaluarea stării actuale a sistemului de transport public din municipiul Chișinău evidențiază existența unei rețele extinse de transport urban și suburban, precum și creșterea semnificativă a volumului de pasageri transportați în perioada analizată. Analiza datelor statistice demonstrează consolidarea rolului transportului electric în mobilitatea urbană și modernizarea parțială a parcului rulant prin introducerea troleibuzelor și autobuzelor noi. Totodată, au fost identificate multiple deficiențe legate de suprapunerea rutelor, congestionarea traficului, starea infrastructurii rutiere, accesibilitatea redusă pentru persoanele cu mobilitate redusă și nivelul insuficient de digitalizare și coordonare operațională. Studiul activității sistemului de transport public din Chișinău a avut ca scop examinarea strategiilor moderne de dezvoltare a transportului public prin aplicarea analizei SWOT în vederea fundamentării unor direcții strategice eficiente, durabile și adaptate nevoilor municipiului.

Cuvinte cheie: *analiza SWOT, mobilitatea populației, infrastructura, autoritățile publice, mijloace de transport public, costuri, eficientă.*

1. Introduction

In the context of the accelerated development of the urban environment and the continuous increase in population mobility, the urban public transport system represents one of the fundamental elements of the municipal infrastructure, playing a decisive role in the efficient functioning of the city. The level of development of public transport directly influences population mobility, territorial accessibility, economic development, environmental quality and the degree of comfort of residents [1-6].

Chisinau is characterized by a permanent increase in passenger flows, the expansion of suburban residential areas and the increase in road traffic intensity, which generates significant pressures on the existing public transport system [7, 8]. Under these conditions, the efficiency of urban public transport depends on the level of organization of the route network, the structure and technical condition of the fleet, the degree of coordination between transport operators, as well as the capacity of the urban infrastructure to ensure the smooth flow of traffic.

The analysis of the urban public transport system requires a complex approach, based on the evaluation of the technical, economic, organizational and operational factors that influence its activity. In this context, the SWOT analysis represents an effective analytical tool for identifying the strengths and existing deficiencies of the system, as well as for determining the development opportunities and external risk factors that may influence its functioning [9].

Applying SWOT analysis allows for an objective assessment of the current state of the public transport system in Chisinau, identification of efficiency reserves and substantiation of strategic directions aimed at modernizing the infrastructure, optimizing the transport network, increasing the quality of services and developing a sustainable and competitive urban mobility system.

2. Theoretical foundations analysis regarding the organization and development of modern urban public transport systems

The modern concept of organizing urban public transport involves reducing dependence on individual cars and orienting the population towards the use of collective transport, pedestrian travel and alternative transport (bicycles, electric scooters, etc.). This objective is achieved by developing integrated transport systems, based on the coordination of different modes of transport: buses, trolleybuses, trams, LRT (Light Rail Transit), metro, suburban trains and intermodal transport.

An important principle of modern European systems is the organization of the transport network based on intermodal nodes. These allow for quick and convenient transfer between different types of transport, reducing the total travel time and increasing the attractiveness of public transport. At the same time, special attention is paid to the priority of public transport in traffic through: dedicated lanes; intelligent traffic lights; limiting car access to central areas; expanding pedestrian areas; developing infrastructure for electric transport.

Another important theoretical foundation is the concept of "accessibility-oriented mobility", according to which the efficiency of the transport system is evaluated not only by the speed of travel, but also by the population's ability to quickly and comfortably reach the main points of urban interest: workplaces, educational institutions, shopping centers and residential areas [8, 10-12].

Modern European systems widely use intelligent ITS (Intelligent Transport Systems) technologies, which include: GPS monitoring of public transport; real-time passenger information; electronic toll systems; automated traffic management; optimization of traffic schedules based on real passenger flows.

Also, the development of European urban transport is closely linked to the objectives of reducing pollutant emissions and energy consumption. For this reason, many European cities are implementing electric transport, hybrid or hydrogen buses and limiting the circulation of vehicles with conventional engines in central areas.

3. Evaluation of the current state of the public transport system in Chisinau municipality from the perspective of infrastructure, accessibility and efficiency of services

The public transport system in Chisinau has an extensive urban and suburban transport network, which ensures the accessibility of most residential areas both in the city and in suburban localities.

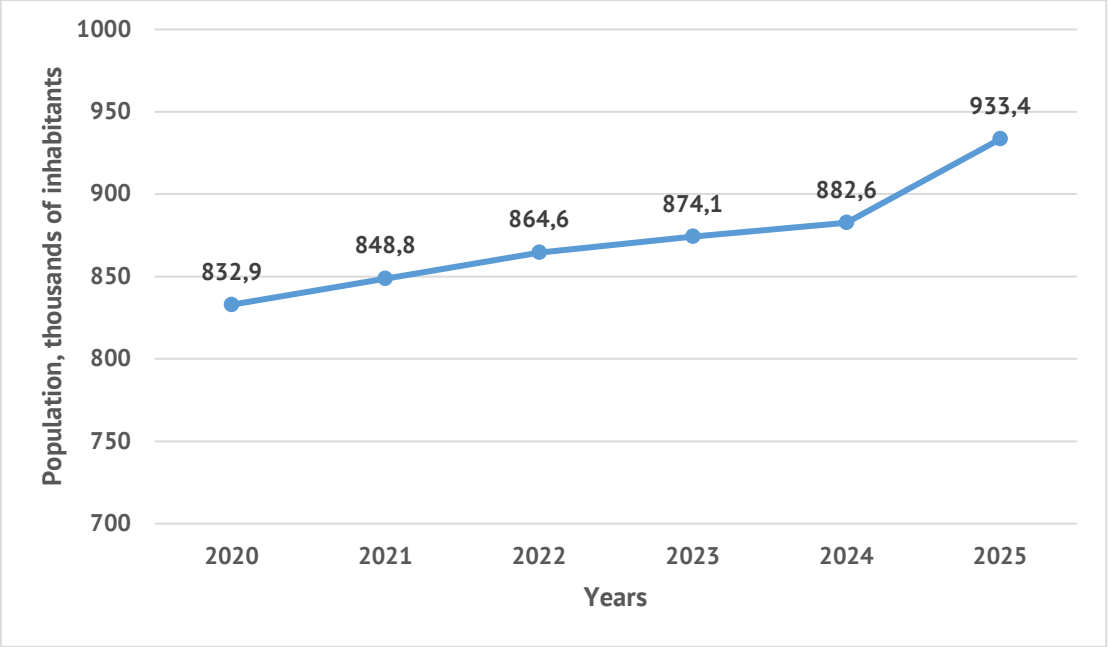

Figure 1. Dynamics of individuals with a place of residence in the municipality of Chisinau, thousand people.

Data on the evolution of the population of Chisinau municipality in the period 2020–2025 highlight a constant trend of increasing the number of inhabitants [13-15]. The number of individuals with a place to live in the municipality increased from 832.9 thousand inhabitants in 2020 to 933.4 thousand inhabitants in 2025, which represents an increase of approximately 100.5 thousand inhabitants or about 12.1 % (Fig. 1).

The analysis of the data in Figure 2 highlights a significant development of the public transport system in Chisinau municipality during the period 2020–2025, both by increasing the volume of transported passengers and by expanding the route network.

The total volume of passengers transported annually increased from 132.4 million passengers in 2020 to 276.0 million passengers in 2025, which represents an increase of more than 2 times. This dynamic indicates the growth of demand for public transport and increased population mobility.

Electric transport continues to represent the basis of the urban transport system. The number of passengers transported by trolleybuses increased from 103.3 million to 199.8 million passengers (+93.4 %), while maintaining the number of routes almost constant (30–32 routes) [15, 16]. This fact demonstrates the increase in the efficiency of electric transport exploitation by modernizing the fleet and increasing transport capacity. At the same time, an accelerated development of bus and minibus transport is observed. The number of bus routes has increased from 23 to 35 routes, mainly due to the expansion of suburban transport. The volume of passengers transported by buses and minibuses has increased from 29.1 million to 76.3 million passengers, which confirms the increasing role of suburban transport [16].

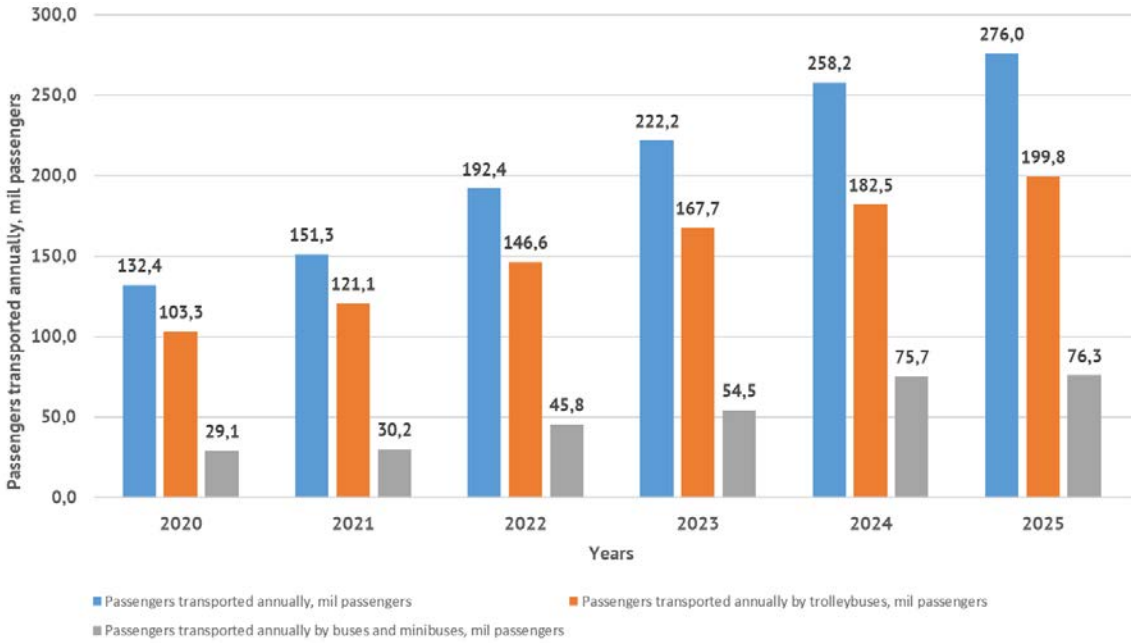

Figure 2. Dynamics of passengers transported by the public transport system in Chisinau [12], [13].

An important advantage of the public transport system is the high degree of use of electric transport. In 2025, 467 trolleybuses were in operation, which constitutes approximately 68.5 % of the total public transport managed by municipal operators (Table 1).

Table 1

Summary and by age structure of the municipal fleet at the end of 2025

Type of means of transport	Number of vehicles, un.	Distribution of vehicles by years of operation			
		up to 5 years	between 5-10 years	between 10-15 years	over 16 years
Trolleybuses	467	175	105	129	58
Buses	215	131	7	77	0
TOTAL	682	306	112	206	58

The analysis of the structure of the bus fleet used in public transport in Chisinau highlights the fact that most units are equipped with diesel engines, corresponding to the Euro 5 and Euro 6 pollution standards [16]. However, the predominant use of diesel buses generates emissions of pollutants, including nitrogen oxides (NOx), fine particles and carbon dioxide (CO_2), which negatively influence the quality of urban air and the level of noise

pollution. Compared to other environmentally friendly public transport means, especially trolleybuses and electric buses, diesel buses have a higher level of environmental pollution [17].

4. Carrying out the SWOT analysis of the urban public transport system.

The analysis of the public transport system in Chisinau highlights the existence of important advantages related to the infrastructure and recent development of the fleet, but also of structural problems that influence the efficiency and quality of transport services.

Strengths

The public transport system in Chisinau has an extensive urban and suburban transport network, which allows ensuring accessibility for most inhabited areas. An important advantage is the high share of electric transport, represented by the trolleybus network, which contributes to reducing environmental pollution.

In recent years, the fleet has been partially modernized through the acquisition of new trolleybuses and buses, which has contributed to increasing transport capacity, comfort and safety of passengers. Also, the infrastructure of public transport stations is relatively well developed and located both in the city and in the suburban area.

Weaknesses

The analysis of the public transport system in Chisinau highlights the existence of a number of structural and functional deficiencies that negatively influence the efficiency and quality of services provided.

The provision of municipal enterprises predominantly with large and very large class means of transport leads to the inefficient use of the fleet on certain routes with low passenger flow, which determines the increase in operating costs, energy consumption and the level of environmental pollution.

The operation of trolleybuses on routes that include narrow-profile road sections reduces their speed and maneuverability, contributing to the formation of congestion and reducing the efficiency of urban traffic.

The high degree of overlap of public transport routes generates inefficient competition between operators, leads to uneven distribution of passenger flows and reduces the overall effectiveness of the public transport system.

The existing infrastructure and means of transport do not fully ensure the necessary conditions for access for people with disabilities and reduced mobility, which limits the accessibility and inclusiveness of public transport services.

The concentration of a large number of public transport vehicles on the central highways of the municipality contributes to overloading the road infrastructure and reducing the commercial speed of public transport.

The lack of a single monitoring and coordination center for all public transport operators limits the possibility of efficient management of traffic and operational processes in real time, based on modern automated monitoring and control systems.

The significant share of road sectors in an inadequate technical condition or in the process of rehabilitation negatively influences the operating conditions of transport means, determining the reduction of commercial speed and increasing maintenance costs.

The insufficient level of passenger information, both in public transport stations and through mobile applications, reduces information accessibility and the comfort of users of the public transport system.

Opportunities

Organizing electric trolleybus routes exclusively on arterial roads with high passenger flow will allow for more efficient use of their capacity, increase commercial speed and reduce urban traffic congestion.

The admission to servicing public transport routes of minibuses and buses, only of operators who have means of transport adapted to the actual passenger flow will ensure the rational use of the rolling stock, optimize operating costs and improve the quality of services offered to passengers.

The gradual transition to environmentally friendly public transport, through the use of hybrid or electric buses, will contribute to reducing polluting emissions, reducing urban noise levels and improving environmental quality in the municipality of Chisinau.

The creation and development of an "express" public transport network between the main sectors of the city will contribute to reducing travel time, increasing population mobility and decongesting the urban road network, especially during peak hours.

Risks

Modernization of infrastructure and renewal of the fleet require considerable financial investments.

The increase in operating costs, energy and spare parts prices may lead to an increase in transport tariffs.

There is also a risk of reducing the interest of private operators in providing public transport services in conditions where the profitability of the activity decreases or the investment recovery period becomes too long.

The instability and frequent changes in the regulatory framework in the field of public transport generate legal uncertainty and difficulties in planning, organizing and providing transport services efficiently.

Based on the presented SWOT analysis, the development of the public transport system in Chisinau should be oriented towards modernization, operational efficiency, increasing accessibility and reducing environmental impact. The proposed strategic directions aim to capitalize on existing strengths and opportunities, as well as to reduce the effects generated by the identified weaknesses and risks. Based on the above, we will present the strategic directions for the development of the public transport system in Chisinau (tab. 2).

Table 2

Development strategies for the public transport system in Chisinau municipality

Objective No. 1 - Optimization and reorganization of the public transport network		
Strategic direction	***Effect***	***Activities***
Creating an efficient, balanced public transport system adapted to real passenger flows.	• Review and restructuring of public transport routes to reduce overlaps between trolleybuses, buses and minibuses; • Introduction of the principle of hierarchical transport: trolleybuses and large buses on main roads; medium/small capacity buses on secondary and suburban routes; • Development of express transport routes between the main sectors of	• reducing travel time; • reducing traffic congestion; • increasing commercial speed; • efficient use of the fleet.

Continuation Table 2

	the municipality: Buiucani – Centru – Botanica; Rîșcani – Centru – Ciocana; • Creation of dedicated lanes for public transport on high-traffic arteries; • Implementation of the public transport prioritization system at traffic lights.	
Objective No. 2 - Modernization and diversification of the fleet		
Ensuring a modern, energy-efficient transport fleet adapted to the real needs of the population.	• Gradual acquisition of: electric buses; hybrid buses; autonomous trolleybuses; • Replacing outdated vehicles with low-energy transport means; • Introducing medium-sized buses on routes with low passenger flow; • Equipping all transport units with: GPS systems; video cameras; air conditioning; electronic toll systems; • Developing infrastructure for charging electric buses.	• reducing energy consumption; • reducing pollution; • increasing passenger comfort and safety; • reducing long-term operating costs.
Objective No. 3 - Digitalization and intelligent management of public transport		
Implementation of an integrated system for monitoring and intelligent management of public transport.	• Creation of a single municipal center for monitoring and coordinating all operators; • Implementation of an intelligent traffic management system; • Development of a unified mobile application for: route planning; real-time arrival time display; electronic payment; • Installation of electronic information panels at stations; • Collection and analysis of data on passenger flows for route optimization.	• efficient real-time traffic management; • increasing information accessibility; • improving passenger experience; • reducing delays.
Objective No. 4 - Increasing accessibility and social inclusion		
Ensuring equal access to public transport services for all categories of the population.	• Adaptation of stations and vehicles for people with disabilities: ramps; low floor; audio and visual information systems; • Modernization of sidewalks and access routes to stations; • Implementation of universal accessibility standards in new infrastructure; • Training of staff on assistance to people with reduced mobility.	• increasing social inclusion; • increasing accessibility of public transport; • improving urban mobility.

Continuation Table 2

Objective No. 5 - Modernization of road infrastructure and stations		
Improving traffic and public transport operating conditions.	• Rehabilitation of roads in poor technical condition; • Modernization of intersections with heavy traffic; • Arrangement of modern stations with: lighting; information panels; video surveillance systems; protected spaces for passengers; • Construction of intermodal terminals to connect urban and suburban routes; • Development of infrastructure for alternative transport: bicycle paths; Park&Ride parking lots.	• increasing safety and comfort; • reducing wear and tear on means of transport; • streamlining urban traffic.
Objective No. 6 - Strengthening financial and institutional sustainability		
Creating a financially stable and administratively efficient public transport system.	• Attracting external funds: European programs; international partnerships; credits for green infrastructure; • Developing public-private partnerships; • Introducing performance contracts for transport operators; • Developing a transparent compensation and subsidy mechanism; Implementing sustainable urban mobility policies.	• increasing economic efficiency; • attracting investment; • ensuring the continuity of the modernization process.

Conclusion

The analysis of the evolution of the public transport system in Chisinau highlights the existence of a continuous process of development and modernization, determined by the increasing demand for urban mobility and the need to adapt the infrastructure to the dynamics of passenger flows. At the same time, the intensification of urban traffic and the increase in the volume of transport require the implementation of integrated measures regarding the development of road infrastructure, the optimization of the transport network and the digitalization of traffic management, in order to increase operational efficiency and reduce travel times. In this context, the modernization of the vehicle fleet and the transition to ecological public transport are essential factors for increasing the sustainability of the urban transport system, reducing the impact on the environment and improving the quality of services provided to the population [18-20].

The strategic development of the public transport system in Chisinau must be oriented towards the creation of a modern, integrated, ecological and accessible system. The implementation of the proposed measures will contribute to improving urban mobility, reducing congestion and pollution, increasing the quality of services and increasing the attractiveness of public transport for the population. The success of these directions depends

on effective cooperation between public authorities, transport operators and financial partners.

Conflicts of interest: The author declares no conflict of interest.

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HARMONISATION OF ROAD FREIGHT TRANSPORT ENTREPRENEURSHIP REGULATION THROUGH THE EU-MOLDOVA AGREEMENT

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Abstract. This study analyses the harmonisation of the regulatory framework for road freight transport entrepreneurship in the Republic of Moldova, in the light of the bilateral Agreement with the European Union on international road freight transport. The rationale lies in the need to assess legislative progress and persistent gaps in the context of Moldova's EU accession candidacy. The study identifies discrepancies between national legislation and the EU acquis, examining market access conditions, authorization requirements, social rules, and safety standards, alongside official statistical data for the period 2020–2025. The methodology combines legal-comparative analysis, examination of primary and secondary legislation, institutional document analysis, and interpretation of data from the National Bureau of Statistics. The comparative analysis of Articles 16–21 of the Road Transport Code No. 150/2014 (as amended by Law No. 423/2023) against Regulation (EC) No. 1071/2009 reveals full compliance on financial standing and transport manager (from 01.01.2026), while divergences persist regarding mutual recognition of professional competence certificates and the absence of MSI grading. Transport Community reports confirm that over 65% of the EU transport acquis remains untransposed. NBS data highlight the dominance of road transport and the significance of international traffic. The conclusions emphasize that completing legislative harmonization and strengthening institutional capacity are essential for integrating Moldovan operators into the EU single market..

Keywords: *bilateral agreement, Community acquis, entrepreneurship, legislative harmonization, market liberalization, road freight transport, transport authorization.*

Rezumat. Articolul analizează armonizarea cadrului de reglementare pentru antreprenoriatul în transportul rutier de mărfuri în Republica Moldova, în lumina Acordului bilateral cu Uniunea Europeană privind transportul rutier internațional de mărfuri. Raționea constă în necesitatea de a evalua progresul legislativ și lacunele persistente în contextul candidaturii Republicii Moldova la UE. Studiul identifică discrepanțele dintre legislația națională și acquis-ul UE, examinând condițiile de acces pe piață, cerințele de autorizare, regulile sociale și standardele de siguranță, alături de datele statistice oficiale pentru perioada 2020–2025. Metodologia combină analiza juridico-comparativă, examinarea legislației primare și secundare, analiza documentelor instituționale și interpretarea datelor de la Biroul Național

de Statistică. Analiza comparativă a articolelor 16–21 din Codul transporturilor rutiere nr. 150/2014 (modificat prin Legea nr. 423/2023) în raport cu Regulamentul (CE) nr. 1071/2009 relevă respectarea deplină a situației financiare și a managerului de transport (din 01.01.2026), în timp ce persistă divergențe în ceea ce privește recunoașterea reciprocă a certificatelor de competență profesională și absența clasificării MSI. Rapoartele Comunității Transporturilor confirmă că peste 65% din acquis-ul UE în domeniul transporturilor rămâne netranspus. Datele NBS evidențiază dominația transportului rutier și importanța traficului internațional. Concluziile subliniază faptul că finalizarea armonizării legislative și consolidarea capacității instituționale sunt esențiale pentru integrarea operatorilor moldoveni în piața unică a UE.

Cuvinte cheie: *acord bilateral, acquis comunitar, antreprenoriat, armonizare legislativă, liberalizarea pieței, transport rutier de mărfuri, autorizare de transport.*

1. Introduction

The road freight transport sector constitutes a foundational element of the Republic of Moldova's economy, contributing significantly to trade flows with external partners and to integration into regional value chains.

Official statistical data reveal the central role of road transport in the national freight transport system, with a dominant share of 87.0% of total freight transported. Nevertheless, 2025 was marked by slightly regressive trends: road transport recorded a 0.2% decrease in freight volume and a more pronounced 3.2% decline in freight turnover compared with 2024 [1, 2]. This trajectory may reflect both conjunctural changes in transport demand and structural adjustments driven by economic dynamics, operational costs, or logistical and regulatory constraints. Despite these decreases, road transport enterprises continued to handle a significant volume of freight, carrying a total of 17.6 million tons. The breakdown of this volume reveals a predominantly domestic orientation: 12.7 million tons (72.2%) were carried in domestic traffic, confirming road transport's role as the primary vector for the internal distribution of goods. At the same time, international traffic accounted for 4.9 million tons (27.8%), indicating a relevant participation of Moldovan operators in cross-border trade flows despite the competitive environment and increasingly stringent compliance requirements. The territorial distribution of road freight transport underscores its essential character for domestic market functioning. The Municipality of Chișinău accounts for 54.5% of the total goods transported by road, reflecting its position as the country’s main economic, logistical, and consumption hub. Development regions contribute differentially: 16.0% in the North region, 20.1% in the Centre, 4.6% in the South, and 4.8% in the Gagauzia Autonomous Territorial Unit, outlining a spatial structure in which the density of economic activities and infrastructure directly influence freight transport intensity [1].

Taken together, these data confirm that road transport remains the overwhelmingly dominant mode of freight movement in the Republic of Moldova, both in terms of volume and territorial coverage. Its dominance underlines the need to consolidate an effective regulatory framework, modernize infrastructure, and enhance the competitiveness of operators in order to support economic development and ensure interoperability with European transport systems.

Against the backdrop of obtaining EU candidate country status in June 2022, aligning the regulatory framework for transport entrepreneurship with European standards has acquired major strategic importance, constituting an essential precondition for the gradual

access of Moldovan operators to the EU market. The Republic of Moldova maintains close trade relations with EU Member States, which absorb a considerable share of its exports. Road transport is the dominant mode for goods movement in this relationship, amplifying the importance of a predictable, coherent regulatory framework compatible with European market access rules. The bilateral Agreement on international road freight transport, concluded between the Republic of Moldova and the European Union, represents the central legal instrument governing the conditions for reciprocal access of vehicles on the territories of the two Parties, and simultaneously establishes the framework for the progressive elimination of administrative restrictions [3].

Academic literature analyzing the diffusion of institutional and contractual models promoted at European and international level consistently highlights a disjunction between the formal adoption of such normative frameworks and their effective implementation in practice, including in domains such as public-private partnerships [4]. Comparative studies attribute this dissonance to insufficient administrative capacities of regulatory authorities, informal resistance by economic actors to compliance costs [5], and inconsistencies generated by fragmented transposition of European norms into domestic legal orders [6].

This research examines the extent to which the Moldovan normative framework governing road freight transport entrepreneurship has been aligned with EU acquis requirements and with the provisions of the bilateral EU-Moldova Agreement. The analysis integrates official statistical data from the National Bureau of Statistics of the Republic of Moldova (NBS) for the period 2020–2025, providing a quantitative picture of sector evolution and empirical grounding for the proposed normative reforms.

The specific objectives are: analysis of the content and implications of the bilateral EU-Moldova Agreement; detailed examination of the conditions for access to the profession of road transport operator under Articles 16–21 of the Road Transport Code (RTC) in comparison with Regulation (EC) No. 1071/2009; statistical analysis of sector developments based on NBS data for 2020–2025; identification of administrative and regulatory barriers; and formulation of proposals for consolidating the regulatory framework.

2. Materials and Methods

This research employs a mixed methodology combining legal-comparative analysis with descriptive statistical analysis and the comparative method. The approach is both qualitative and quantitative, seeking to understand the mechanisms of legislative harmonization while also quantifying trends in the road freight transport sector over the period 2020–2025.

The legal-comparative analysis involved a systematic examination of normative acts in both the Moldovan and European legal orders, with emphasis on identifying similarities, differences, and normative gaps relative to the reference acquis. Primary sources include: the Road Transport Code of the Republic of Moldova No. 150/2014; Government Decision No. 773/2016; European Regulations No. 1071/2009, No. 1072/2009, No. 561/2006, and No. 165/2014; EU Directives; the EU-Moldova Association Agreement; and other relevant programmatic documents.

The statistical component of the research draws on data from NBS press releases on freight and passenger transport for the period 2020–2025, accessed from the statistical database (statistica.gov.md). The indicators used include: freight volumes transported by mode (million tons); freight turnover (million tonne - kilometres); the share of road transport in total freight carried; and the breakdown by domestic/international road freight traffic.

The documentary analysis encompassed the bilateral EU-Moldova Agreement on road freight transport, the EU-Moldova Association Agreement, European Commission progress reports, and Transport Community documents.

The comparative method was employed to juxtapose the provisions of the Moldovan normative framework with the EU acquis requirements along three dimensions: access to the profession, conditions for access to the international market, and social and safety standards.

The methodological limitations reside in the limited availability of disaggregated data on international road freight transport carried exclusively by Moldovan operators, and in the accelerated pace of the legislative process. Nevertheless, the normative framework and statistical data analyzed reflect the state of the sector at the time of elaboration of this study.

3. Results

3.1. Statistical Analysis of Road Freight Transport in the Republic of Moldova (2020–2025)

Statistical data published by the National Bureau of Statistics of the Republic of Moldova confirm the clear dominance of road transport in the national freight structure throughout the entire period 2020–2025. The share of road transport varied between 79.3% (the minimum recorded in 2023) and 93.5% (the maximum in 2021), a range that also reflects structural changes in the NBS data collection methodology [1, 2].

Table 1

Volume of freight transported in the Republic of Moldova, by mode of transport, 2020–2025 (million tons)

Mode of transport	2020	2021	2022	2023	2024	2025
Road (total)	42.2	39.1	16.9†	15.7†	17.3†	17.6†
– domestic traffic	n/a	n/a	12.4	11.0	12.5	12.7
– international traffic	n/a	n/a	4.5	4.7	4.8	4.9
Rail	3.2	2.6	3.5	3.9	2.8	2.5
Inland waterway + Air	0.1	0.1	0.5	0.2	0.1	0.1
Total (million tons)	45.5	41.8	20.9†	19.8†	20.2†	20.2†
Road share (%)	93.1	93.5	80.9	79.3	85.6	87.0

Source: NBS, Annual press releases on freight and passenger transport, 2020–2025. Note: † Data from the survey of specialized for-hire transport enterprises (excluding own-account carriers with fewer than 10 vehicles) — methodology applied from 2022. 2025 data are preliminary (NBS, press release of February 2026). n/a = data not available at disaggregated level for 2020–2021.

Table 1 highlights a significant structural change in NBS methodology from 2022 onwards, when the statistical survey covered only specialized for-hire transport enterprises, which explains the apparent discontinuity in the time series. Direct comparability between 2020–2021 data and the 2022–2025 series is therefore limited. Despite this limitation, the general trend confirms the dominance of road transport throughout the period. The 2022–2023 contraction (–5.1% in 2023 compared with 2022) reflects the economic slowdown and disruptions generated by the regional geopolitical context (the conflict in Ukraine), followed by a visible recovery in 2024 (+2.0% compared with 2023) and stabilization in 2025 [1, 2].

The increase in road transport's share from 79.3% in 2023 to 85.6% in 2024 and 87.0% in 2025 reflects, on the one hand, the consolidation of the private road transport sector and the expansion of Moldovan operators on international routes and, on the other hand, the significant decline in rail transport (−32.9% in January–September 2024 compared with the same period of 2023), affected by disruptions to regional infrastructure.

Table 2

Freight turnover achieved by transport enterprises in the Republic of Moldova, 2020–2025 (million tonne-kilometres)

Mode of transport	2020	2021	2022	2023	2024*	2025
Road	5,724	5,316	5,007	5,190	5,324	5,041
Rail	427	374	940	531	520	625
Inland waterway + Air	7	7	125	119	122	128
Total (million t-km)	6,151	5,535	6,072	5,840	5,966	5,794
Road share (%)	93.1	96.0	82.5	88.9	89.3	87.0

*Source: NBS, Annual press releases on freight transport, 2020–2025. Note: * 2024 data are estimated on the basis of available quarterly press releases (Jan–Sep 2024: 4,286.4 million t-km). 2025 data are preliminary (NBS, press release of February 2026; total turnover 2025: 5,794.2 million t-km, a decrease of 2.9% compared with 2024).*

Freight turnover (tonne-kilometres) reflects average transport distances and traffic intensity. Table 2 indicates a downward trend in total turnover over 2020–2023, partly explained by the reorientation of post-pandemic trade flows and by disruptions caused by the war in Ukraine, which affected traditional east-west transit routes. The stagnation in 2024–2025 (turnover 2025: 5,794.2 million t-km, −2.9% compared with 2024) suggests that the sector still lacks the incentives needed for a significant expansion of international activity, underlining the importance of normative reforms regarding access to the European market [1, 2].

Figure 1 illustrates that road transport maintained a dominant share throughout the entire 2020–2025 period.

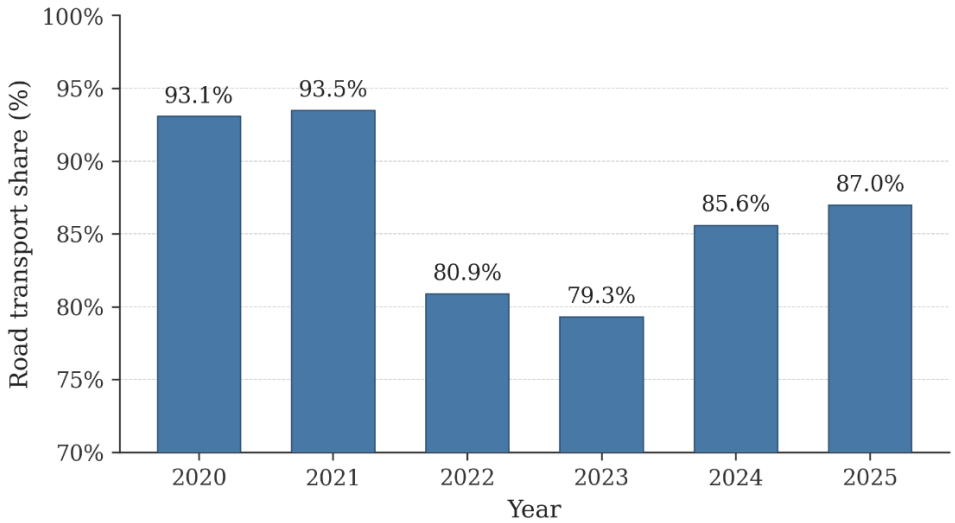

Figure 1. Evolution of road transport's share in total freight transported (%), 2020–2025.

Source: NBS, Annual press releases on freight transport, 2020–2025. 2025 data are preliminary. Note: NBS methodological discontinuity in 2022 (only enterprises with ⩾10 vehicles included).

The visible decrease in 2022–2023 (from 93.5% in 2021 to 79.3–80.9% in 2022–2023) is partly explained by the NBS reporting methodology change, which produced a statistical discontinuity, and partly by the relative recovery of rail transport in 2022–2023. The upward trend in 2024 (85.6%) and 2025 (87.0%) confirms that private road transport has regained and consolidated its market share [1, 2].

Table 3

Structure of road freight transport by type of traffic, 2022–2025 (million tons and %)

Indicator	2022	%	2023	%	2024	%	2025	%
Total road freight (million t)	16.9	100%	15.7	100%	17.3	100%	17.6	100%
Domestic traffic	12.4	73.2%	11.0	70.4%	12.5	72.3%	12.7	72.2%
International traffic	4.5	26.8%	4.7	29.6%	4.8	27.7%	4.9	27.8%

Source: NBS, Press releases on freight transport, 2022–2025. Note: 2024 and 2025 data are estimated/preliminary based on available NBS press releases. International traffic values for 2024–2025 are calculated proportionally from available quarterly structure data.

Table 3 reveals that international traffic consistently accounted for 27–30% of total road freight volume carried by Moldovan operators in the period 2022–2025. The increase in the international traffic share from 26.8% in 2022 to 29.6% in 2023, followed by a slight adjustment to 27.7–27.8% in 2024–2025, suggests an expansion of cross-border activity but also a stabilisation trend in the context of transport capacity saturation under the current EU market access framework [1, 2].

A complementary perspective is offered by the Republic of Moldova's foreign trade data: in 2024, road transport carried 82.0% of merchandise exports and 84.8% of imports [7], with export destinations concentrated towards the European Union (67.3% of total exports) [8]. This structure demonstrates the critical dependence of the Moldovan economy on unrestricted access to the European road market and underlines the strategic importance of the regulatory harmonisation process.

3.2. The Regulatory Framework of the Republic of Moldova on Access to the Occupation of Road Transport Operator: Comparative Analysis with Regulation (EC) No. 1071/2009

The legislative system of the Republic of Moldova in the field of road transport is structured on a hierarchical and multi-layered normative architecture. The Road Transport Code (RTC) No. 150/2014 [9], as amended by Law No. 423 of 22 December 2023 (in force from 01 January 2026) [10], constitutes the fundamental legislative act, establishing the general principles of sectoral policy, mechanisms for the authorisation of transport activities, conditions of access to the occupation, and the institutional competences of regulatory and supervisory authorities. The amendments introduced by Law No. 423/2023 represent the most significant step of alignment with the EU acquis in recent years, bringing the Moldovan normative framework to its highest level of compliance achieved to date.

The cumulative conditions for access to the occupation of road transport operator are governed by Article 16 of the RTC, which establishes a four-pillar system:

– the existence of an effective and stable establishment;
– good repute;
– financial standing;
– professional competence.

This structure faithfully replicates the architecture of Regulation (EC) No. 1071/2009 of the European Parliament and of the Council, which constitutes the European Union's reference standard for access to the occupation of road transport operator [11]. Registration in the Register of Road Transport Operators — managed by the National Road Transport Agency (ANTA) — is conditional upon cumulative fulfilment of all four criteria, ensuring a minimum level of qualitative selection of operators and limiting access by entities lacking genuine economic substance.

The first condition, the existence of an effective and stable establishment, is regulated in detail by Article 17 of the RTC. The legal text requires operators to maintain a real establishment with documents accessible to supervisory authorities (Art. 17(a)), to organise fleet operations such that vehicles used in international traffic return to one of the operational centres (Art. 17(b)), to hold road vehicles registered with ANTA (Art. 17(c)), and to effectively and continuously conduct their administrative and commercial activities at their establishment (Art. 17(d)–(e)). The requirement under Art. 17(b) on the return of vehicles to the operational centre is particularly important from the perspective of combating the "letterbox company" phenomenon — entities formally registered in the Republic of Moldova but without genuine activity on the national territory — a phenomenon which undermines fair competition in the international transport market and whose elimination constituted one of the priorities of the EU's Mobility Package I [11, 12].

The second condition, good repute, is regulated by Article 18 of the RTC. The condition is considered unfulfilled when the transport manager or the enterprise has been convicted by a final court judgement of economic offences, human trafficking or drug offences, or transport-related offences (Art. 18(1) (a)), or has received three administrative sanctions within 12 consecutive months for any of the serious infringement categories listed under Art. 18(3). The list of infringements leading to the failure to satisfy the good repute condition under Art. 18(3) of the RTC reproduces the categories from Annex IV to Regulation (EC) No. 1071/2009, covering: serious exceeding of driving time limits (a)–(b), tachograph fraud (c), illegal carriage of dangerous goods (d), vehicles with serious technical deficiencies (e), transport without required authorisations (f), axle weight overloading (g), and driving without a valid licence (h). This complete adoption of European categories represents significant progress compared with earlier versions of the RTC and provides a solid basis for the application of the principle of mutual recognition of sanctions between Moldova and EU Member States [10, 11].

The third condition, financial standing, is regulated by Article 19 of the RTC, as amended by Law No. 423/2023. The financial thresholds laid down in Art. 19(1) are identical to those of Art. 7 of Regulation (EC) No. 1071/2009: at least €9,000 for the first vehicle used (Art. 19(1)(a)), €5,000 for each additional vehicle with a maximum authorised mass exceeding 3.5 tons (b), and €900 for vehicles in the 2.5–3.5 tons range (c). Additionally, Art. 19(1)(e) of the RTC establishes specific thresholds for operators conducting international transport under ECMT authorisations or INTERBUS carnets. The currency conversion mechanism under Art. 19(4) of the RTC — using the National Bank of Moldova exchange rate published on the first working day of October, applied throughout the following calendar year — ensures annual updating of values in Moldovan lei and is comparable to the practice of EU Member States. This full alignment of financial standing thresholds, achieved through Law No. 423/2023 and entering into force on 01 January 2026, eliminates one of the principal divergences previously identified between Moldovan legislation and the EU acquis [10, 11].

The fourth condition, professional competence, is governed by Articles 20–21 of the RTC. The condition is considered fulfilled when the transport manager and the drivers of the enterprise hold professional competence certificates issued pursuant to Article 43 of the RTC, obtained following a mandatory written examination (Art. 20(2)). The transport manager must be domiciled in the Republic of Moldova, be employed and remunerated by the enterprise, and effectively and continuously coordinate transport activities (Art. 21(2)). The limits imposed by Art. 21(2) of the RTC — a maximum of 4 enterprises and a combined fleet of no more than 50 vehicles per manager — are more stringent than the minimum required by Regulation (EC) No. 1071/2009, aiming to prevent nominal management without genuine substance. Furthermore, Art. 21(4) of the RTC provides for a 30-day period for replacing a transport manager who no longer meets the access conditions, maintaining operational continuity during this transition [10, 11].

The detailed comparative analysis of the access conditions under Articles 16–21 of the RTC in relation to Regulation (EC) No. 1071/2009 is summarized in Table 5.

Table 5

Comparative analysis of Articles 16–21 RTC No. 150/2014 (as amended by Law No. 423/2023) against Regulation (EC) No. 1071/2009

Access criterion	Reg. (EC) 1071/2009 (EU)	RTC No. 150/2014 (Art. 16–21)	Comparative assessment
Effective and stable establishment	Real establishment, accessible documents, vehicles registered in the state of establishment, effective and continuous activity (Art. 5)	Art. 17 RTC: establishment with access to documents, vehicles registered with ANTA, effective and continuous activity, obligation for vehicles to return to operational centre	SUBSTANTIAL COMPLIANCE. Art. 17 RTC fully replicates the logic of Art. 5 of Reg. 1071/2009. Notable addition: the obligation to return vehicles to the operational centre (Art. 17(b)) — an important safeguard against "letterbox companies".
Good repute	Relevant criminal convictions; repeated serious infringements in: driving time, tachographs, weights, ECMT, safety (Annex IV, Reg. 1071/2009)	Art. 18 RTC: same offence categories; 3 sanctions within 12 consecutive months in any of the categories under Art. 18(3)(a)–(h)	SUBSTANTIAL COMPLIANCE. The list under Art. 18(3) reproduces Annex IV categories. The 3 sanctions/12-month threshold is identical. MINOR DIVERGENCE: the EU Regulation separately classifies "Most Serious Infringements" (MSI) with distinct weighting — the RTC does not introduce this grading.
Financial standing	⩾€9,000 for first vehicle; ⩾€5,000 for each additional >3.5 t vehicle; ⩾€900 for 2.5–3.5 t vehicles (Art. 7, Reg. 1071/2009)	Art. 19 RTC: identical — €9,000 first vehicle; €5,000 each >3.5 t; €900 for 2.5–3.5 t; €3,000 each taxi. Annual conversion via NBM rate of 1 October.	FULL COMPLIANCE (from 01.01.2026). The Art. 19 RTC thresholds are IDENTICAL to Reg. 1071/2009. This complete alignment, effective from 01.01.2026 (Law No. 423/2023), eliminates one of the principal previously identified divergences. The NBM currency conversion mechanism is adequate and comparable to EU practice.

Continuation Table 5

Professional competence	Certificate following mandatory written examination; knowledge in 9 domains (Annex I); mutual recognition in the EU (Art. 8, Reg. 1071/2009)	Art. 20–21 RTC: certificate after mandatory written examination; transport manager domiciled in Moldova, employed and remunerated; max. 4 enterprises / 50 vehicles per manager	SUBSTANTIAL COMPLIANCE. Certification systems are similar. SIGNIFICANT DIVERGENCE: Moldovan certificates are NOT mutually recognised in EU Member States. Limitation to 4 enterprises/50 vehicles per manager is more restrictive than Reg. 1071/2009.
Transport manager	Natural person with genuine link to enterprise, EU residence, effectively and continuously responsible (Art. 4, Reg. 1071/2009)	Art. 21 RTC: domicile in Moldova, employed and remunerated by the enterprise, effective and continuous coordination, 30-day replacement period	FULL COMPLIANCE. Art. 21 RTC requirements are more stringent than the European minimum (mandatory employment and remuneration condition), reducing the risk of nominal managers. The 30-day replacement period is comparable to Member State practice.

Source: Elaborated by the author based on comparative analysis of Articles 16–21 RTC No. 150/2014 (as amended by Law No. 423/2023, in force 01.01.2026) and Articles 4–8, Annex I, Annex IV of Regulation (EC) No. 1071/2009.

Table 5 demonstrates that the amendments introduced by Law No. 423/2023 have resulted in a substantial level of compliance with the EU acquis on access to the road transport occupation, with full compliance in the chapters on financial standing and transport manager. The most significant remaining divergence is the absence of mutual recognition of professional competence certificates between Moldova and EU Member States — a limitation with a direct impact on the mobility of Moldovan transport managers and drivers on the European market. A second divergence lies in the absence of Most Serious Infringements (MSI) grading, as provided for in Regulation (EC) No. 1071/2009, compared with the mere enumeration of categories in Art. 18(3) of the RTC, which may affect the proportionality of the sanctioning response of Moldovan authorities relative to that of Member States.

The balance between state intervention and self-regulation of the private sector is a fundamental challenge in any entrepreneurial regulatory framework. As examined in the academic literature, "state intervention cannot be avoided", with the essential requirement being that it ensures "the appropriate degree of interference... that does not undermine the natural self-regulation of society", while simultaneously correcting the failures of spontaneous development where necessary [13].

The road freight transport sector graphically illustrates this tension: the technical, social, and safety complexity of the activity requires a robust institutional presence, yet excessive regulation can inhibit entrepreneurial initiative and generate unjustified compliance costs. Within this conceptual framework, the institutional architecture of Moldova's transport sector is structured around the National Road Transport Agency (ANTA), which performs the role of central regulatory and supervisory authority responsible for managing the Register of Road Transport Operators, issuing transport authorizations, conducting inspections, and applying sanctions. The Ministry of Infrastructure and Regional Development performs the function of coordinating sectoral policies and monitoring the harmonization process with the EU acquis.

A critical aspect is the insufficient level of digitalization of administrative procedures relative to European standards. Although the Republic of Moldova launched the "e-Transport Authorization" information system in July 2020 — developed with the support of the USAID Moldova Structural Reforms programme, rather than from its own institutional capacity — the ANTA Director characterized the initiative at the time of launch as "an important step towards the digitalization of public services", implicitly acknowledging the incipient nature of the process [14]. The complete digitalization of ECMT authorizations and road books entered into force only on 1 January 2026, with a grace period for operators until 1 April 2026 to adapt to the new system [15]. By contrast, EU Member States have integrated and interoperable electronic systems for managing transport operator registers, connected to the European Register of Road Transport Undertakings (ERRU) [16], to which the Republic of Moldova has not yet achieved interconnection — a gap with direct implications for the capacity of Moldovan authorities to verify in real time the status of operators engaged in international traffic.

3.3. The EU-Moldova Agreement on International Road Freight Transport and Synthetic Comparative Analysis of the Normative Framework against the EU Acquis

The bilateral Agreement between the European Union and the Republic of Moldova on international road freight transport establishes the legal framework for the operation of commercial vehicles belonging to operators of one Party on the territory of the other, defining the reciprocal rights and obligations of carriers, market access conditions, control mechanisms, and provisions on information exchange [3]. The Agreement was signed on 29 June 2022 in Lyon, France, and entered into force on 21 August 2023. Originally conceived as a temporary instrument to address significant road transport disruptions caused by Russia's war of aggression against Ukraine, the Agreement has been extended three times through decisions of the Joint Committee established thereunder: the first extension, adopted in December 2022, extended its validity to 30 June 2024; the second extension, signed in March 2024, extended it to 31 December 2025; and the third extension, adopted at the third meeting of the bilateral Road Transport Dialogue in March 2026, set 31 March 2027 as the new end date [3, 17, 18]. These successive extensions reflect the demonstrated utility of the Agreement for both Parties: road exports from Moldova to the EU grew by 57% in volume and 41% in value in Q3 2024 compared with Q3 2021 (prior to the Agreement's conclusion). The EU also benefited significantly: EU road exports to Moldova increased by 49% in value and 36% in volume between Q3 2021 and Q3 2024 [18].

The main components of the Agreement cover: (i) the authorization regime for bilateral, transit, and third-country transport; (ii) the conditions for issuing ECMT (European Conference of Ministers of Transport) authorizations, enabling access to the European market without individual national permits; (iii) rules on cabotage; and (iv) dispute settlement mechanisms and the joint committee responsible for implementation.

The process of gradual market access liberalization envisages the progressive elimination of bilateral authorization quotas and their replacement by a fully liberalized regime, conditional upon the attainment of normative and institutional compliance criteria. This makes the Agreement an instrument for stimulating the harmonization process, creating concrete conditionalities that accelerate domestic legislative reforms. The Joint Committee established by the Agreement provides a structured dialogue mechanism allowing for the identification of practical obstacles and the adoption of necessary corrective measures [3].

The extended comparative analysis of the entire relevant normative framework, supported by external reports from the European Commission and the Transport Community, reveals a

differentiated picture of the degree of harmonization of Moldovan legislation, summarized in Table 6. The European Commission observes that "Moldova has some level of preparation in the area of transport policy" and that "some progress has been made", but that "the country needs to continue alignment with the EU acquis, across all modes of transport, and to implement it effectively" [19]. The Transport Community similarly reports that "more than 65% of the EU transport acquis has not yet been transposed" by observer participants, including the Republic of Moldova, and that progress in implementing action plans is "moderate, with an average completion rate of 39%" [20].

Table 6

Degree of harmonization of the legislation of the Republic of Moldova with the EU acquis in road freight transport

Regulatory domain	EU reference instrument	Compliance level	Observations / Reference sources
Legend: C = Compliant (full transposition, effective implementation) | PC = Partially compliant (formal transposition, deficient implementation) | MC = Minimally compliant (partial transposition, significant normative gaps) | N = Non-compliant (absence of transposition or fundamental divergences)			
Access to occupation / licensing (Art. 16–21 RTC)	Reg. (EC) 1071/2009	**PC → C**	Substantial transposition achieved; full compliance on financial standing and transport manager from 01.01.2026 (Law 423/2023). Persistent divergences: absence of mutual recognition of certificates and MSI grading. European Commission explicitly recommends "adoption of social and market rules for road transport" [19, 20].
Access to the international market	Reg. (EC) 1072/2009	**MC**	Access remains conditional on bilateral agreements and ECMT authorizations; cabotage is not permitted. Transport Community notes that "more than 65% of the EU transport acquis has not yet been transposed" by the three observer participants [15, 20].
Social rules (driving time, rest periods)	Reg. (EC) 561/2006	**PC**	Formal transposition completed. European Commission notes that effective implementation and roadside enforcement remain insufficient; recommends strengthening control capacity [19]. Transport Community: "moderate" progress in implementing road action plans [20].
Digital tachographs	Reg. (EU) 165/2014	**MC**	Incomplete enforcement system; penetration rate of new-generation tachographs remains low. Full digitalization of ECMT authorizations entered into force only on 01.01.2026 [15]. Interoperability with the ITF/OECD Digital ECMT system was at testing stage in 2024.
Professional qualification of drivers	Directive 2003/59/EC	**PC**	Periodic training system implemented. Divergences: limited training centre capacity; Moldovan certificates not mutually recognized in all EU Member States — a limitation with direct impact on the international mobility of drivers [22].

Continuation Table 6

Vehicle technical standards / roadworthiness testing	Directive 2014/47/EU	**MC**	Normative framework partially aligned; insufficient inspection equipment in regional locations. Transport Community notes "gaps in institutional capacities of observer participants" [20].
Road safety / network management	Directive 2008/96/EC	**MC**	European Commission explicitly recommends "adoption of a new road safety strategy based on the Safe System approach" [19]. Transport Community: "road safety policy reforms are ongoing, but further efforts are needed for measurable on-the-ground improvements" [20].
Dangerous goods transport	ADR / Dir. 2008/68/EC	**PC**	Functional legal framework; Transport Community documents "continued progress in regional harmonization" on dangerous goods, including for observer participants [23]. Practical roadside monitoring remains limited.

Source: Elaborated by the author based on legal-comparative analysis and verifiable external sources: European Commission [19], Transport Community [20], ANTA [14, 15]. Methodological note: The qualitative scale used is inspired by the methodology of European Commission progress reports and Transport Community reports. The compliance level reflects the normative and implementation status at the time of study elaboration (2025–2026).

Table 6 reveals that the most significant progress has been achieved in domains where the EU acquis sets requirements that are predominantly normative-technical in nature (access to occupation, dangerous goods transport), compared with domains requiring substantial investments in physical infrastructure and electronic monitoring capacity (digital tachographs, road safety, access to the international market). This distribution reflects the limits of the Republic of Moldova's administrative and financial capacity rather than the absence of political will to harmonise [19, 20].

3.4. Entrepreneurial Barriers and Compliance Obstacles

The analysis of barriers faced by Moldovan entrepreneurs in international road freight transport activities reveals the existence of several categories of obstacles [21], originating both in deficiencies of the domestic normative framework and in access asymmetries relative to the European market [24].

The first category encompasses administrative barriers generated by excessive bureaucracy in the process of obtaining and renewing international transport authorizations. The incomplete digitalization of interactions with ANTA amplifies these obstacles, particularly for small and medium-sized enterprises [23]. The second category comprises compliance barriers generated by high costs [25]: earlier studies on regulatory costs in the road transport sector in EU candidate countries indicate that these are significantly higher than the European average, due to administrative inefficiencies and fragmented compliance. Nevertheless, the full alignment of financial standing thresholds under Art. 19 of the RTC (from 01.01.2026) partly reduces this asymmetry. The third category refers to market access barriers [26] generated by the bilateral authorization quota system and cabotage restrictions, which place Moldovan carriers in an asymmetric position relative to European operators [3, 19]. The fourth category covers the absence of mutual recognition of documents and certificates, identified in Table 6 as a significant divergence from the EU acquis.

4. Results and Discussion

Transport is a sector of exceptional complexity compared with other service sectors. At its core, it constitutes a multi-product industry providing differentiated services (for both freight and passengers), delivered through distinct infrastructures. The sector employs a wide variety of technologies (transport modes), some of which are subject to heavy taxation while others benefit from significant subsidies, reflecting important social dimensions and geographic distribution implications. Economic analysis of transport must therefore simultaneously consider technical, economic, and social aspects.

It is evident that a condition for the integration of the Republic of Moldova into the European Union is the harmonization of national legislation with European regulations in the field of road transport [26]. The results of the statistical and legal-comparative analysis confirm the research hypothesis that the process of legislative harmonization of the Republic of Moldova with the EU acquis in road freight transport is characterized by a significant gap between the formal transposition of European norms and their effective implementation — a conclusion supported by the external reports of the Transport Community and the European Commission.

A notable area of progress is represented by the amendments introduced by Law No. 423/2023, which brought the financial standing thresholds under Art. 19 of the RTC to the exact level of Regulation (EC) No. 1071/2009. The entry into force of these amendments on 01.01.2026 constitutes the most significant step of normative alignment in the domain of access to occupation, eliminating one of the principal compliance barriers identified in earlier literature. The European Commission implicitly acknowledges these advances by observing that Moldova has made "some progress" in the field, adding that these advances must be continued and consolidated through effective implementation [19].

NBS statistical data for 2020–2025 provide the quantitative context for the relevance of the normative reforms analyzed. The fact that road transport accounts for 79–93% of total freight volumes transported, and that international traffic consistently represents 27–30% of road carriers' activity, demonstrates that any change in the regulatory framework has direct and significant macroeconomic effects [1, 2]. The stabilization of freight turnover at around 5,800–6,000 million tonne-kilometres in 2024–2025 signals that the sector has not yet fully recovered its pre-pandemic activity level, with structural constraints contributing to this dynamic.

A cross-cutting issue identified in the research is the insufficient involvement of road transport entrepreneurs' associations in public consultation processes. The Transport Community explicitly emphasizes that "continued technical assistance and political commitment are essential for alignment with EU standards" [20].

5. Conclusions

This study has analyzed the process of harmonization of the regulatory framework for road freight transport entrepreneurship in the Republic of Moldova, integrating detailed legal-comparative analysis of Articles 16–21 of the Road Transport Code with official NBS statistical data for the period 2020–2025 and with external assessments from the Transport Community and the European Commission.

The first major conclusion is that road freight transport constitutes the dominant sector of the transport economy in the Republic of Moldova, with a share of 79–93% of total freight volumes transported in the period 2020–2025, and with international traffic

consistently accounting for 27–30%. The 2025 data indicate sector stabilization under the current European market access restrictions.

The second major conclusion derives from the comparative analysis of Articles 16–21 of the RTC against Regulation (EC) No. 1071/2009: the amendments introduced by Law No. 423/2023 have resulted in full compliance with the chapters on financial standing (identical thresholds of €9,000/€5,000/€900, from 01.01.2026) and transport manager. Persistent divergences concern: (i) the absence of mutual recognition of professional competence certificates; and (ii) the absence of MSI grading in the sanctioning system. The qualitative assessment in Table 5, supported by verifiable external sources, confirms that the domains with minimum compliance (access to the international market, digital tachographs, road safety) coincide with those for which the European Commission has issued explicit recommendations.

The third conclusion underlines that the bilateral EU-Moldova Agreement and the conditionalities linked to the liberalization of EU market access constitute an effective instrument for accelerating normative harmonization. The Transport Community confirms that progress in implementing transport action plans is "moderate", with an average completion rate of 39%, and that more than 65% of the EU acquis has not yet been transposed by the Republic of Moldova.

The policy recommendations formulated are: (i) acceleration of the digitalization of ANTA procedures and interoperability with the European Register of Road Transport Undertakings (ERRU); (ii) initiation of negotiations for mutual recognition of professional competence certificates; (iii) introduction of MSI grading in the sanctioning system; (iv) strengthening of mechanisms for verifying compliance with social rules and digital tachographs; (v) intensification of structured dialogue with transport entrepreneurs' associations; and (vi) integration of the sustainability dimension into the national transport strategy.

Research Data Availability Statement: The statistical data used in this study are publicly accessible through the official database of the National Bureau of Statistics of the Republic of Moldova (https://statistica.gov.md). Specifically, the data on freight and passenger transport for the period 2020–2025 are available in the annual press releases published by NBS. No new primary datasets were generated for this study; all quantitative data were obtained from publicly available secondary sources, including NBS press releases, European Commission progress reports, and Transport Community annual reports. The normative documents analyzed (Road Transport Code No. 150/2014, Law No. 423/2023, EU Regulations and Directives, the EU-Moldova bilateral Agreement) are publicly available in the Official Gazette of the Republic of Moldova (https://monitorul.gov.md/) and in the Official Journal of the European Union (https://eur-lex.europa.eu). All sources are fully cited in the References section. The author confirms that the data underlying the findings of this study will remain accessible to other researchers after publication through the cited public repositories.

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Contribution of Authors

Nina Garștea: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft, Writing – Review and Editing.

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DIGITAL TRANSFORMATION IN PUBLIC PROCUREMENT: OPPORTUNITIES AND CHALLENGES IN SOUTH AFRICAN MUNICIPALITIES

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Abstract. This study explores the opportunities and challenges associated with digital transformation in public procurement within South African municipalities. The article is grounded in the understanding that traditional procurement systems are often characterized by inefficiency, excessive paperwork, procurement delays, limited transparency, and vulnerability to corruption and financial mismanagement. Consequently, municipalities are turning to digital technologies such as e-procurement platforms, electronic tendering systems, digital supplier databases, and automated workflow systems to modernize procurement processes. The study adopts a qualitative research approach based on a review of existing literature on government reports, policy documents, and scholarly publications related to digital governance and public procurement in South Africa. The findings reveal that digital transformation in public procurement presents significant opportunities for municipalities, including improved procurement efficiency, reduced administrative costs, enhanced transparency, strengthened accountability, faster service delivery, and better monitoring of procurement activities. However, the study further identifies several challenges such as inadequate digital infrastructure, limited financial resources, shortage of technical skills, resistance to organizational change, cybersecurity risks, unreliable internet connectivity, and weak institutional capacity hindering the successful implementation of digital procurement systems in South African municipalities. The study concludes that although digital transformation has the potential to revolutionize public procurement and strengthen good governance in South African municipalities, its success depends on strategic leadership, investment in digital infrastructure, capacity building, and the development of effective regulatory frameworks. The study recommends increased investment in digital skills training, stronger cybersecurity measures, and improved collaboration between government and technology stakeholders to ensure sustainable and effective digital procurement systems in local government.

Keywords: *digital transformation; public procurement, digital technologies, municipalities.*

Rezumat. Acest studiu explorează oportunitățile și provocările asociate cu transformarea digitală în achizițiile publice din municipalitățile sud-africane. Articolul se bazează pe

înțelegerea faptului că sistemele tradiționale de achiziții sunt adesea caracterizate de ineficiență, birocrație excesivă, întârzieri în achiziții, transparență limitată și vulnerabilitate la corupție și management financiar defectuos. În consecință, municipalitățile apelează la tehnologii digitale, cum ar fi platformele de achiziții electronice, sistemele electronice de licitații, bazele de date digitale ale furnizorilor și sistemele automatizate de flux de lucru pentru a moderniza procesele de achiziții. Studiul adoptă o abordare calitativă a cercetării, bazată pe o analiză a literaturii existente privind rapoartele guvernamentale, documentele de politici și publicațiile academice legate de guvernanța digitală și achizițiile publice din Africa de Sud. Constatările arată că transformarea digitală în achizițiile publice prezintă oportunități semnificative pentru municipalități, inclusiv îmbunătățirea eficienței achizițiilor, reducerea costurilor administrative, sporirea transparenței, consolidarea responsabilității, furnizarea mai rapidă a serviciilor și o mai bună monitorizare a activităților de achiziții. Cu toate acestea, studiul identifică în continuare mai multe provocări, cum ar fi infrastructura digitală inadecvată, resursele financiare limitate, lipsa competențelor tehnice, rezistența la schimbarea organizațională, riscurile de securitate cibernetică, conectivitatea nesigură la internet și capacitatea instituțională slabă, care împiedică implementarea cu succes a sistemelor digitale de achiziții în municipalitățile sud-africane. Studiul concluzionează că, deși transformarea digitală are potențialul de a revoluționa achizițiile publice și de a consolida buna guvernare în municipalitățile din Africa de Sud, succesul acesteia depinde de leadership strategic, investiții în infrastructura digitală, consolidarea capacităților și dezvoltarea unor cadre de reglementare eficiente. Studiul recomandă creșterea investițiilor în formarea competențelor digitale, măsuri mai puternice de securitate cibernetică și o colaborare îmbunătățită între guvern și părțile interesate din domeniul tehnologiei pentru a asigura sisteme de achiziții digitale sustenabile și eficiente în administrația locală.

Cuvinte cheie: *transformare digitală; achiziții publice, tehnologii digitale, municipalități.*

1. Introduction

Public procurement plays a vital role in ensuring effective delivery service, financial accountability, and building citizen trust in local government institutions. In South Africa, municipalities have encountered persistent issues such as procurement inefficiencies, excessive paperwork, delays, and corruption, which impede governance and development outcomes [1,2]. The advent of digital transformation offers municipalities an opportunity to modernize their procurement systems, aligning them with principles of good governance and improving institutional performance [3]. Digitisation provides a transformative approach to addressing issues related to public procurement. Globally, governments are adopting digital tools to enhance supply chains and procurement processes. The Organisation for Economic Co-operation and Development (OECD) 2015 procurement framework identifies e-procurement as one of its fundamental principles of best practices, while the World Bank has advocated for electronic Government Procurement (e-GP) to boost transparency and efficiency [4]. South Africa has acknowledged this trend as well.

The Supply Chain Management Review (2015) outlined a strategy for modernising procurement, which includes the implementation of e-procurement [5,1]. A new Public Procurement Bill is currently being developed to consolidate and update procurement legislation, offering a significant opportunity to integrate digital processes into the core of the system [6]. Some foundational elements are already established; the Office of the Chief Procurement Officer (OCPO) has initiated a Central Supplier Database (CSD) for online vendor

registration and an e-Tender portal for announcing bid opportunities [7]. These platforms have begun to enhance transparency and accessibility, although they only address certain aspects of the procurement cycle. This study, therefore, evaluates both the opportunities and challenges of digital procurement systems, concentrating on their role in reducing corruption, improving accountability, and enhancing service delivery in South African municipalities.

2. Background of procurement systems in South Africa

Public procurement and supply chain management serve as the foundation for government service delivery. In South Africa, public procurement holds particular significance, representing approximately 15% of the nation's GDP [8]. During the 2021-22 period alone, there were 2.94 million procurement transactions documented across national and provincial departments, engaging over 76,000 suppliers, with 83% being small or medium enterprises [9]. Consequently, effective supply chains have a direct impact on the quality of services provided to citizens and the economic empowerment of businesses. However, the government supply chain processes in South Africa have historically faced challenges related to inefficiencies and integrity [10]. Traditional manual methods, characterized by extensive paperwork, in-person approvals, and isolated systems, create opportunities for human error and interference [7]. This has led to issues such as fraud, corruption, delays, and a lack of accountability, which ultimately compromise service delivery. Recent high-profile procurement scandals and audit findings highlight the urgent need for reform [10]. Section 217 of the South African Constitution 1996, supported by the Public Finance Management Act (1999) and the Municipal Finance Management Act (MFMA) (2003), mandates that public procurement be executed in a manner that is fair, equitable, transparent, competitive, and cost-effective. Nevertheless, an antiquated, paper-based system hinders the ability to achieve these standards. The Auditor-General has previously characterized public procurement processes as "deteriorating" and has raised concerns regarding the insufficient use of IT [11]. Therefore, it is evident that a new approach is essential to bridge the gap between policy and practice.

The local government in South Africa is currently experiencing significant turmoil, primarily due to elevated levels of corruption and inadequate financial accountability. The degree to which municipal governance is prepared by the Auditor General of South Africa (AGSA). As per the Consolidated General Report on Local Government Outcomes MFMA 2021 [12], 64% of South African municipalities engaged in unauthorized expenditures totaling R20.45 billion. Similarly, 75% of municipalities reported incurring fruitless and wasteful expenditures. Furthermore, only 16% of municipalities achieved a clean audit, while 38% received unqualified audits with findings. Additionally, 30% of municipalities were qualified with findings, 2% received adverse findings, and 10% were issued disclaimers, marking them as the poorest performers [3;12]. Ms. Tsakane Maluleke, the Auditor General, stated that local government is characterised by accountability and service delivery failures, poor governance, weak institutional capacity, and instability [13]. This situation has placed a significant burden on the public procurement processes within South African municipalities.

Furthermore, the Consolidated Municipal Audit Reports 2025 observes that there is a looming crisis within the procurement processes in the country. The Unauthorised, Irregular, Fruitless, and Wasteful Expenditure (UIFWE) balance has escalated from R264.10 billion to R268.13 billion between the periods of 2023/24 and 2024/25 due to the failure of internal control mechanisms, consequence management, and the violation of SCM regulations

[13,14]. Several municipalities, including eThekwini, Tshwane, and Nelson Mandela Bay, have repeatedly been reported for irregular expenditure, inadequate contract management, and the lack of implementation of corrective measures [15]. There has been a series of irregular procurement in Johannesburg due to poor oversight and regular turnover in senior managerial positions. Although Cape Town has better governance systems, it still faces challenges with digitisation in the procurement process [14]. These statistics suggest that traditional procurement systems, which rely on manual operations and paper documentation, are inherently incapable of addressing ongoing inefficiencies and corruption.

Digital transformation in public procurement gave birth to electronic procurement (e-procurement) or digital procurement in the public sector. E-procurement is recognized as a unique element of the government service internet nexus, commonly referred to as e-government [10]. The predominant perspective on the definition of e-procurement is based on the viewpoint of the United Nations regarding the topic. The World Bank defines public electronic procurement (e-procurement) as the utilization of information and communication technology (particularly the Internet) by governments to manage their procurement interactions with suppliers for the acquisition of goods, works, and consultancy services needed by the public sector [4,16]. The essence of this definition is rooted in the understanding that e-procurement is viewed through the lens of an online transactional relationship between the government and service providers [17]. According to [18] public e-procurement is the use of information and communication technology, such as the internet, by governments in their procurement relationships with bidders for the acquisition of goods, works, and services required by the public sector." This consistency underscores the prominence of the commercial interpretation of e-procurement.

On a global level, frameworks (for example, OECD Digital Government Toolkit and Electronic Government Procurement (e-GP) Framework) established by the OECD and World Bank have shown that digitization reduces fraud, enhances accountability, and strengthens governance (6,19]. Unlike partial reforms such as policy changes or staff restructuring, digital procurement represents the only comprehensive solution capable of resolving procurement challenges, as it incorporates transparency, traceability, and automation throughout all stages of the procurement process [17]. Therefore, by minimizing human discretion, creating audit trails, and enabling real-time monitoring, digital systems effectively address the core issues identified in Auditor-General reports, including irregular spending, insufficient consequence management, and non-compliance. Thus, without digitization, municipalities will continue to perpetuate inefficiencies and corruption; however, with its adoption, they can establish robust procurement systems that restore public trust and ensure sustainable service delivery [15].

Fundamentally, it is against this background that this study sought to highlight both the opportunities and challenges of integrating digital processes into procurement, making it essential to evaluate their effects on enhancing governance, reducing corruption, and improving service delivery in South African municipalities. The study therefore is guided by the following objectives;

- To identify the opportunities presented by digital procurement systems in enhancing transparency, accountability, and service delivery.
- To assess the challenges affecting the implementation of digital transformation in municipal procurement systems.

- To examine the impact of digital procurement systems on reducing corruption and procurement irregularities in municipalities.

3. Literature Review

Public procurement in South African municipalities has been plagued by inefficiencies, excessive paperwork, delays, and a vulnerability to corruption, all of which erode service delivery and public trust [17]. In response to these challenges, digitization has emerged as a transformative solution, reflecting a global trend where governments are increasingly adopting digital tools to modernize their supply chains and procurement systems [5, 16]. International guidelines, such as the OECD's 2015 procurement principles and the World Bank's e-GP model, highlight the importance of e-procurement in enhancing transparency, efficiency, and accountability. South Africa is beginning to embrace this approach, as evidenced by the National Treasury (2015) and the development of a Public Procurement Bill that lays the foundation for digital transformation [3,19]. Initiatives like the Central Supplier Database (CSD) and the e-Tender portal, launched by the Office of the Chief Procurement Officer, have already improved transparency and accessibility, although they currently cover only parts of the procurement process. At the municipal level, practical examples include Cape Town's use of e-procurement platforms, eThekwini's electronic tendering systems, Johannesburg's digital supplier databases, and Tshwane's automated workflow systems, all of which illustrate the growing adoption of digital tools [8]. These developments show the incorporation of e-procurement in South African municipalities.

3.1. Theoretical Framework - Good Governance Theory

The theory of good governance outlines key principles for effective government functioning, regardless of its structure [20]. Established by [21], it emphasizes accountability, control, responsiveness, transparency, public participation, economy, and efficiency. This framework aims to encompass these principles and more [21]. Its relevance in this research is highlighted by its focus on accountability, transparency, efficiency, responsiveness, and integrity as vital for effective public sector management. In South African municipalities, the Auditor-General's reports for 2024 and 2025 reveal procurement failures, with irregular expenditures exceeding R268 billion in 2025, undermining these governance principles [13]. Traditional procurement systems, characterized by excessive documentation and poor oversight, struggle to ensure accountability and transparency. In contrast, digital procurement systems embody Good Governance Theory by enhancing traceability (through audit trails), transparency (via e-tender portals), and efficiency (through automated workflows). By adopting digital tools, municipalities can streamline procurement processes, making them faster, more cost-effective, and accountable to the public. Thus, Good Governance Theory provides a framework that clarifies why digital procurement is the best solution to address inefficiencies and irregularities in municipalities [6].

3.2. The role of digital technologies in improving public procurement processes in South African municipalities

One of the functions of digitizing public procurement is to enhance transparency and accountability. By utilizing digital platforms for public procurement, each stage of the process can be recorded and made accessible to regulatory authorities and the public [22]. This significantly diminishes the chances for corrupt practices, such as clandestine agreements or modified documents. This is exemplified by Johannesburg's e-Procurement System, which

permits the public to track every tender and contract, allowing suppliers and citizens to observe procurement activities in real time [19]. Likewise, Cape Town has adopted digital systems for supplier registration and tender access, which enhance administrative efficiency and foster fair competition [23]. The eThekwini and Tshwane municipalities have also embraced electronic tendering and automated workflow systems, resulting in quicker procurement cycles and improved oversight [17]. These instances mitigate the risk of fraud and corruption by restricting human discretion and automating processes, thus enhancing transparency and accountability.

The Industry 4.0 emphasizes not only the incorporation of cutting-edge technologies but also the reorganization of the methods by which data and resources are acquired, distributed, and utilized to provide services in a more efficient and sustainable manner [24]. For example, the Nelson Mandela Bay Municipality has implemented online supplier registration systems to minimize paperwork and enhance accessibility for small and medium enterprises [12]. The Buffalo City Metropolitan Municipality has launched electronic tender submission portals, which decrease turnaround times and lower administrative expenses [23]. In a similar vein, the Mangaung Metropolitan Municipality has embraced workflow automation tools to oversee procurement activities, ensuring adherence to regulations and minimizing irregular spending [25]. Even smaller municipalities, such as Polokwane, have trailed cloud-based procurement systems to enhance transparency and efficiency in the acquisition of goods and services [7]. These instances illustrate that South African municipalities are progressively acknowledging the significance of Industry 4.0 principles in procurement. Therefore, by utilizing automation, cloud technologies, and digital tendering systems, they are not only cutting costs and delays but also bolstering transparency and accountability.

Cloud computing and Inernet of Things (LoT) are revolutionizing procurement in South African municipalities, allowing them to adapt to changing demands. According to [26] cloud platforms provide unmatched flexibility for organizations to scale their systems as needed. This is crucial in municipal procurement, where demand can vary due to emergencies or seasonal needs. In addition, [27] notes that cloud computing supports remote work, ensuring procurement continuity during disruptions like the COVID-19 pandemic. Municipalities are adopting these technologies; for example, Nelson Mandela Bay Municipality has tested cloud-based supplier registration for quick vendor onboarding during peak demand [25]. Buffalo City Metropolitan Municipality uses IoT for logistics tracking, enabling real-time supply chain adjustments. Mangaung Municipality has implemented cloud-supported workflow automation to scale procurement for large infrastructure projects [26]. Even smaller municipalities like Polokwane are using cloud systems to manage fluctuating demands for essential services [12]. This scalability not only addresses immediate needs but also strengthens the overall procurement framework. By integrating IoT with cloud platforms, municipalities improve inventory visibility and supply chain management, reducing stock-outs and delays in infrastructure projects.

Digital technologies are increasingly essential for improving public procurement in South African municipalities. They enhance efficiency, transparency, service delivery, and public satisfaction [28]. Digitized procurement ensures timely delivery of learning materials to schools, essential medicines to clinics, and fewer delays in infrastructure projects [29]. Digital tracking provides reliability by allowing stakeholders to monitor order placements, approvals, and expected arrivals, which reduces disruptions and builds public trust in

government commitments [7]. Municipalities are adopting these technologies across various services. For example, the City of Ekurhuleni has launched pilot smart water management systems using IoT sensors to monitor water distribution, reducing leaks and ensuring timely access to potable water [30]. The Msunduzi Municipality has introduced digital waste management platforms to optimize collection routes and schedules, improving efficiency and reducing illegal dumping [23]. In Sol Plaatje Municipality, land allocation processes are now digitized, allowing citizens to access information on available plots and track application progress transparently [28]. Similarly, Mogalakwena Municipality is testing cloud-based procurement systems to effectively manage infrastructure project demands [10; 25]. These examples show that digital procurement systems provide benefits beyond financial savings, significantly improving daily life. By reducing paperwork and adopting electronic workflows, municipalities are enhancing their operations.

Digital technologies are becoming increasingly vital in enhancing public procurement processes within South African municipalities. They not only improve efficiency and transparency but also play a direct role in enhancing service delivery and public satisfaction [28]. When procurement systems are digitized, schools receive their learning materials promptly, clinics are stocked with essential medicines, and infrastructure projects experience fewer delays [11; 23]. The reliability provided by digital tracking, allowing stakeholders to know precisely when an order was placed, who approved it, and when it is expected to arrive, minimizes disruptions and fosters public trust in the government's capacity to fulfil its commitments [16].

Municipalities are already implementing these technologies across various service sectors. For instance, the City of Ekurhuleni has initiated pilot programs for smart water management systems that utilize IoT sensors to oversee water distribution networks, thereby reducing leakages and ensuring the timely provision of potable water [19, 29]. The Msunduzi Municipality has launched digital waste management platforms that monitor collection routes and schedules, enhancing efficiency and curbing illegal dumping [31]. In the Sol Plaatje Municipality, land allocation processes have been digitized, enabling citizens to access information regarding available plots and track the progress of their applications transparently [15, 26].

Likewise, the Mogalakwena Municipality has tested cloud-based procurement systems to manage varying demands for infrastructure projects, ensuring that resources are allocated effectively [10]. These instances demonstrate that digital procurement systems offer benefits that extend beyond mere financial savings, leading to significant enhancements in daily life. Consequently, by minimizing paperwork and embracing electronic workflows, municipalities are promoting environmental sustainability, in line with the National Development Plan and broader green economy objectives.

4. Methodology

The article uses a qualitative research approach to explore the opportunities and challenges of digital transformation in public procurement within South African municipalities. The methodology involves analyzing secondary data sources, including government policy documents, Auditor-General Reports, National Treasury publications, municipal records, and academic literature on digital governance and procurement. The Auditor-General's municipal audit reports provide crucial statistical evidence of procurement inefficiencies, irregular expenditures, and systemic weaknesses, forming the empirical basis

for problem identification. Case studies from municipalities like Cape Town, eThekwini, Johannesburg, Tshwane, and Nelson Mandela Bay highlight practical experiences with digital procurement initiatives, showcasing both successes and ongoing challenges. The data were thematically analyzed with a focus on three main objectives (i) examining the impact of digital systems on reducing corruption and irregularities, (ii) identifying opportunities for enhanced transparency, accountability, and service delivery, (iii) identifying challenges to implementation. This methodology ensures a comprehensive understanding of how digitization can address procurement challenges, situating South Africa's procurement reforms in a global context and demonstrating why digital procurement is the most effective solution for reducing inefficiencies and corruption in municipalities.

5. The impact of digital procurement systems on reducing corruption and procurement irregularities in municipalities

Digital procurement systems are essential for reforming South African municipalities, addressing inefficiencies, irregularities, and corruption in public procurement. In addition, [33] notes that these systems enhance transparency, efficiency, inclusivity, and oversight, promoting good governance and accountability in municipal services. E-tender portals and supplier databases make procurement information publicly available, reducing manipulation and fostering citizen trust [23, 33]. For instance, Cape Town's e-procurement platforms allow online supplier registration and access to tender opportunities, streamlining processes and ensuring fair competition [32, 34]. Automation improves efficiency by cutting down paperwork and speeding up procurement cycles, thus saving taxpayer money and ensuring timely resource allocation for service delivery [33]. The eThekwini Municipality's electronic tendering systems demonstrate how digitization can reduce delays and costs while limiting fraud opportunities [19]. Ultimately, real-time monitoring tools enhance oversight, enabling officials to detect irregularities early, ensure compliance with regulations, and integrate accountability into municipal operations, thereby reducing corruption and procurement issues.

Digital procurement systems are crucial for reforming South African municipalities by addressing inefficiencies and corruption in public procurement. More so, [32] highlights that these systems promote transparency, efficiency, oversight, and inclusivity, thereby enhancing good governance and accountability. For example, Johannesburg has implemented digital supplier databases to ensure fair competition and accountability [34, 35]. Online tendering platforms increase inclusivity, allowing SMMEs to access procurement opportunities, which supports local economic development. The Tshwane Metropolitan Municipality has adopted automated workflows to speed up procurement cycles and improve monitoring, further promoting inclusivity and accountability [36]. By implementing modern e-procurement systems, South African municipalities can maximize the value of public spending, especially given the Auditor-General's reports on significant procurement failures and irregular expenditures. Thus, digital procurement systems represent a governance reform that integrates transparency, efficiency, inclusivity, and oversight, offering a path to restore accountability, reduce corruption, and improve service delivery [28, 35].

South Africa's e-procurement system, centralized through the e-Tender Publication Portal and Central Supplier Database (CSD), provides a unified framework for municipalities to modernize procurement, reduce irregularities, and fight corruption [37]. Leading municipalities like Cape Town and Johannesburg have pioneered digital procurement, while

other municipalities, such as Nelson Mandela Bay, have adopted electronic supplier registration and automated compliance checks to limit human discretion and ensure only approved suppliers can tender [35,38]. Similarly, Buffalo City Metropolitan Municipality has improved supplier verification using the CSD, preventing fraud and enhancing accountability. Mangaung Metropolitan Municipality has tested digital workflow systems for real-time procurement oversight, enabling officials to identify and address irregular spending promptly [38]. Polokwane Municipality has also adopted online tender advertising, increasing access for small and medium enterprises (SMMEs) and promoting inclusivity in local economic development [30, 36]. These examples show how municipalities beyond major cities are aligning with the OCPO's strategic goals, using ICT tools to standardize procurement, improve oversight, and enhance transparency in governance. Overall, these digital procurement initiatives represent not just technical upgrades but also governance reforms that boost efficiency, reduce corruption, and restore public trust in municipal institutions, ensuring optimal public expenditure for South African citizens.

In Gauteng, an IT infrastructure was acquired without following procurement procedures, resulting in a loss of over R148 million, despite cheaper options [37]. In the Northern Cape, significant funds were spent on mammogram services, although the hospital lacked a mammogram machine [34, 38]. In KwaZulu-Natal, contracts for radiology equipment were awarded to unqualified bidders who also inflated their prices compared to rightful bidders [39]. The Eastern Cape's Department of Road and Public Works did not follow proper procurement procedures when hiring a consultant for its 2016/2017 financial statements [16, 39]. The department sought approval to bypass competitive bidding as per Treasury regulation 16A6.4, but the request was denied. They appointed the consultant, anyway, reporting the R45 million expenditure as irregular [38]. These cases underscore the need for digital procurement to reduce corruption and irregularities in South African municipalities.

6. The opportunities presented by digital procurement systems in enhancing transparency, accountability, and service delivery

The e-Procurement system in South African municipalities has diminished opportunities for corruption, streamlined supplier registration, and improved contract management, thereby strengthening trust in public institutions. This has been observed in South African municipalities that have adopted digital technologies and where digital procurement reforms have been implemented to tackle inefficiencies and irregular expenditures [31]. For instance, in Cape Town, the introduction of an e-procurement platform has enhanced supplier access and alleviated administrative bottlenecks [27]. Likewise, eThekwini has adopted electronic tendering systems that have reduced procurement cycles and minimized human interference [33, 38]. In Johannesburg, digital supplier databases have improved contract management, although challenges remain due to inadequate oversight and leadership turnover [40]. Therefore, the experiences of these municipalities in South Africa illustrate that digitization in procurement not only mitigates corruption but also instils accountability and efficiency within governance frameworks.

Digital procurement systems offer significant opportunities to improve transparency, accountability, and service delivery within South African municipalities [16]. In Cape Town, the implementation of an e-procurement platform has alleviated administrative bottlenecks by allowing suppliers to register and access tender opportunities online [2, 40]. This advancement operationalizes transparency by making procurement cycles visible and

traceable, thus reducing the chances for manipulation [30]. From a theoretical perspective, Good Governance Theory highlights the importance of accountability and efficiency, both of which are enhanced through audit trails and automated workflows. The experience of Cape Town illustrates how digitization institutionalizes accountability, as it minimizes discretion and strengthens oversight, ultimately leading to improved service delivery outcomes by ensuring fair and efficient allocation of resources [41]. This example demonstrates how digital procurement systems integrate governance principles into municipal operations, transforming procurement from a bureaucratic obstacle into a transparent and citizen-focused process.

In eThekwini, the adoption of electronic tendering systems has optimized procurement cycles, leading to reduced delays and less human interference [1, 5]. It is evident that through the implementation of digital tender submissions and evaluations, eThekwini has diminished opportunities for corruption while expediting procurement processes, thus improving responsiveness to the needs of citizens. The municipality's embrace of digital procurement exemplifies how technology can act as a governance facilitator, incorporating accountability mechanisms that guarantee fair competition among suppliers [9,12]. The efficiency improvements realized in this context translate directly into enhanced service delivery, as procurement delays, previously a significant barrier, are reduced, enabling more effective allocation of resources in infrastructure and social services [6, 39]. Therefore, this case underscores how digital procurement systems not only modernize administrative functions but also promote the diffusion of innovation throughout institutional frameworks, strengthening both accountability and transparency in municipal governance.

Finally, Tshwane has adopted automated workflow systems that expedite procurement approvals and enhance monitoring [4]. This situation highlights the relevance of Good Governance Theory, as automation minimizes irregular expenditure by restricting human discretion and ensuring adherence to procurement regulations. The system's capability to produce real-time reports improves accountability by equipping decision-makers with precise data for oversight [15, 29]. From the perspective of service delivery, expedited approvals allow for quicker project implementation, meeting community needs without bureaucratic hindrances. Tshwane's experience illustrates how digital procurement systems can revolutionize governance frameworks by integrating transparency and accountability into routine processes, thereby bolstering citizen confidence in municipal institutions [16;40]. Consequently, it can be concluded that digital procurement is not just a technological advancement but a governance reform that enhances institutional capacity, mitigates corruption, and improves service delivery. As a result, by embedding transparency and accountability into procurement cycles, Tshwane exemplifies how digital systems actualize governance principles, ensuring that procurement serves as a catalyst for legitimacy and citizen trust [29].

7. The challenges affecting the implementation of digital transformation in municipal procurement systems

The issue of ICT infrastructure within South African municipalities is clearly reflected in the inconsistent adoption of digital procurement systems. Although digitisation necessitates reliable internet connectivity, modern hardware, and integrated platforms, numerous municipalities continue to face challenges with outdated computers and unstable networks [3, 9]. This situation has resulted in a disjointed digital environment where certain

metropolitan areas, such as the City of Cape Town, have successfully utilized the e-Tender portal, while smaller municipalities like Moroka Local Municipality still depend on manual processes [6, 40,41]. In Cape Town, supplier data frequently needs to be re-entered into separate systems for contract management, which undermines efficiency and leads to duplicated efforts [38]. Likewise, the eThekwini Municipality has tested electronic tendering; however, connectivity problems in satellite offices often necessitate that emergency procurements are processed offline. This circumvents digital records and diminishes transparency [5, 23]. The Tshwane Metropolitan Municipality has implemented workflow monitoring tools, yet procurement deviations, such as direct appointments below threshold values, are still managed manually, resulting in substantial expenditures remaining outside the digital framework [30]. In Nelson Mandela Bay, reports from the Auditor-General have highlighted irregular expenditures associated with inadequate ICT infrastructure, where officials have reverted to using spreadsheets due to unreliable networks, thereby creating unclear records that undermine accountability objectives [23,38]. These instances demonstrate the challenges faced in implementing e-procurement across South African municipalities.

Public procurement in South Africa functions within a highly regulated framework, which poses considerable challenges to digital transformation. The current procurement legislation, spread across the PFMA, MFMA, and Treasury regulations, was established for traditional paper-based processes [29]. Municipal instances vividly illustrate these challenges; for example, in the City of Johannesburg, officials have reported difficulties in reconciling electronic tender submissions with the statutory requirements for physical documentation, resulting in duplication and delays [33,41]. The eThekwini Municipality, despite testing e-tendering platforms, continues to handle deviations and emergency procurements offline due to regulatory requirements that mandate manual authorization [40]. In Nelson Mandela Bay, findings from the Auditor-General revealed irregular expenditure associated with the inconsistent application of procurement rules, where digital systems were circumvented to adhere to outdated legal requirements [43]. These instances illustrate how Good Governance Theory, which promotes transparency and accountability through streamlined digital systems, contrasts with the reality of bureaucratic inertia that perpetuates inefficiency. The South African scenario emphasizes that effective e-procurement necessitates not only technological readiness but also legal and institutional adjustments to foster transparency, efficiency, and accountability across all municipalities.

The effectiveness of technology in public procurement ultimately depends on its users, with the human factor being one of the most significant barriers to digital transformation in South African municipalities. Numerous procurement officials and supply chain managers have received training in, and are familiar with, paper-based or semi-digital processes, resulting in a skills gap when it comes to operating advanced e-procurement software, analyzing digital data, and troubleshooting system issues [32, 43]. This gap is particularly noticeable in municipalities like the City of Tshwane, where officials have faced challenges in adapting to workflow monitoring tools, frequently reverting to manual reporting formats. Likewise, in the City of Johannesburg, inadequate training has resulted in inconsistent utilization of e-platforms, thereby undermining the anticipated efficiency improvements [44]. Resistance to change exacerbates this issue. In municipalities such as eThekwini, certain officials have opposed e-procurement reforms due to the heightened transparency that diminishes opportunities for discretion or potential corruption [1, 9]. Others have voiced

concerns regarding technology or fear that automation may make their positions obsolete, mirroring observations in Nelson Mandela Bay, where Auditor-General reports highlighted staff reluctance to fully adopt digital systems. This resistance illustrates a broader institutional inertia, where established routines and vested interests hinder the pace of reform. In conclusion, the human element, comprising skills, attitudes, and professionalization, remains a critical determinant of the success or failure of digital procurement in South African municipalities.

8. Recommendations

Budget limitations can thus serve as an obstacle – particularly at the local government level, where IT funding is restricted. A sustainability strategy is essential to ensure that once an e-procurement platform is implemented (occasionally with support from donors or central authorities), it remains funded and maintained over the long term. The World Bank cautions that e-GP initiatives frequently commence as projects but struggle once initial funding ceases, making long-term commitment vital.

The obstacles to digitising the procurement of South Africa's government are considerable, yet they are not impossible to overcome. These challenges include gaps in technology and infrastructure, the necessity for legal and procedural reforms, human factors, and considerations of equity. The experiences of other nations, along with guidance from international organizations, offer valuable lessons on how to address these challenges. The following section examines some of these frameworks and best practices that South Africa can utilize to alleviate difficulties and ensure a successful digital transformation of its public procurement.

The findings reveal that transitioning procurement to an online platform entails the digital storage of sensitive information (including bid prices, company data, and government purchasing plans). This data can become vulnerable to cyber-attacks or fraud if not adequately protected. Recent years have witnessed an increase in cyber incidents targeting South African institutions, highlighting the necessity for strong security protocols. The e-procurement system must incorporate robust encryption, user access controls, and monitoring mechanisms to avert hacking or data breaches.

The findings also suggest that another facet of the regulatory challenge is the bureaucratic red tape that may hinder digitisation. Public sector procurement is often criticized for being overly rule-bound and rigid. Experts have advised that South Africa should streamline and simplify procurement processes as part of the digitisation initiative. This entails revising specific approval workflows, bid evaluation methods, or reporting obligations to conform to best practices and the capabilities of contemporary technology. Essentially, the government should refrain from automating inefficiencies; rather, it should re-engineer processes to be more efficient before digitising them. Accomplishing this may necessitate modifications to Treasury instructions or guidelines.

A comprehensive field analysis study must be conducted, incorporating insights from all e-procurement stakeholders, including system administrators, procurement managers, and suppliers. The insights gathered from these e-procurement stakeholders should focus on their experiences with e-procurement during the procurement process, as well as other supporting factors such as the user-friendliness of the system and its accessibility.

9 Conclusion

This research showed that digital transformation in public procurement equips South African municipalities to address inefficiencies, corruption, and accountability issues. By adopting e-procurement platforms, electronic tendering, supplier databases, and automated workflows, municipalities can enhance transparency, reduce administrative costs, and improve governance. Digital procurement offers significant benefits, including increased efficiency, lower costs, better transparency, stronger accountability, faster service delivery, and improved monitoring. However, challenges like inadequate infrastructure, limited technical skills, weak institutional capacity, and cybersecurity threats can impede success. The Auditor-General's reports reveal a need for reform, with irregular expenditures exceeding R268 billion in 2025, highlighting governance failures. Without strategic leadership and investment, digital procurement may become ineffective. In conclusion, digital procurement is a key solution to South Africa's municipal procurement crisis, dependent on strategic leadership, infrastructure investment, skills development, and robust regulations. If municipalities embrace these reforms, digital procurement could restore public trust, reduce corruption, and ensure service delivery meets citizens' needs transparently and accountably.

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INVESTIGATING EXPERIENTIAL GRAPHIC USER INTERFACE OF SMART CITY-ENABLED TRANSPORTATION SYSTEM IN LAGOS, NIGERIA

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Abstract. Smart cities leverage information and communication technology to boost operational efficiency, disseminate information to the public, and enhance the quality of government services and the welfare of citizens. Smart transportation is largely anchored in digital devices, which are heavily driven by visual elements. These visual cues include icons, illustrations, colours, typographic contents, menu bars, grids, spacing, animation, avatars, visual selectors, interactive maps, and other visual indicators. The appropriate use of visual cues determines the usability of these technological platforms. This study examines the graphic visual components that comprise the user interface-driven tools enabling the smart city transportation system in Lagos, Nigeria. The research design employed is a qualitative descriptive approach. Data were collected through both primary and secondary sources. The results indicated that user interface tools (ride-sharing apps, traffic delivery reports, and wayfinding systems) are indeed deployed with varying degrees to enhance smart mobility in the Lagos metropolis. Finally, the deployment of the user interface tools needs to be fully optimized to achieve better results.

Keywords: *Graphic User Interface, Information and Communication Technology, Smart city, Transportation System, Visual Cues.*

Rezumat. Orașele inteligente utilizează tehnologia informației și comunicațiilor pentru a spori eficiența operațională, a disemina informații către public și a îmbunătăți calitatea serviciilor guvernamentale și bunăstarea cetățenilor. Transportul inteligent este în mare măsură ancorat în dispozitive digitale, care sunt puternic influențate de elemente vizuale. Aceste indicii vizuale includ pictograme, ilustrații, culori, conținut tipografic, bare de meniu, grile, spațiere, animație, avatare, selectori vizuali, hărți interactive și alți indicatori vizuali. Utilizarea adecvată a indiciilor vizuale determină utilizabilitatea acestor platforme tehnologice. Acest studiu examinează componentele vizuale grafice care alcătuiesc instrumentele bazate pe interfața utilizator care permit sistemul de transport al orașelor inteligente din Lagos, Nigeria. Designul cercetării utilizat este o abordare descriptivă calitativă. Datele au fost colectate atât din surse primare, cât și secundare. Rezultatele au

indicat că instrumentele interfeței utilizator (aplicații de partajare a călătoriilor, rapoarte de livrare a traficului și sisteme de orientare) sunt într-adevăr implementate în grade diferite pentru a îmbunătăți mobilitatea inteligentă în metropola Lagos. În cele din urmă, implementarea instrumentelor interfeței utilizator trebuie să fie complet optimizată pentru a obține rezultate mai bune.

Cuvinte cheie: *Interfață grafică cu utilizatorul, Tehnologia informației și comunicațiilor, Oraș inteligent, Sistem de transport, Indicii vizuale*

1. Introduction

The overall appearance and user experience of technological devices is referred to as a graphic user interface (GUI). GUI is the medium through which users interact with digital devices, relying on graphical elements such as icons, including secondary notation, rather than text-based interfaces, typed command labels, or text navigation [1]. The effectiveness of a GUI depends not only on its functional capabilities but also on its design aesthetics, which influence usability, accessibility, and overall user experience [2]. Dixon [3] explained that the experiential graphic design (EGD) principle entails the use of digital technologies and systems that drive dynamic user interface content to create immersive, functional, and sensitive user experiences. This aspect of graphic design is largely influenced by the early form of environmental graphic communication, which emanates from the hieroglyphic cave paintings found in France and Spain. Wayfinding systems in city streets, highways, landmarks, hospitals, airports, and other public spaces are enlivened with experiential graphics. Architecture, however, acts as the canvas upon which EGD are embedded, enabling spatial orientation and enhancing the legibility of the city. EGD cues are essential in the planning and implementation of smart cities worldwide.

The density of human activity that characterizes urban centres across the world constantly strains infrastructure and developmental amenities available in urban environments. Modern cities are embracing innovative ideas to improve the efficiency of the limited infrastructure available and enhance citizens' quality of life. According to Jong, Joss, Schraven, Zhan, and Weijnen [4], metropolitan areas worldwide have deployed initiatives to improve urban infrastructure and services, creating better environmental, social, and economic conditions and further boosting cities' attractiveness and competitiveness. Globally, competitive cities leverage information, communication, and technological templates defined via the concept of "smart cities". Shea and Burns [5] defined a smart city as a municipality that integrates information and communication technology (ICT) to improve operational efficiency, share information with the public, and improve both the quality of government services and citizen welfare. Greco and Cresta [6] categorizes the smart city concept into three distinct approaches: (1) an approach that prioritizes 'hardware,' highlighting new technologies and infrastructure as essential for the smart city; (2) an approach that places significant importance on social and human capital in the definition of a smart city; (3) an integrated approach that characterizes a smart city by possessing both qualities above, as a smart city must ensure the synergy between technology and human and social capital to foster a conducive environment for ongoing growth and innovation.

The drive towards the actualization of smart cities has become necessary for global competitiveness amongst contemporary cities. Therefore, smart cities are anchored on enriching the city's infrastructure to stimulate economic growth and enhance residents' quality of life by exploring smart technologies and data analysis. According to the IESE

Business School [7], the performance indicators for ranking a smart, sustainable city in the global index of top-performing smart cities include economy, environment, governance, human capital, international outreach, social cohesion, technology, urban planning, and mobility and transportation. London tops the list of the smartest cities in the world, followed by New York, Paris, Tokyo, Berlin, Washington, Copenhagen, Oslo, Singapore, and San Francisco [7]. These cities were selected based on their high overall scores across several established performance indicators.

In Nigeria, Lagos, with an estimated population of over 20 million, is regarded as having the potential to attain smart city status based on its available infrastructure, human capital, and social integration [8]. However, the challenges of population growth, infrastructure deficit, and traffic congestion have created an urgent need for smart transportation innovations in cities, including Lagos. The Lagos State Government has introduced Smart City initiatives that leverage ICT to improve urban services, particularly transportation [9].

Transportation plays a central role in the development of smart cities as mobility is essential to economic growth and social interaction [10]. Ridesharing platforms, traffic reporting platforms, and wayfinding systems are smart mobility innovations that expand access to transportation, address navigation issues, and reduce vehicular congestion in the city [11, 12]. Taxi-hailing applications are powered by smart city infrastructures.

This study assesses the experiential graphic user interface of the smart city-enabled transportation systems in Lagos metropolis. Its specific objective is to appraise existing innovations in Lagos metropolis with a view to informing policies that will stimulate improvements in the transportation system within Lagos metropolis and cities with similar attributes.

2. Literature Review

2.1 Experience Design

Experience design involves creating holistic experiences across every aspect of services and products, both physical and digital. This includes what users encounter, the environment, the products, the interface, and many other elements, such as sound, smell, or taste, which are crucial for creating a positive user experience [13]. Experience design focuses on creating a positive relationship between users and the product/environment as an integrated whole. The feelings, memories, and perceptions of the users are fundamental to successful experience design. User interface maximizes the user-centeredness of products.

User Interface is the process designers adopt to create digital device interfaces, focusing on looks or style [14]. The development of user interfaces is often anchored in anticipating users' needs and goals. According to Stevens [15], the user interface designer considers the human user and how the mind works using patterns, spacing, and colour to guide the human user. Graphic icons and elements are the gateways to the usability of a digital interface. A graphical user interface (GUI) enables users to interact with electronic devices through graphical icons and visual indicators, such as secondary notation, rather than text-based interfaces, typed command labels, or text navigation [16]. Gube [17] defines user experience (UX) as the way a person feels when interacting with a system. The system, in this case, includes a website, a web application, or desktop software and, in contemporary times, represents some form of human-computer interaction (HCI). User experience (UX) addresses users' needs, values, and capabilities, as well as a website's limitations. Jordan [18] proposes a pleasure-based design approach that addresses four layers of users' needs: safety,

functionality, usability, and pleasurable experience. Thus, the quality of digital experiences, especially in transportation, depends heavily on the intuitiveness and inclusivity of GUIs.

2.2 Ridesharing Mobile Application

The concept of ridesharing emerged in the context of addressing the individual mobility problem [11]. Ride-sharing connotes the shared use of a motor vehicle by a driver and passengers, either for non-profit or paid service, based on billing information supplied by the attendees. The transportation mode offers significant economic and environmental advantages, such as mitigating traffic congestion during peak hours, reducing fuel consumption and emissions, minimizing travel time, and decreasing parking costs [Chan & Shaheen, 2012, cited in 11].

Ridesharing could either be dynamic, involving a network, organized on a trip-by-trip basis, and managed by the government, or carpooling and vanpooling that is casual and unofficial, usually run by participants. Mitropoulos, Kortsari, and Ayfantopoulou [19] posited that ride-sharing trips are characterised by matching applications made possible by drivers and passengers finding potential rides. The trips usually involve community-based trust mechanisms (for example, user ratings) and provide links to social networks, enabling prospective sharers to identify one another. Moreover, ridesharing improves traffic performance by matching travellers with similar routes and schedules on short notice [11]. Anthopolous and Tzimos [12] noted that the introduction of online platforms has revolutionized travel between service providers and users. User experience is fundamental to the usability and functionality of ride-sharing platforms. The ease of use of the ride-sharing user interface enables users to accomplish their goals.

2.3 Wayfinding System

A wayfinding system is a vital element for effective connectivity within human settlements [20]. The essence is to assist users in achieving prompt, precise communication and information on legibility, readability, and convenience. Its applications include city planning, infrastructure services, transportation, tourist destinations, and urban informatics, among others. For wayfinding, graphical elements and tools such as charts, colours, diagrams, graphs, images, typography, soundtracks, maps, symbols, and billboards, as well as information kiosks, are employed [21]. But it has received attention from researchers, particularly the transport planners.

Studies have explored various dimensions of the wayfinding system. van Lierop et al. [20] examined users' experiences with wayfinding along a cycle route on a highway in the Netherlands before and after the installation of two new pilot wayfinding systems. Findings indicated that changes to the location, size, and clarity of signage improved cyclists' experience. Cyclists reported that they navigate the routes easily, travel-related stress decreased, and travel time decreased. Minano et al. [22] studied the existing and future concepts of wayfinding systems with varying technical requirements within the UK transport industry, highlighting the merits and demerits of wayfinding technologies. From the review, it was concluded that industry information systems are not performing optimally because they rely on legacy systems that are not cost-effective to run, cannot easily integrate with new technologies, and require users to work around limitations. It was concluded that considering "the number of stakeholders and array of technologies, wayfinding in the transportation industry is a challenge that will likely result in an eventual system-of-systems created by multiple stakeholders." Ferri, Popp, and Wulfhorst [23] examined individual user

experience throughout the wayfinding journey to provide insights into the role and influence of smartphones during the process. They found that Google Maps is most widely used among other apps that provide integrated spatio-temporal information. It was concluded that smartphones helped survey participants overcome navigational stress, but they have limitations and do not always aid wayfinding because they can distract participants. This limitation is expected to make it difficult for designers to understand how people behave in public transport spaces and to ensure that smartphone navigation matches the real-world signs and directions in those spaces. It is noteworthy that wayfinding is beyond digitalisation, as may be assumed when referring to smart cities; rather, emphasis should be on functionality and usability, as Lai [21] has studied.

3. Materials and Methods

Lagos, in southwestern Nigeria, comprises 20 local government areas. Though Lagos is the smallest State in Nigeria, it is the most populous. The choice of Lagos, Nigeria, was based on the fact that it is not only one of the few states in Nigeria to have launched smart city initiatives, but has also demonstrated a level of commitment to achieving smartness within its jurisdiction [24]. The three aspects identified and examined in this study relate to addressing transportation problems within the state. For instance, Lagos State in Nigeria boasts the highest number of e-hailing ride operators using ride-sharing apps. The initiative to enable electronic Traffic Report Delivery System is the first of its kind in Nigeria. Lastly, Lagos State deploys a unique wayfinding system, which deserves examination.

A qualitative descriptive research design was employed. A descriptive study describes a situation, problem, or phenomenon but does not focus on the relationship or association [25]. The researchers sourced data from secondary sources comprising journal articles, newspapers, magazines, government publications, and books. The secondary data were complemented by primary data obtained from field surveys and observations. The data analysis focused on inductive exploration of data employed by [24] in a related study. The research explored some selected experiential graphic design-driven user interface tools that facilitate smart city transportation in the Lagos metropolis. These information technology tools include Ride-Sharing App Interface, Traffic Report Delivery System, and Wayfinding systems.

4. Results and Discussion

4.1 Ride-Sharing App

The rise of ride-sharing app-enabled services in the Lagos metropolis indicates the embrace of technology in redefining the transportation system. Information Technology drives the city of the future. Lagos State is leveraging ICT tools to actualize a smart city. Vehicle ride-sharing systems are changing the way citizens commute in their daily schedules by adopting new transportation scheduling models [26].

Rideshare was pioneered by Uber, which provides a service that connects drivers with commuters needing transportation without sharing space with a crowd [27]. Rideshare supports the public transportation system in Lagos, just as it does in other competitive smart cities worldwide. The interfaces of ride-sharing apps are significantly driven by visual cues to enhance usability. These cues include icons, illustrations, colours, typographic contents, menu bars, grids, spacing, animation, avatars, visual selectors, interactive maps, and other visual indicators. When the app opens, users are prompted by a text information menu bar asking for their destinations. In the lower section, three interactive icons with drop shadows create depth.

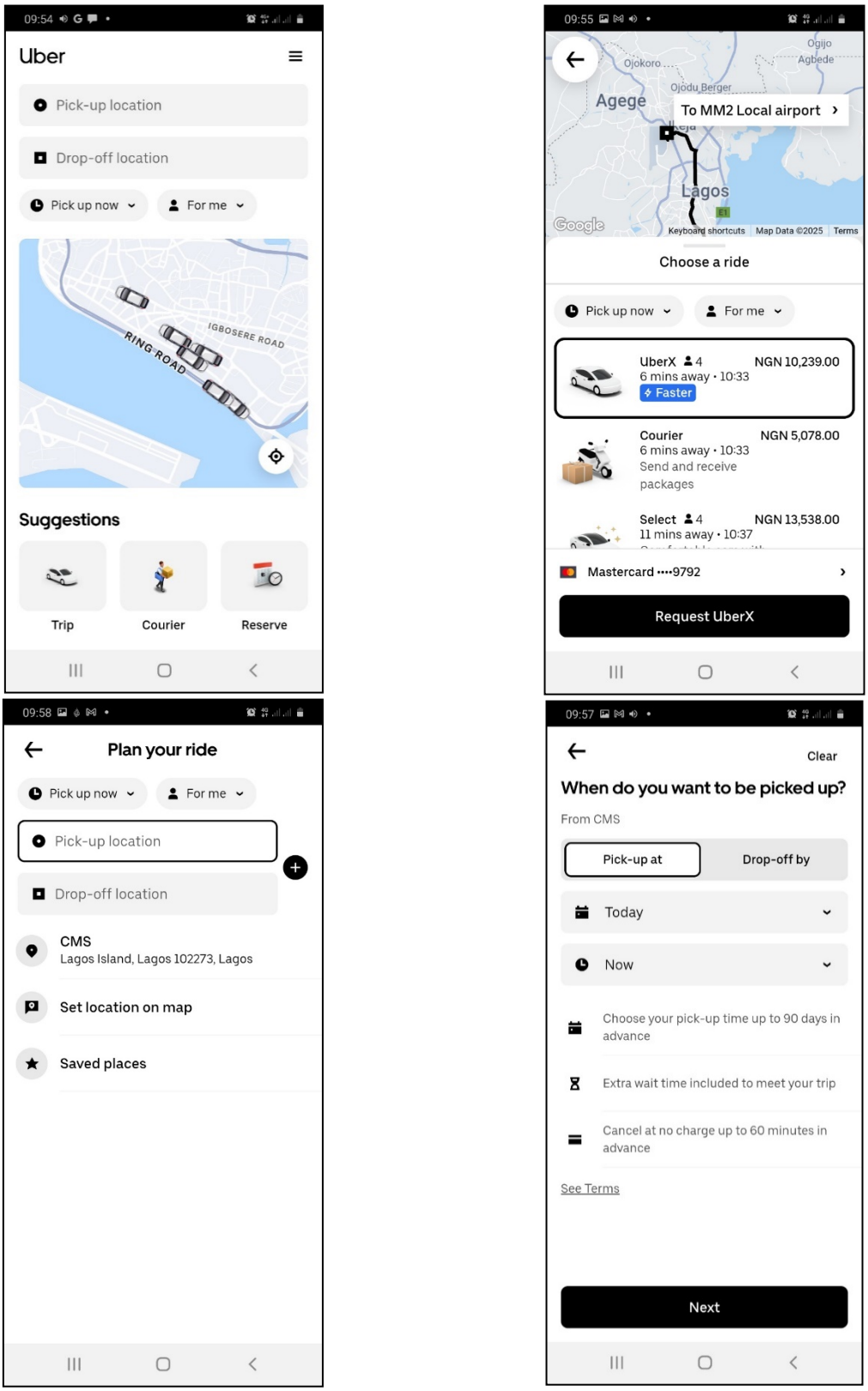

Figure 1. Uber Ridesharing user interface.
Source: Authors' Fieldwork (2025).

A graphical representation of a road with simulated cars serves as the background for the ride-sharing application's entry page. The user selects the pick-up location from the provided menu and taps and fills in the destination. The application interface is embedded with bold, bright colours that contrast with the bold, legible text. Blue is the dominant colour

of the interface to communicate safety and comfort. Users can also select their preferred vehicle, represented by a clip art image of a racing car. The user is supplied with the information, such as the driver's image and car plate number, in black text on a white, spacious background. The driver's arrival time is displayed on a green background with negative spaces. The exciting aspect of the app interface is the GPS-powered graphical map with animated clip art of a vehicle that shows the driver navigating to the user's location (Figure 1).

The study reveals that GUIs play a critical role in shaping user interaction with smart city-enabled transportation systems in Lagos. The findings show that different ride-hailing platforms, such as Uber, Bolt, and Rida, were the most widely used GUI-based tools in Lagos, and that intuitive design elements, such as icons, colour-coded indicators, and maps, significantly improve usability. However, global apps like Uber and Google Maps were rated highly due to their universal design frameworks and optimized user interfaces, echoing Helling's [27] assertion that good interface design enhances adoption.

4.2 Traffic Report Delivery

Findings show that the Lagos State government collaborated with an outdoor advertising agency to deploy a real-time traffic information system that provides commuters with advanced traffic information on busy routes. Lagos Traffic Information System (LATIS) collects traffic data. It transmits accurate traffic information across a dedicated network of smart advertising billboards located near designated stops, covering an estimated 210 kilometres of roads in the metropolis [28]. The reports are delivered in a typographic style with colours visible on a light background, enabling the audience to view the reports with ease (Figures 2 and 3). To achieve this, cameras are mounted at strategic positions across these routes. These cameras record traffic conditions along the routes and transmit them to the public via designated social media accounts [28].

Figure 2. Lagos Traffic Information System.
Source: Parrotnigeria [29].

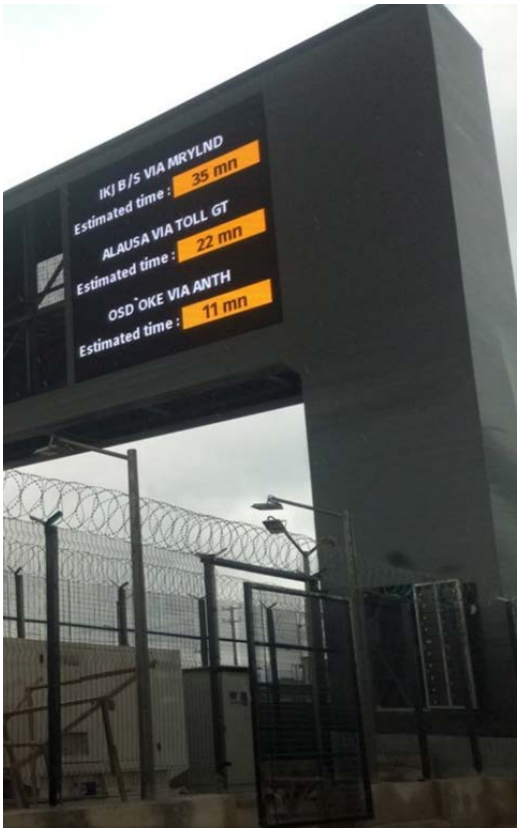

Figure 3. The estimated time to different locations is displayed on the advertising billboard within the metropolis.
Source: Billboard Arena [30].

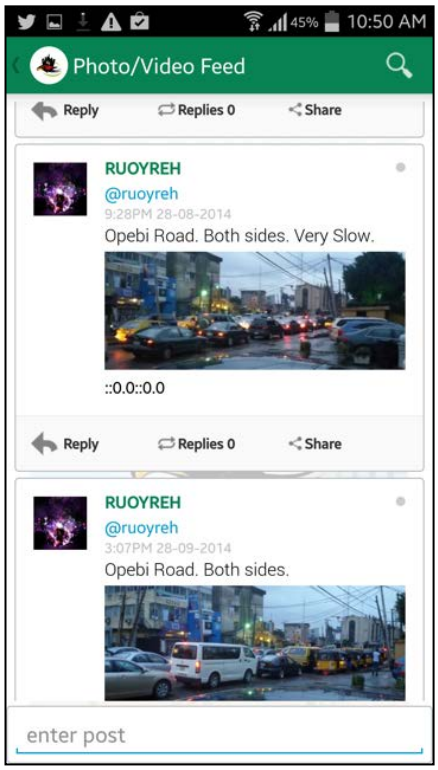

Figure 4. Gidi Traffic Twitter page interface.
Source: Authors' Fieldwork (2023).

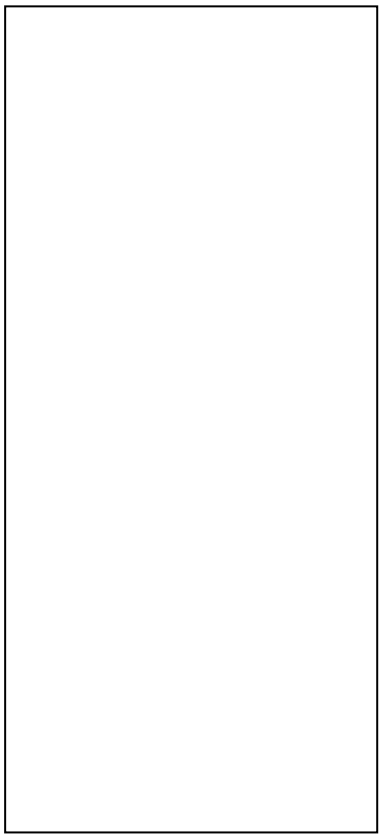

Figure 5. GPS user interface.
Source: Authors' Fieldwork (2019).

Other private entities provide traffic information for commuters in the Lagos Metropolis. Giditraffic is a private initiative in Lagos State that uses crowdsourced information to provide real-time, visually oriented traffic updates to Lagosians navigating the city (Figure 4). Giditraffic provides traffic updates by relying on its massive 16,000 Twitter followers, who report what they see around the city with visual images [31]. The Tsaboin Traffic Talk application enables commuters to share real-time traffic experiences via text updates and images. Navigation applications such as Google Maps use colour psychology to communicate traffic updates to people. The red track line indicates heavy traffic, while the blue line represents free-flow traffic (Figure 5).

4.3 Wayfinding Signage System

Wayfinding involves information systems that help people navigate a physical environment and enhance their experience of the planet. Therefore, wayfinding is vital in complex built environments, including healthcare facilities, campuses, and transportation hubs. However, the complexities of metropolitan environments require functional visual cues, such as maps, directions, and symbols, to guide residents and visitors to their destinations. Montello and Freundschuh [32] posited that wayfinding is the mental process of orienting oneself within an environment, which includes planning and choosing routes. Specifically, wayfinding is the process of identifying a current location and determining how to reach a destination as quickly and effortlessly as possible [33]. Easy accessibility and navigation in both familiar and unfamiliar environments enhance the functionality of such places. People visiting built environments are eager to accomplish their goal of visiting such places as quickly as possible, without negative feelings or spatial anxiety. The wayfinding signs in Lagos metropolis, as shown in Figure 6, are located on major roads and streets, showing traffic directions and street names. However, the look and feel of road signs, as well as their appropriateness of positioning, are vital in urban traffic corridors, especially in smart cities. TransportDay [34] explained that road signs provide illustrative guidance to road users for safer, more convenient travel. The signs on Lagos roads are constructed and erected in accordance with international standards [35]. However, some one-way roads in the metropolis are not marked. Motorists unknowingly drive against traffic, causing chaos on the roads. Drivers on Lagos roads reported that 30 per cent of the roads have no signs indicating one-way streets or other warnings [36]. These poorly placed signs do not align with the smart city value of seamless transportation. Lagos has both static and digital signs on.

Figure 6. Street Identification Signs.
Source: Authors' Fieldwork (2022).

Figure 7. Traffic Sign.
Source: Techcabal cited in [37].

5. Conclusions

The study explores experiential graphics users of the smart city-enabled transportation system in Lagos metropolis, Nigeria. It therefore assesses the smart city in transport management implementation in the metropolis. Findings indicated that the ride-sharing apps are embraced by citizens in the Lagos metropolis, thus supporting the public transportation system. Findings also showed collaboration between the Lagos State government and an outdoor advertising agency to deploy a real-time traffic information system. The collaboration implies that commuters have access to traffic information across various routes, enabling them to navigate busy routes within the metropolis. Additionally, the wayfinding system in the Lagos metropolis is widely deployed. Nonetheless, there is a need to integrate areas yet to be captured with the system to address the instances of driving against traffic, especially on unidirectional roads.

It is noteworthy that this is a preliminary study. While the researchers adopted a qualitative descriptive approach, which has its limitations, a broader quantitative study that would engage other stakeholders in Lagos metropolis, such as citizens, policymakers, and the private sector, to share their experiences and perceptions of the graphic user interfaces, is desirable and recommended for future research in Lagos, Nigeria.

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HOME-BASED PREPARATION AS A MEDIATING MECHANISM BETWEEN CONFIDENCE IN AUTONOMY AND ENGAGEMENT IN THE FLIPPED CLASSROOM

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Abstract. This study aims to explore the mediating role of home preparation initiative (HPI) in the relationship between learner autonomy confidence (LAC) and active engagement in flipped classrooms (EC) at the University of Kinshasa (DRC). Grounded in self-efficacy and self-regulation theories, the study shows that LAC significantly influences EC (β = 0.45, p = 0.01), confirming the importance of learner autonomy confidence as a driver of engagement. In contrast, HPI does not significantly mediate this relationship (non-significant indirect effect, bootstrap CI [−0.04; 0.23]), suggesting that contextual constraints (limited material resources, large class sizes) may hinder its effectiveness. The results also highlight the importance of emphasizing confidence in autonomy while adapting teaching methods to local realities, particularly by promoting the implementation of collaborative and metacognitive support mechanisms. The findings will contribute to the literature by providing insights into optimizing the flipped classroom model in sub-Saharan Africa, while also emphasizing the need for further research on potential additional mediators (motivation, social support).

Keywords: *Flipped classroom, confidence in autonomy, initiative-taking, home preparation, active engagement, mediation, self-efficacy, self-regulation, higher education, Democratic Republic of Congo (DRC), active learning.*

Rezumat. Acest studiu își propune să exploreze rolul de mediator al inițiativei de pregătire la domiciliu (IPA) în relația dintre încrederea în autonomia elevului (ICC) și implicarea activă în clasele inversate (IC) la Universitatea din Kinshasa (RDC). Bazat pe teorii ale autoeficacității și autoreglării, studiul arată că IAC influențează semnificativ IC (β = 0,45, p = 0,01), confirmând importanța încrederii în autonomia elevului ca factor determinant al implicării. În schimb, IPA nu mediază semnificativ această relație (efect indirect nesemnificativ, IC bootstrap [-0,04; 0,23]), sugerând că constrângerile contextuale (resurse materiale limitate, clase mari) pot împiedica eficacitatea acesteia. Rezultatele subliniază, de asemenea, importanța accentuării încrederii în autonomie, adaptând în același timp metodele de predare la realitățile locale, în special prin promovarea implementării unor mecanisme de sprijin colaborativ și metacognitiv. Constatările vor contribui la literatura de specialitate oferind perspective

asupra optimizării modelului de clasă inversată în Africa Subsahariană, subliniind totodată necesitatea unor cercetări suplimentare asupra potențialilor mediatori suplimentari (motivație, sprijin social).

Cuvinte cheie: *clasă inversată, încredere în autonomie, luare de inițiativă, pregătire pentru acasă, implicare activă, mediere, autoeficacitate, autoreglare, învățământ superior, Republica Democrată Congo (RDC), învățare activă.*

Introduction

Le paysage éducatif contemporain est marqué par une transformation profonde des paradigmes pédagogiques, notamment avec l'émergence des approches centrées sur l'apprenant. Parmi celles-ci, la classe inversée s'impose comme un modèle innovant, redéfinissant les rôles traditionnels de l'enseignant et de l'étudiant [1–4]. Cette méthode, qui inverse les phases d'acquisition des connaissances [réalisées à domicile] et d'application [en présentiel], exige des étudiants une autonomie accrue et une implication active dans leur apprentissage. Cependant, son efficacité dépend largement de la capacité des apprenants à s'engager dans des activités préparatoires en dehors du cadre scolaire, une dimension souvent négligée dans les recherches antérieures [5–7]. En République Démocratique du Congo (RDC), où les défis éducatifs incluent des infrastructures limitées, les méthodes pédagogiques moyennement efficaces, les insuffisances d'utilisation des méthodes actives et des effectifs pléthoriques, l'adoption de la classe inversée soulève des questions spécifiques quant à son adaptabilité et à ses mécanismes sous-jacents [8–11]. Dans ce contexte, l'Université de Kinshasa, en tant qu'institution phare du système éducatif national, offre un terrain pertinent pour explorer les dynamiques psychopédagogiques qui influencent la réussite de cette approche.

L'engagement des étudiants en classe inversée ne saurait être réduit à une simple question de motivation intrinsèque ou extrinsèque. Des études récentes soulignent le rôle clé de la confiance en l'autonomie, définie comme la croyance en sa capacité à organiser et réguler son propre apprentissage [12–15]. Cette confiance, conceptualisée dans le cadre de la théorie de l'auto-efficacité, est particulièrement capitale dans des environnements où les apprenants doivent assumer une responsabilité accrue dans leur préparation [16,17]. Pourtant, les recherches menées en Afrique subsaharienne révèlent que les étudiants, bien qu'ils fassent preuve d'une volonté d'autonomie, rencontrent des obstacles structurels et psychologiques qui limitent leur engagement effectif [18,19]. À l'Université de Kinshasa, où les ressources numériques et les accompagnements individualisés restent rares, la confiance en l'autonomie pourrait jouer un rôle déterminant dans la transition vers des méthodes actives comme la classe inversée. Cependant, peu d'études ont examiné comment cette confiance interagit avec des comportements concrets, tels que la prise d'initiatives dans la préparation à domicile, pour favoriser un engagement soutenu en classe.

Une lacune majeure dans la littérature réside dans l'absence d'analyses empiriques sur les mécanismes médiateurs qui lient la confiance en l'autonomie à l'engagement en classe inversée. Bien que des travaux aient établi un lien direct entre ces deux variables [20–22], les processus intermédiaires restent mal compris, notamment dans les contextes universitaires africains. La prise d'initiatives dans la préparation à domicile en classe inversée, définie comme l'ensemble des actions proactives entreprises par l'étudiant pour anticiper et préparer les séances en présentiel [23], émerge comme une variable potentielle pour expliquer cette relation. En effet, la prise d'initiatives qu'il s'agisse de rechercher des

ressources complémentaires, de s'auto-évaluer ou de collaborer avec des pairs pourrait agir comme un levier médiatisant, transformant la confiance en actions tangibles [24,25]. Pourtant, cette hypothèse n'a pas été testée de manière systématique, particulièrement dans des environnements où les étudiants doivent composer avec des contraintes matérielles et sociales significatives [26,27]. Cette omission limite la portée des recommandations pédagogiques proposées pour optimiser l'efficacité de la classe inversée.

La présente étude vise à combler cette lacune en investiguant le rôle médiatisant de la prise d'initiatives au cours de la phase à domicile dans la relation entre la confiance en ses capacités d'apprentissage autonome et l'engagement en classe inversée. En s'appuyant sur le modèle de l'auto-régulation de Zimmerman (2002), nous postulons que la confiance en l'autonomie ne suffit pas à garantir un engagement optimal ; elle doit être accompagnée de comportements proactifs, tels que la prise d'initiatives dans la préparation à domicile, pour se traduire en résultats concrets. Cette hypothèse s'inscrit dans une perspective socio-constructiviste, où l'apprentissage est vu comme un processus actif et socialement situé [28,29]. En outre, cette recherche s'ancre dans le cadre théorique de l'engagement académique de Fredricks et al. [30], qui distingue les dimensions comportementale, cognitive et affective de l'engagement toutes potentiellement influencées par la prise d'initiatives dans préparation à domicile. Une telle approche permet non seulement de clarifier les mécanismes psychologiques en jeu, mais aussi d'éclairer les pratiques pédagogiques adaptées aux réalités de l'enseignement supérieur et universitaires congolais.

La justification de cette étude repose sur son potentiel à informer les politiques éducatives et les stratégies d'enseignement en RDC. Alors que le système LMD (Licence-Master-Doctorat) encourage une pédagogie centrée sur l'étudiant, son implantation se heurte à des résistances liées à des habitudes d'apprentissage traditionnelles et à un manque de préparation des apprenants [31]. Comprendre comment la prise d'initiatives dans la préparation à domicile peut renforcer l'impact de la confiance en ses capacités d'apprentissage autonome sur l'engagement en classe inversée offre des pistes concrètes pour concevoir des interventions ciblées. Par exemple, des modules de formation à l'autonomie ou des plateformes collaboratives pourraient être développés pour stimuler la prise d'initiatives, surtout dans un contexte où l'accès aux ressources est limité. De plus, cette recherche contribue à la littérature internationale en fournissant des données empiriques issues d'un contexte sous-représenté, enrichissant ainsi les débats sur l'universalité des modèles pédagogiques [32,33].

Au vu de tout ce qui précède, notre problématique s'articule autour de la question suivante : Dans quelle mesure la prise d'initiatives dans la préparation à domicile médiatise-t-elle la relation entre la confiance en l'autonomie et l'engagement en classe inversée chez les étudiants ?

2. Méthodologie de la recherche

2.1. Conception générale

Les données ont été recueillies à partir d'un échantillon d'étudiants inscrits à la Faculté de Psychologie et des Sciences de l'éducation de l'Université de Kinshasa. Ces étudiants avaient été exposés à une approche pédagogique innovante fondée sur le modèle de la classe inversée, notamment déployée lors de deux enseignements spécifiques pour lesquels nous nous sommes intéressés séparément, à savoir le cours de Pédagogie expérimentale en 2ème année de Master (département des Sciences de l'Education – SED) et le cours Valeurs,

Principes et Symboles de la République en 3ème année de Licence (parcours Gestion des entreprises et organisation du travail – GEOT) dans le cadre du système LMD (Licence-Master-Doctorat). Nous avons ensuite évalué la fiabilité de notre instrument de mesure en calculant le coefficient alpha de Cronbach qui est reconnu comme un indicateur statistique éprouvé en matière de fidélité des outils à l'enquête. Nous avons donc utilisé le logiciel SPSS (Statistical Package for the Social Sciences) spécifiquement adapté à ce type de traitement et de validation des données quantitatives.

2.2. Description de l'instrument de recherche

Dans les opérations déployées en vue de la recherche menée, l'outil d'évaluation retenu s'avère être l'échelle du sentiment d'efficacité personnelle mobilisé en contexte de classe inversée, dispositif validé 44 items en 8 dimensions, dont la cohérence interne a été avant le début de la recherche validée au travers des valeurs jugées satisfaisantes du coefficient alpha de Cronbach : capacité d'apprentissage autonome (6 items, $\alpha = 0,70$), prise d'initiative dans la préparation à domicile (5 items, $\alpha = 0,71$), persistance face à la difficulté (6 items, $\alpha = 0,800$), fixation/atteinte d'objectifs personnels (6 items, $\alpha = 0,73$), gestion du stress et de l'autonomie (6 items, $\alpha = 0,70$), engagement dans les activités en classe (5 items, $\alpha = 0,72$), apprentissage continu et auto-évaluation (5 items, $\alpha = 0,74$), réception-usage du feedback (5 items, $\alpha = 0,74$). Les étudiants évaluent leur niveau d'adhésion à chaque item à l'aide d'une échelle de Likert en 5 niveaux, échelonnée de 1 (« jamais ») à 5 (« toujours ») qui permet une mesure fine et différenciée de la perception. Pour cet article et en cherchant à répondre à la problématique que nous nous posons, nous n'en avons parmi ces dimensions, ciblé que 3 révélatrices dont la capacité d'apprentissage autonome, la prise d'initiative dans la préparation à domicile, et l'engagement dans les activités en classe.

Tableau 1

Echelle d'évaluation du sentiment de l'efficacité personnelle en classe inversée et exemples d'items

Sous-échelles	Exemples d'items
Capacité d'apprentissage autonome	Je me sens en mesure de gérer mon temps pour étudier les contenus avant les séances en classe
Prise d'initiative dans la préparation à domicile	Je recherche des ressources additionnelles (articles, tutoriels, forums) pour compléter ma préparation.
Persistance face aux difficultés	Lorsque je rencontre des concepts difficiles, je cherche des solutions pour mieux les comprendre.
Fixation et atteinte des objectifs personnels	Je définis des objectifs d'apprentissage clairs pour chacune de mes séances d'étude.
Gestion du stress et de l'autonomie	Je sais identifier les situations stressantes et je trouve des moyens de les atténuer.
Engagement dans les activités en classe	Je participe activement aux discussions en classe en partageant mes idées et perspectives.
Apprentissage continu et auto-évaluation	Je prends régulièrement le temps de réfléchir à mes progrès et à mes compétences acquises.
Réception et utilisation du feedback	Je suis ouvert aux critiques constructives et je les considère comme des opportunités d'apprentissage.

Ce tableau présente notre instrument de recherche relatif au sentiment de l'efficacité personnelle en classe inversée afin d'évaluer l'auto-efficacité en classe inversée, pour une octave de sous-échelles relatives aux compétences requises pour autonomiser et engager toute une population d'étudiants. L'auto-apprentissage est évalué à travers la disposition à organiser son temps et sa charge de travail indépendamment [17], et l'initiative dans la préparation hors classe à l'aide de ressources complémentaires est illustrée par la proactivité dans la recherche des supports nécessaires pour mieux performer [23]. La persistance dans les efforts face à l'adversité reflète le contrôle cognitif en situation ([12], et donner le sens et réaliser le but personnel évalue l'aptitude à définir un but d'apprentissage spécifique, mesurable et temporellement défini [34]. L'auto-régulation émotionnelle ou gestion du stress évalue la capacité à situer les sources de stress et/ou de tension [35], l'engagement dans les tâches en classe mesure l'application et participation dans les discussions d'activités [30]. L'auto-évaluation dans l'apprentissage et l'apprentissage pour soi explore la réflexivité par rapport aux acquis et savoirs mobilisés [36], et enfin la réception et mise à profit du feedback évalue l'ouverture à la critique constructive et au réinvestissement des commentaires pour les faire progresser [37,38]. La conciliation combinée de ces différentes dimensions offre une vision plus globale des compétences d'auto-régulation, d'auto-perception ainsi que des capacités motivationnelles dans l'indispensable processus propédeutique à la réussite des dispositifs de cours inversé.

2.3. Participants

Les 127 étudiants de la Faculté de psychologie et des sciences de l'éducation de l'Université de Kinshasa qui composent l'échantillon, se caractérisent par une répartition genrée équilibrée, 53 hommes (41,7 %) et 74 femmes (58,3 %), et en termes d'âge, par une majorité de 70,1 % (n = 89) de 18–24 ans, contre 29,9 % (n = 38) de 25 à 30 ans. Concernant le niveau d'études, la très grande majorité des répondants (96,1 %, n = 122) sont en troisième année de licence (L3) (et seulement 3,9 % (n = 5) en première année de master (M1)).

2.4. Analyse des données

Dans le cadre de cette recherche, l'analyse des données a été réalisée à l'aide du test de régression par macro-process intégré sous le logiciel SPSS (version 25) dans un modèle de médiation 4 proposé par Hayes [39], qui permet d'administrer rigoureusement les effets médiateurs tout en contrôlant des variables confondantes, qui peuvent apparaître comme des risques dans la recherche en psychologie et en sciences de l'éducation [40]; de ce fait, cette méthode s'est révélée opportune pour déconstruire les effets directs et indirects réciproques entre chaque variable d'intérêt en nous permettant d'expliquer ce qui a lieu dans le cadre des mécanismes qui sous-tendent la relation considérée. Plus précisément, elle a permis de vérifier si la prise d'initiatives dans la préparation à domicile (PIPRA) joue effectivement le rôle de médiateur significatif de la relation entre la confiance en l'autonomie (CAAU) et l'engagement en classe inversée (EAC), en ayant recourt à des méthodes de bootstrapping (5 000 échantillons) assurant la robustesse des estimations et la réduction des erreurs de type I (Preacher & Hayes, 2008) ; et nous avons effectivement choisi cette macro, recommandée pour sa pertinence dans une analyse de médiation complexe [41,42] qui permette également de générer des intervalles de confiance à 95 % pour les effets indirects, et renforçant ainsi le rôle des inférences statistiques. D'ailleurs, cette démarche s'est inscrite dans une perspective confirmatoire, en respect des bonnes pratiques en analyse de médiation [43], ouvrant ainsi une discussion sur le levier et les implications théoriques et pratiques de l'étude.

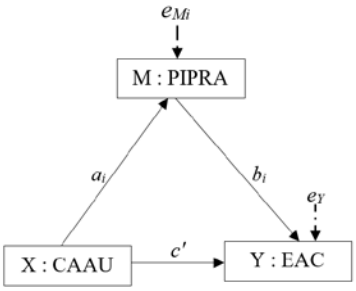

Figure 1. Modèle conceptuel de l'étude.

Légende. X: variable indépendante, M: variable médiatrice, Y : variable dépendante.

Cette figure 1 expose la façon dont la Confiance en Capacité d'apprentissage autonome (CAAU) concourt à l'Engagement (EAC) dans les activités en présentiel grâce à la Prise d'initiatives dans la préparation à domicile (PIPRA) comme variable médiatrice. L'effet total (c) de la CAAU sur le EAC se décompose à la fois en un effet indirect (a*b) et direct (c').

3. Résultats

En vue de tester l'hypothèse d'une médiation de la relation entre la Confiance en l'Autonomie des Apprenants (CAAU) et l'Engagement Actif en Classe (EAC) par la Prise d'Initiatives dans la Préparation à Domicile (PIPRA), une analyse globale de médiation a été effectuée selon un modèle de régression à l'aide de la macro PROCESS pour SPSS [39]. Les données obtenues (présentées ci-après) nous paraissent favoriser une mise au jour des mécanismes de cette relation sous l'angle des effets directs et indirects des variables étudiées, en exposant les coefficients de régression, les intervalles de confiance et les niveaux de significativité qui nourrissent leurs enjeux statistiques et théoriques.

L'analyse de médiation menée dans le Tableau 2 met en lumière des résultats nuancés concernant le rôle médiateur de la Prise d'Initiatives dans la Préparation à Domicile (PIPRA) dans le lien Confiance en l'Autonomie des Apprenants (CAAU) – Engagement Actif en Classe (EAC).

D'une part, l'ensemble du modèle est significatif, $F(1, 78) = 27{,}06$, $p < 0{,}001$, et le $R^2 = 0{,}26$, indique qu'environ 25,76 % de la variance du EAC est expliquée par les variables considérées, ce qui représente un apport explicatif substantiel [44]. L'effet total de la CAAU sur le EAC ($\beta = 0{,}53$, $p < ,0001$) renseigne que la capacité d'apprentissage autonome représente un prédicteur important d'engagement en classe inversée. Cependant, lorsque est introduite la Prise d'initiative dans la préparation à domicile comme médiateur, l'effet direct de la CAAU sur le EAC reste significatif ($\beta = 0{,}45$, $p = 0{,}00$), tout comme celui indirect via la PIPRA ($\beta = 0{,}09$, IC bootstrap [−0,04 ; 0,23]), mais ce dernier indique une absence de significativité puisque son intervalle de confiance retourne une valeur 0 [45,46]. Autrement dit, et précisément dans cette recherche, la prise d'initiative dans la préparation à domicile n'apparaît pas comme un médiateur, mais la capacité d'apprentissage autonome influence directement l'engagement dans les activités d'apprentissage en classe qui sont indépendantes de la prise d'initiatives par les étudiants dans leur préparation à domicile. Ces résultats confirment donc l'importance de la confiance en l'autonomie dans l'apprentissage comme levier d'engagement pour l'apprentissage en classe inversée, mais ne corroborent pas notre hypothèse selon laquelle cette relation serait médiatisée par la prise d'initiative dans la préparation à domicile.

Tableau 2

Tableau synthétique des effets de médiation : effet direct, indirect et total de la médiation (n=127)

R	R-sq	MSE	F	df1	df2	p
0,51	0,26	0,40	27,06	1,00	78,00	0,00
	coeff	se	t	p	LLCI	ULCI
constant	1,67	0,36	4,54	0,00	0,94	2,40
CAAU	0,53	0,10	5,20	0,00	0,33	0,73
			Effet total de X sur Y (c) :			
	Effet	se	t	p	LLCI	ULCI
	0,53	0,10	5,20	0,00	0,33	0,73
			Effet direct de X sur Y (c') :			
	Effet	se	t	p	LLCI	ULCI
	0,44	0,12	3,68	0,00	0,20	0,69
			Effet indirect de X sur Y (a*b)			
	Effect	BootSE	BootLLCI	BootULCI		
PIPRA	0,08	0,06	-0,04	0,23		

Note. 1 CAAU = Confiance en l'Autonomie des Apprenants ; PIPRA = Prise d'Initiatives dans la Préparation à Domicile ; EAC = Engagement Actif en Classe ; R = Coefficient de corrélation multiple ; R-sq = Coefficient de détermination (variance expliquée) ; MSE = Erreur quadratique moyenne ; F = Statistique de Fisher ; df1 = Degrés de liberté du numérateur ; df2 = Degrés de liberté du dénominateur ; se = Erreur standard ; LLCI = Limite inférieure de l'intervalle de confiance ; ULCI = Limite supérieure de l'intervalle de confiance ; BootSE = Erreur standard bootstrap ; BootLLCI = Limite inférieure de l'intervalle de confiance bootstrap ; BootULCI = Limite supérieure de l'intervalle de confiance bootstrap. Effet total (c) : Effet de la CAAU sur le FAC sans prise en compte de la PIPRA. Effet direct (c') : Effet de la CAAU sur le FAC en contrôlant pour la PIPRA.
Effet indirect (a*b) : Effet de la CAAU sur le FAC via la PIPRA. *p < ,05 indique une significativité statistique. Les valeurs de p et les IC bootstrap permettent d'évaluer la significativité de l'effet indirect. Si l'IC bootstrap ne contient pas zéro, l'effet indirect est considéré comme significatif.

4. Discussion des résultats

Un éclairage nuancé sur les mécanismes psychopédagogiques sous-tendant l'engagement en classe inversée, dans un univers marqué par des défis structurels et pédagogiques singuliers, comme ceux de l'Université de Kinshasa, ressort des résultats de cette étude. En lien avec la littérature, nos analyses confortent que la confiance en l'autonomie (CAAU) est un prédicteur significatif de l'engagement actif en classe (EAC), avec un effet direct solide (β = 0,46, p = ,0004) en résonance avec les travaux antérieurs soulignant l'importance de l'auto-efficacité dans le cadre de pratiques plus actives devant des étudiants rendre davantage responsables [15,17]. En revanche, contrairement à notre hypothèse de départ, la prise d'initiatives dans la préparation à domicile (PIPRA) ne se révèle pas un médiateur pertinent de cette relation, l'effet indirect se révélant n'étant pas significativement différent de 0 (IC bootstrap [−0,04 ; 0,23]). L'absence de médiation interroge les modèles théoriques existants, en particulier ceux de Zimmerman [17] et Ryan & Deci [25], qui postulent que les comportements d'initiative personnelle que l'on veut agencés dans la PIPRA, devraient produire de la confiance en actions effectives non proscrites dans la voie de l'engagement.

Plusieurs pistes permettent d'expliquer ce résultat surprenant. D'abord, le contexte éducatif congolais, marqué par le faible niveau de ressources et l'accès limité aux outils numériques [8,9] qu'il peut éventuellement limiter des actions fructueuses des étudiants pour traduire leur confiance en leur autonomie par des initiatives préparatoires efficaces. En effet comme le soulignent Habib et al. [18] et Zavale et Langa [19], les freins de nature structural (absence d'infrastructures, effectifs pléthoriques) sont capables de bloquer l'offre d'un comportement auto-régulé, alors même que les étudiants en auraient la volonté. Un autre aspect à signaler est que la PIPRA mesurée dans cette recherche ne semble pas rendre compte de toute la diversité des prises d'actions proactives possibles dans un environnement où les apprenants s'approprient davantage des méthodes informelles ou collaboratives [24,27].

En dernier ressort, d'autres variables sur lesquelles nous ne nous étions pas penchés comme la motivation intrinsèque ou le soutien social pourraient avoir un effet médiateur plus influent [20,21]. Tout cela fait notamment penser qu'en contexte où les ressources matérielles et sociales font défaut, la confiance dans l'autonomie affecte l'engagement directement, sans passer par les actions individuelles formalisées. Il s'agit d'un point de grande portée pour les pratiques pédagogiques mais aussi dans le domaine des politiques éducatives en RDC. D'une part, ils soulignent que favoriser le développement de la confiance en l'autonomie reste une priorité pour une mobilisation effective des élèves dans une démarche de classe inversée dans les termes des cadres théoriques socio-constructivistes [28,29], d'autre part, ils interrogent les stratégies d'accompagnement des étudiants en préconisant des dispositifs d'appui concret (ex. : plateformes collaboratives, tutorat) pour permettre la transition vers des stratégies d'enseignement actives [30,31].

Plutôt que d'interroger plus avant les modalités d'activation de la PIPRA, on pourrait répondre à l'enjeu en mobilisant des leviers alternatifs (ex. : adoption des stratégies métacognitives, concurrence entre pairs) dans les processus de compréhension pour mieux favoriser l'engagement dans l'apprentissage. De plus, la présente recherche participe à la littérature internationale sur le processus d'enseignement apprentissage en posant que le modèle pédagogique ne peut être importé sans qu'il soit contextualisé, relatif aux particularités locales [32,33] et ouvre sûrement la voie à d'autres éléments susceptibles d'être inclus en vue de l'obtention des objectifs visés, tels que l'auto-régulation ou les déterminants motivationnels dans les contextes similaires.

5. Conclusion

La présente étude a cherché à évaluer le rôle médiateur de la prise d'initiatives dans la préparation à domicile (PIPRA) dans la relation entre la confiance en l'autonomie (CAAU) et l'engagement actif (EAC) à l'Université de Kinshasa dans le cadre de la classe inversée. Les résultats valident l'hypothèse d'un rôle pronostique significatif de la CAAU pour EAC, qui va dans le sens des théories de l'auto-efficacité et de l'auto-régulation. En revanche, non seulement la prise d'initiative dans la préparation à domicile ne joue pas un rôle médiateur significatif, mais cela laisse penser qu'une CAAU élevée influence directement le EAC, sans se paraître passer en premier lieu par un acte d'initiation individuelle formalisée, comme cela a été prémédité dans les hypothèses initiales, et à faire penser que dans un cadre assez contraignant tant sur l'aspect structurel que matériel. Cette observation permet de mettre en évidence les limites des modèles pédagogiques élaborés en occident et utilisés dans des environnements éducatifs africains largement dépourvus de ressources et d'infrastructures, et montre également qu'il est urgent de repenser les manières d'accompagner les étudiants,

notamment en intégrant des dispositifs éducatifs conformes au contexte locaux, tels que le développement des compétences métacognitives, ou la promotion du travail coopératif.

Ces résultats ouvrent des pistes à la fois théoriques et pratiques. D'un point de vue théorique, ils invitent à approfondir l'étude des mécanismes psychopédagogiques à l'œuvre dans l'engagement dans la classe inversée, en incluant d'autres médiateurs possibles du phénomène étudié, tels que la motivation intrinsèque, ou le soutien social. Pour les praticiens et les décideurs, il souligne l'urgence de concevoir des interventions spécifiques visant à susciter la confiance dans l'autonomie et à y donner un cadre propice à sa parole, en mettant par exemple en place des modules de formation ou d'apprentissage en ligne. Enfin, cette recherche contribue à enrichir la littérature sur l'enseignement supérieur en Afrique subsaharienne en fournissant des données empiriques issues d'un contexte délaissé par les chercheurs, tout en réclamant de futures investigations destinées à finaliser des modèles d'apprentissage actif répondant aux défis de la région.

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COMPARATIVE ASSESSMENT OF ALPHANUMERIC AND GRAPHICAL PASSWORD AUTHENTICATION METHODS

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Abstract. As digital ecosystems expand, traditional alphanumeric credentials face critical vulnerabilities due to human cognitive limitations and predictable reuse behavior. This study presents a comparative empirical evaluation of traditional text-based passwords and a sequential, recognition-based graphical authentication framework designed around culturally familiar visual elements. Using a controlled experimental setup with a sample size of 203 university students, both modalities were tested under multiple simulated scenarios to assess security, ease of use, retention, and entry velocity. The empirical findings demonstrate that the graphical password architecture significantly outperformed the alphanumeric control baseline, showing a +1.4 increase in ease of use and a +1.2 enhancement in long-term memorability metrics. Additionally, authentication speed improved by 5.9 seconds on average. However, the visual nature of the interface introduces an elevated risk of shoulder-surfing incursions. We conclude that integrating cued visual cues with alphanumeric strings via multi-layered or hybrid frameworks effectively counteracts baseline text vulnerabilities while preserving superior recognition properties.

Keywords: *authentication velocity, biometric alternatives, graphical credentials, identity management, picture superiority, recognition memory, shoulder surfing, user interface usability.*

Rezumat. Pe măsură ce ecosistemele digitale se extind, acreditările alfanumerice tradiționale se confruntă cu vulnerabilități critice din cauza limitărilor cognitive umane și a comportamentului previzibil de reutilizare. Acest studiu prezintă o evaluare empirică comparativă a parolelor tradiționale bazate pe text și a unui cadru de autentificare grafică secvențială, bazat pe recunoaștere, conceput în jurul unor elemente vizuale familiare din punct de vedere cultural. Folosind o configurație experimentală controlată cu un eșantion de 203 studenți universitari, ambele modalități au fost testate în mai multe scenarii simulate pentru a evalua securitatea, ușurința în utilizare, retenția și viteza de introducere. Rezultatele empirice demonstrează că arhitectura grafică a parolei a depășit semnificativ performanța de bază a controlului alfanumeric, arătând o creștere de +1,4 în ușurința în utilizare și o îmbunătățire de +1,2 în metricile de memorabilitate pe termen lung. În plus, viteza de autentificare s-a îmbunătățit în medie cu 5,9 secunde. Cu toate acestea, natura vizuală a

interfeței introduce un risc crescut de incursiuni de tip „shoulder surfing”. Concluzionăm că integrarea indiciilor vizuale cu șiruri alfanumerice prin intermediul unor cadre multistratificate sau hibride contracarează eficient vulnerabilitățile textului de bază, păstrând în același timp proprietățile superioare de recunoaștere.

Cuvinte cheie: *viteză de autentificare, alternative biometrice, acreditări grafice, gestionarea identității, superioritatea imaginii, memoria de recunoaștere, „shoulder surfing”, utilizabilitatea interfeței utilizator.*

Abbreviations

M: Mean; SD: Standard Deviation; PII: Personally Identifiable Information; JES: Journal of Engineering Science; IS: International System of Units.

1. Introduction

As digital ecosystems expand, the reliance on traditional alphanumeric passwords has become a significant liability due to the inherent tension between memory retention and security complexity [1]. While users frequently sacrifice security by reusing predictable credentials to avoid forgetting them, these cognitive limitations often necessitate the adoption of more intuitive authentication modalities [2]. Graphical authentication methods, which utilize image-based cues, patterns, and gesture sequences, have emerged as a viable alternative that leverages visual recognition to enhance both usability and resistance to brute-force attacks [3, 4].

By tapping into the human brain's heightened capacity for long-term visual memory, these systems effectively mitigate vulnerabilities associated with text-based input, such as keylogger exploitation and shoulder surfing [5]. Nonetheless, despite their improved memorability, graphical systems remain subject to specific security challenges, including the risk of shoulder surfing, which continues to necessitate further research into robust, multi-layered authentication designs [6, 7]. Furthermore, integrating these visual interfaces with conventional alphanumeric requirements offers a hybrid framework that compensates for the weaknesses of each individual method [8].

This hybrid approach utilizes cued click points and visual sequences to increase the authentication space, significantly raising the cost for attackers attempting brute-force or phishing incursions [9]. Recent empirical evaluations suggest that dynamic, multi-factor implementations—incorporating both recall-based graphical elements and one-time passwords—significantly reduce these susceptibility windows [10]. Moreover, such dual-factor systems address the critical trade-off between user convenience and the imperative for cryptographic strength by allowing users to toggle entry modes based on environmental sensitivity [11]. Expanding the grid size or implementing multi-step verification workflows further strengthens these systems against automated guessing and targeted exploitation. The primary objective of this paper is to deliver a rigorous, comparative architectural and usability analysis to evaluate these competing paradigms under uniform environmental parameters.

2. Materials and Methods

This research focuses on the comparative assessment of alphanumeric (text-based) and graphical (image-based) password authentication methods, particularly in the context of security, usability, and user satisfaction. To achieve this, a controlled experimental approach was designed, involving the development of two distinct authentication systems and their subsequent evaluation by users.

2.1. System Development

Two separate login interfaces were developed to serve as the basis for comparison:

1. Text-Based Authentication System: A conventional alphanumeric password system where users entered a string of characters (letters, numbers, and special symbols) to authenticate.
2. Graphical Authentication System: An image-based authentication prototype designed to leverage sequential visual recognition memory. The interface presents users with a structured 2 x 4 grid containing eight distinct visual targets.

During the registration phase, the user must select a combination of exactly four images in a specific, self-determined sequence. To authenticate successfully during login, the system requires multi-layered recall: the user must not only identify the correct four images but must also replicate the precise chronological order in which they were selected during registration, establishing a strict spatial-temporal credential key. These two systems were designed with identical parameters to ensure fairness in the evaluation process, such as a similar authentication flow and security thresholds.

2.2. Selection of Participants

The participants for the study were selected from students at the Federal University Birnin Kebbi. Students were chosen as the target group because they represent a diverse demographic in terms of technological familiarity, cognitive abilities, and usability preferences. Sample Size: A total of 203 students were recruited for the study. The sample size was determined to achieve sufficient representation for robust data analysis.

Inclusion Criteria: Participants were required to have basic computer literacy to ensure they understood the interaction with both authentication systems.

Consent: All participants were informed about the purpose of the study, and their consent was obtained before participation.

2.3. Experimental Procedure

Each participant underwent the following procedure sequentially:

1. Introduction and Training: Participants were briefed about both systems and given time to familiarize themselves with their operation, including brief hands-on practice sessions.
2. First Interaction: Participants were asked to create and use their credentials for the text-based password system to log in and log out multiple times.
3. Second Interaction: Participants were then asked to create and use their credentials for the image-based password system to log in and log out multiple times.
4. Simulated Scenarios: Participants were instructed to recall their credentials under varying conditions (e.g., immediately after setup, after some time, and in a simulated 'high-pressure' scenario) to measure differences in memorability and speed.

2.4. Feedback Collection & Data Analysis

After completing their interaction with both systems, participants filled out a structured questionnaire evaluating perceptions of Security, Usability, Memorability, and Speed. The data collected from the questionnaire responses and recorded login sessions were processed and analyzed to compare success rates of login attempts, average time taken for authentication, and user satisfaction levels. Regarding ethical considerations, the study strictly adhered to ethical research standards by maintaining the absolute anonymity and confidentiality of all participant data. No personally identifiable information (PII) was stored.

3. Architectural Design & Prototype Interfaces

The research evaluation relied on two distinct software prototypes developed as uniform testing environments. These setups present users with separate functional modules for identity enrollment (registration pages) and access verification (login pages).

3.1. System A: Graphical Password Tester

System A utilizes a recognition-and-sequence-based graphical authentication mechanism designed around local cultural familiarity to enhance human recognition memory pathways. The structural layout of the deployment is broken down into two core interactive screens:

• **Registration Interface**: figure 1 showcase the baseline spatial-temporal credential key. The interface displays a static 2 x 4 layout grid containing distinct portraits of eight historical Nigerian heads of state (Balewa, Azikiwe, Ironsi, Gowon, Murtala, Obasanjo, Shagari, and Buhari). To successfully create a graphical password, users must click on exactly four distinct presidential portraits in a precise, self-selected chronological sequence, which serves as the cryptographic password key.

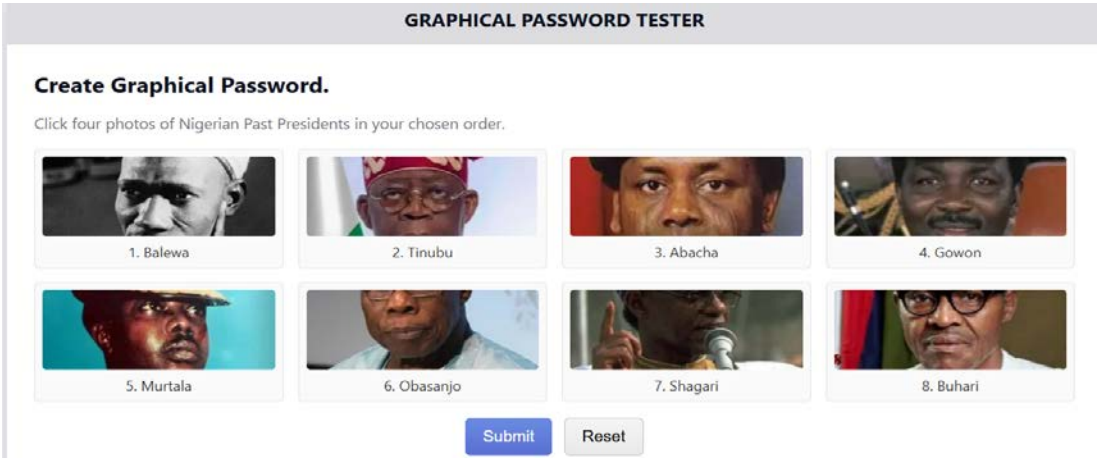

Figure 1. Recognition-based registration interface.

• **Login Interface:** During access verification, users are presented with the identical, static image matrix. To authenticate successfully, the system demands sequential multi-layered recall. The user must replicate the exact four-image chronological selection configured during registration. Inputs are registered via sequential grid coordinates, and visual confirmation boxes track selections. Figure 2 showcase graphical password tester.

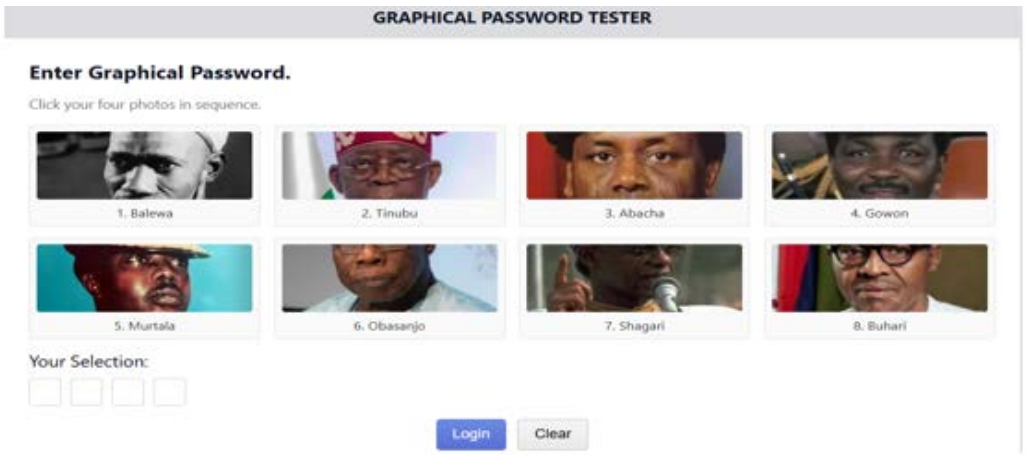

Figure 2. Recognition-based login interface.

3.2. System B: Text-Based Password Tester

System B serves as the baseline control group, utilizing conventional alphanumeric authentication structures that match standard modern web application layouts. The interface flow is divided into standard alphanumeric entry pages:

• Registration Interface: This module captures standard textual identity parameters to enroll a new user account within the database. Users are prompted to input a unique Username, a valid Email address, a chosen Password string, and a secondary Confirm Password string to mitigate typographical errors, subject to system complexity rules.

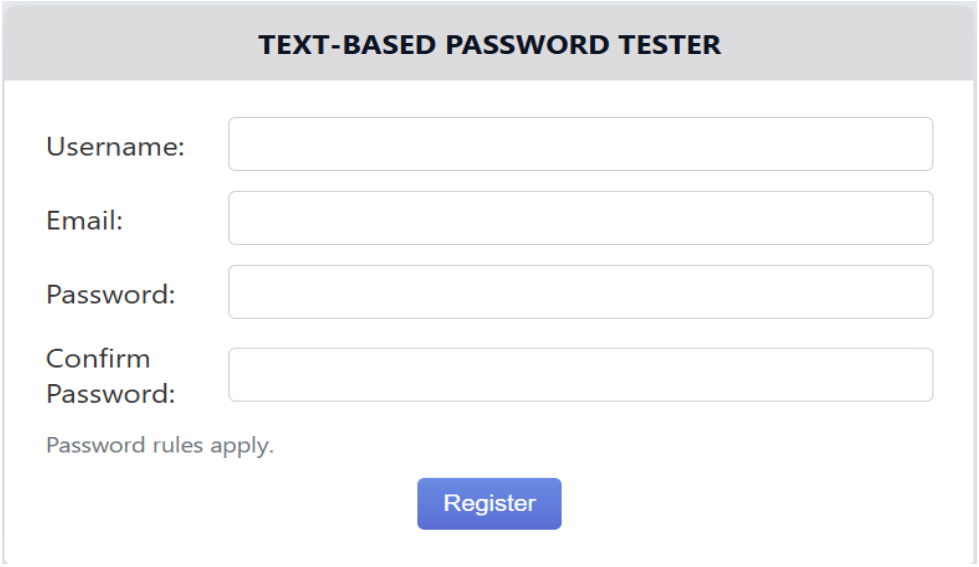

Figure 3. Recall-based registration interface.

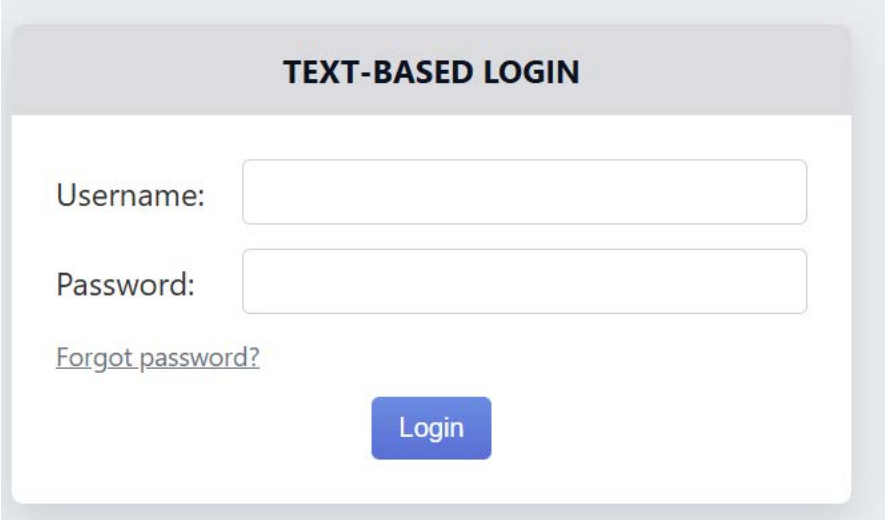

Figure 4. Recall-based login interface.

• Login Interface: A streamlined, standard two-factor input layout used for session access control. The interface prompts the user to provide their registered username string alongside their matching alphanumeric password string to gain system entry.

4. Results and Discussion

The empirical data compiled from the 203 student participants yielded clear variances between the two deployment methodologies across all core testing indices. As mandated by the layout guidelines, Table 1 outlines the statistical evaluation parameters strictly without vertical grid lines.

Table 1

Statistical Summary of System Metrics Evaluation

Metric Evaluated	Graphical Mean (M)	Graphical SD (SD)	Alphanumeric Mean (M)	Alphanumeric SD (SD)	Statistical Margin (Winner)
Perceived Security	4.2	0.8	3.5	1.0	+0.7 (Graphical)
Ease of Use	4.5	0.7	3.1	1.1	+1.4 (Graphical)
Memorability	4.6	0.6	3.4	1.2	+1.2 (Graphical)
Login Speed (seconds)	8.3s	2.1s	14.2s	3.8s	-5.9s (Graphical Faster)

Perceived Security: The graphical password system was rated as more secure (M = 4.2, SD = 0.8) compared to the alphanumeric system (M = 3.5, SD = 1.0). As a general metric, 70% of participants perceived the graphical system as superior in terms of security. This aligns with previous research suggesting that graphical passwords reduce susceptibility to automated phishing and traditional keylogging attacks by relying on visual recognition rather than plain-text entry. However, while graphical passwords were favored, participants raised concerns about 'shoulder surfing,' a potential vulnerability where visual inputs can be easily observed by over-the-shoulder bystanders.

Ease of Use: Ease-of-use ratings heavily favored graphical passwords, with 80% of participants deeming them highly user-friendly. This result supports existing usability research highlighting how image-based systems align seamlessly with human cognitive strengths, particularly visual recognition memory. In contrast, alphanumeric systems, though deeply familiar, impose a significant cognitive load when users are forced to construct and recall complex combinations of letters, numbers, and special characters to satisfy modern security policies.

Memorability: Graphical passwords substantially outperformed alphanumeric systems in terms of long-term retention (M = 4.6, SD = 0.6 vs. M = 3.4, SD = 1.2). A strong majority (75%) of respondents rated graphical passwords as easier to remember. This outcome stems from the psychological 'picture superiority effect.' Users reported associating graphical passwords with meaningful or intuitive visual narratives, making them easier to recall over time.

Login Speed: Graphical passwords enabled much faster authentication times (M = 8.3 seconds, SD = 2.1) compared to alphanumeric passwords (M = 14.2 seconds, SD = 3.8). 70% of participants explicitly reported faster authentication experiences using graphical passwords. These results suggest that while graphical systems may initially appear less familiar to novice users, their learning curve is shallow, encouraging quicker and smoother interactions once mastered.

Overall System Preference & Implications: A significant majority (75%) of participants indicated they would prefer using graphical passwords in daily life, highlighting a high potential for widespread adoption. Bridging the gap between these systems through hybrid models—such as combining an alphanumeric credential with an accompanying graphical confirmation sequence—could address varied user needs while capitalizing on the strengths of both approaches.

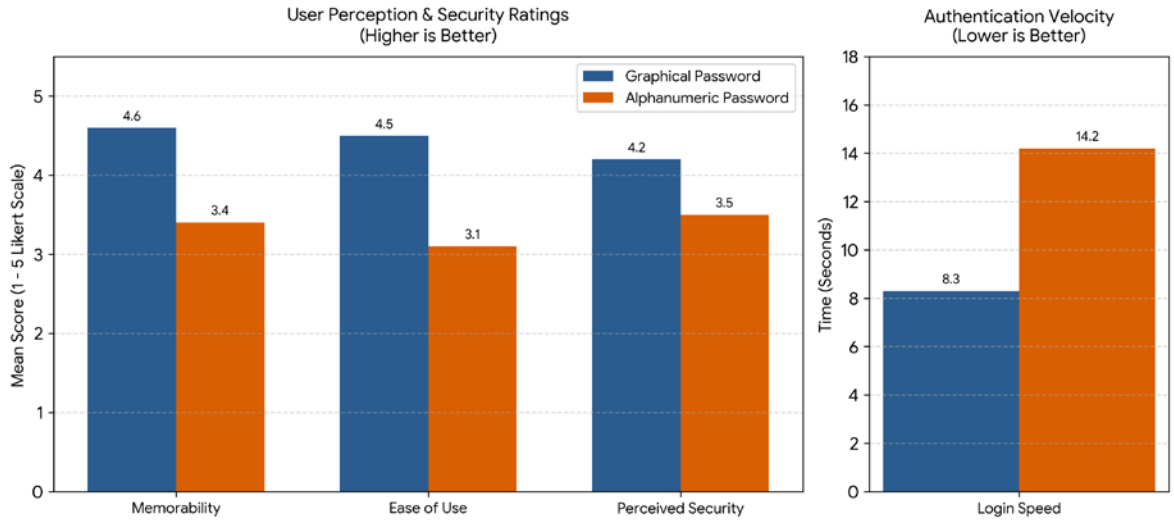

Figure 5. Empirical evaluation of system metrics comparing graphical and alphanumeric password modalities.

5. Conclusions

This research investigated the user preferences and experiences with alphanumeric and graphical password systems among 203 students at the Federal University Birnin Kebbi. The study revealed that graphical passwords are widely favored, with the majority of participants highlighting advantages in ease of use, memorability, login speed, and overall user satisfaction. In contrast, alphanumeric passwords, while familiar, proved to be less user-friendly and more prone to operational challenges such as password forgetfulness and complex syntax compliance. The findings demonstrate the potential of graphical password systems as a viable alternative to traditional text-based authentication. However, concerns such as susceptibility to shoulder-surfing threats must be addressed to maximize the security profile of graphical password systems. Hybrid models and adaptive security features, such as dynamic graphical displays or multi-factor authentication, could further capitalize on these strengths while effectively nullifying baseline vulnerabilities.

Research Data Availability Statement

The raw questionnaire evaluation datasets and system testing session logs compiled during this study are securely archived and available from the corresponding author upon reasonable academic request.

Contribution of Authors

Sabiu Lawali Tsafe: Conceptualization, Methodology, Software development, Writing – original draft.
Abdulhakeem Ibrahim: Data curation, Experimental evaluation, Investigation.
Armayau Saadu: Supervision, Validation, Writing – review & editing.

Conflicts of Interest

The authors declare no conflict of interest.

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THE ROLE OF FAMILY MEDICINE IN STRENGTHENING PUBLIC HEALTH AND SUSTAINABLE DEVELOPMENT

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Abstract. Access to primary healthcare services is a key indicator of health system performance, reflecting both their efficiency and equity. The study analyzes the evolution of access to family medicine in the Republic of Moldova during the period 2019–2024, under the influence of the crisis generated by the COVID-19 pandemic, and compares recent data (2023) with the situation in Romania, Poland, and Ukraine. The methodology included an analysis of national and international statistical sources [1], as well as graphical representations of trends. The results show that in the Republic of Moldova, overall access declined significantly between 2020 and 2021, reaching a level of approximately 75–80%, but gradually recovered in the following years, reaching 83% in 2023. However, disparities persist between urban (88%) and rural (77%) areas, more pronounced than in Romania or Poland, where the differences are under 5%. By comparison, Ukraine has a lower overall level of access (78%), exacerbated by the context of multiple crises. The conclusions highlight the need to strengthen primary healthcare infrastructure, expand telemedicine, and implement support programs for rural areas as solutions to reduce inequalities and align with European standards.

Keywords: *public health, primary healthcare, family medicine, sustainability, health policies.*

Abstract. Accesul la serviciile medicale primare reprezintă un indicator esențial al performanței sistemelor de sănătate, reflectând atât eficiența, cât și echitatea acestora. Studiul analizează evoluția accesului la medicina de familie în Republica Moldova în perioada 2019–2024, sub influența crizei generate de pandemia COVID-19, și compară datele recente (2023) cu situația din România, Polonia și Ucraina. [1], Metodologia a inclus analiza surselor statistice naționale și internaționale, precum și reprezentarea grafică a tendințelor. Rezultatele arată că în Republica Moldova accesul total a scăzut semnificativ în perioada 2020–2021, atingând un nivel de circa 75–80%, dar a cunoscut o redresare graduală în anii următori, ajungând la 83% în 2023. Totuși, persistă disparități între mediul urban (88%) și cel rural (77%), mai accentuate decât în România sau Polonia, unde diferențele sunt sub 5%. Comparativ, Ucraina prezintă un nivel general mai redus al accesului (78%), accentuat de

contextul crizelor multiple. Concluziile evidențiază necesitatea consolidării infrastructurii medicale primare, a extinderii telemedicinei și a programelor de sprijin pentru zonele rurale, ca soluții pentru reducerea inegalităților și alinierea la standardele europene.

***Cuvinte-cheie**: sănătate publică, servicii medicale primare, medicina de familie, durabilitate, politici de sănătate.*

1. Introduction

Family medicine is a strategic component of the healthcare system, making an essential contribution not only to improving the health of the population but also to the economic and sustainable development of society. This is demonstrated through a patient-centered approach, disease prevention, and continuity of care at the community level. By providing preventive, curative, and educational services, family medicine reduces the need for costly hospital interventions and ensures effective management of chronic diseases. Thus, it helps reduce the financial burden on the healthcare system, increases equitable access to services, and supports social cohesion, especially in rural or disadvantaged areas. International models of practice vary, but converge on the same fundamental principles. In the British system, the family physician serves as the "gatekeeper" of the system, coordinating access to specialists. In the Netherlands and the Nordic countries, the emphasis is on digitalization, prevention, and community collaboration. In the U.S., although the system is fragmented, family medicine is an established specialty, integrated into insurance networks. In post-Soviet countries, such as the Republic of Moldova, the transition from the Semashko model to one centered on family medicine has been complex and gradual, requiring structural reforms and investments in professional training.

Over the past two decades, the literature highlights a profound reconfiguration of family medicine in the face of global challenges: demographic transition, the rising burden of noncommunicable diseases, health inequalities, and health crises (such as the COVID-19 pandemic). A new paradigm of family medicine is emerging—one that is digitalized, integrated, interdisciplinary, and population-centered. The concept of the "primary care team" replaces the solitary figure of the physician, and the emphasis is on collaboration with nurses, psychologists, social workers, and public health specialists. Recent studies by Kringos et al. (2020) and Saltman & Rico (2021) argue that the future of family medicine depends on its ability to respond in an integrated, preventive, and proactive manner to the needs of the community. At the same time, the literature does not ignore systemic challenges: chronic underfunding of family medicine services, a shortage of qualified staff, low professional attractiveness, as well as resistance to change within administrative structures. These challenges require a long-term vision, based on coherent public policies, investment in human resources, and the strengthening of the role of family medicine as an essential service for social cohesion and sustainable development.

In conclusion, the literature reflects the fact that family medicine is not merely a medical profession, but a philosophy of care that places the patient at the center of the system and offers an integrative, continuous, and humanistic approach to health. In a world where medical complexity and uncertainty are on the rise, family medicine offers stability, trust, and efficiency—values indispensable to an equitable and sustainable health system.

In the Republic of Moldova, strengthening the role of family medicine is crucial to reforming the health system and achieving the goals of universal coverage with essential services. At the same time, it serves as a driver of equity and sustainability, contributing to

the achievement of the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being for All). Family medicine is an essential primary resource for economic growth, due to its role in promoting public health and reducing costs associated with complicated treatments or unnecessary hospitalizations. By providing preventive and health promotion services, family medicine helps maintain a healthy and productive workforce, which boosts economic productivity. Furthermore, an efficient and accessible health system reduces the financial burden on the healthcare system and supports the economic stability of communities. In conclusion, family medicine not only cares for individuals but also serves as a fundamental pillar for the sustainable development and economic growth of society.

The economic impact of family medicine is multifaceted:

- It promotes a healthy workforce, contributing to productivity and reducing absenteeism;
- It reduces costs associated with emergency care and hospitalizations;
- It strengthens communities' ability to be self-sustaining through ongoing local support;
- It develops specialized human resources by supporting professional training and employment in the medical field. Illustration!

Family medicine plays an essential role as a primary resource in economic growth through several mechanisms:

1. Improving population health: Easy access to family medicine services contributes to the prevention and early management of diseases, reducing the incidence and severity of health problems. A healthy population is more productive and performs better in economic activities.
2. Reducing healthcare costs: Through prevention and early treatment, family medicine reduces the need for costly interventions in advanced stages of disease, freeing up resources for other investments and economic development.
3. Strengthening the workforce: By promoting health and preventing disease, family physicians help maintain an active and efficient workforce, which stimulates economic growth.
4. Human resource development: Family medicine creates employment and professional training opportunities, contributing to the development of human capital, an essential factor for sustainable economic growth.
5. Increased access to healthcare services: By providing healthcare services at the local level, family medicine reduces inequalities and encourages communities to actively participate in economic activities.

Thus, family medicine not only improves public health but also boosts productivity, reduces costs, and supports sustainable economic development.

2. Discussion and Results

The correlation between family medicine, access to primary healthcare services, and public satisfaction (2019–2024)

Access to family medicine services is a key factor in maintaining and improving the health of the population in the Republic of Moldova. Data show that urban areas have easier access to primary care services compared to rural areas, which is directly reflected in health indicators such as life expectancy and infant mortality .

Between 2019 and 2024, the primary healthcare system was severely impacted by the COVID-19 pandemic, which placed significant strain on medical resources and limited patients' routine access to preventive care and chronic disease managemen. Restrictions and the redeployment of medical staff to manage COVID cases reduced the capacity of family medicine to provide continuous services, especially in already disadvantaged rural areas .

This situation led to increased dissatisfaction regarding wait times and accessibility, with a negative impact on overall patient satisfaction, particularly in rural areas . However, in the post-pandemic period, efforts have been made to restore and digitize primary healthcare services, which have begun to alleviate these issues (Ministry of Health of the Republic of Moldova, 2024).

In terms of satisfaction, communication with the family doctor remains a central element, and improving it contributes to increased trust in the system and more efficient use of healthcare services . Between 2019 and 2024, the population's access to family medicine services in the Republic of Moldova saw significant developments, marked by the impact of the health crisis caused by the COVID-19 pandemic.

In 2019, family medicine service coverage was estimated at approximately 87% of the population, with positive growth particularly in urban areas, as a result of reforms initiated in primary health care and dedicated funding programs .

During 2020–2021, the pandemic led to a significant reduction in access, driven by restrictive quarantine measures, the reallocation of resources to address epidemiological emergencies, and patients' reluctance to seek medical care. It is estimated that visits to family doctors decreased by about 20–25%, with the impact being felt more acutely in rural areas, where pre-existing inequalities have worsened[2]. In 2022, the process of adapting the system and the gradual introduction of digital tools—online consultations and telemedicine services—enabled a slight recovery in access, reaching approximately 80% of the population, though remaining below pre-pandemic levels. Between 2023 and 2024, through the strengthening of digital infrastructure, professional training programs for medical staff, and the implementation of information and awareness campaigns, access to family medicine services increased again, exceeding 85% and approaching pre-pandemic levels. However, challenges remain in ensuring equitable access, particularly for the rural population and socially vulnerable groups (Ministry of Health of the Republic of Moldova, 2024).

Table 1

Trends in access to primary healthcare services in the Republic of Moldova by urban and rural areas (%) for the period 2019–2024.

YEAR	TOTAL ACCESS	URBAN ACCESS	RURAL ACCESS
2019	87	92	80
2020	68	75	60
2021	65	72	58
2022	80	85	74
2023	83	88	77
2024	86	90	80

Source: *Compiled by the author based on the data analyzed (World Health Organization, 2022; OECD, 2023; Ministry of Health of the Republic of Moldova, 2024).*

The data presented in Table 1 reflect significant fluctuations in access to primary healthcare services in the Republic of Moldova in recent years, with a general trend toward recovery following the impact of the COVID-19 pandemic.

- 2019–2021: In 2019, the overall access rate was 87%, with higher access in urban areas (92%) compared to rural areas (80%). A sharp decline is observed in 2020 (68% overall) and continues in 2021 (65% overall), a direct consequence of the restrictions imposed by the COVID-19 pandemic, which limited the population's access to primary healthcare services, particularly in rural areas. Rural access declines more sharply, indicating the vulnerabilities of rural health infrastructure in crisis situations.
- 2022–2024: After 2021, the healthcare system begins to recover, and overall access to primary care services increases gradually: 80% in 2022, 83% in 2023, and an estimated 86% for 2024. This positive trend is the result of measures to adapt healthcare services, including the development of telemedicine and the expansion of family medicine capacity. However, disparities between urban and rural areas remain evident, with rural access still lagging behind urban levels by approximately 10%.
- **The Role of Family Medicine:** Family medicine, as the main component of primary healthcare services, has played a crucial role in maintaining access and continuity of care, particularly in the context of pandemic restrictions. Investments in this sector, such as the digitization of medical offices and staff training, have contributed to the gradual recovery of access worsened[3].
- **Persistent challenges:** Low rural access points to the need for differentiated policies aimed at reducing territorial inequalities, improving healthcare infrastructure in disadvantaged areas, and supporting family doctors in rural areas.

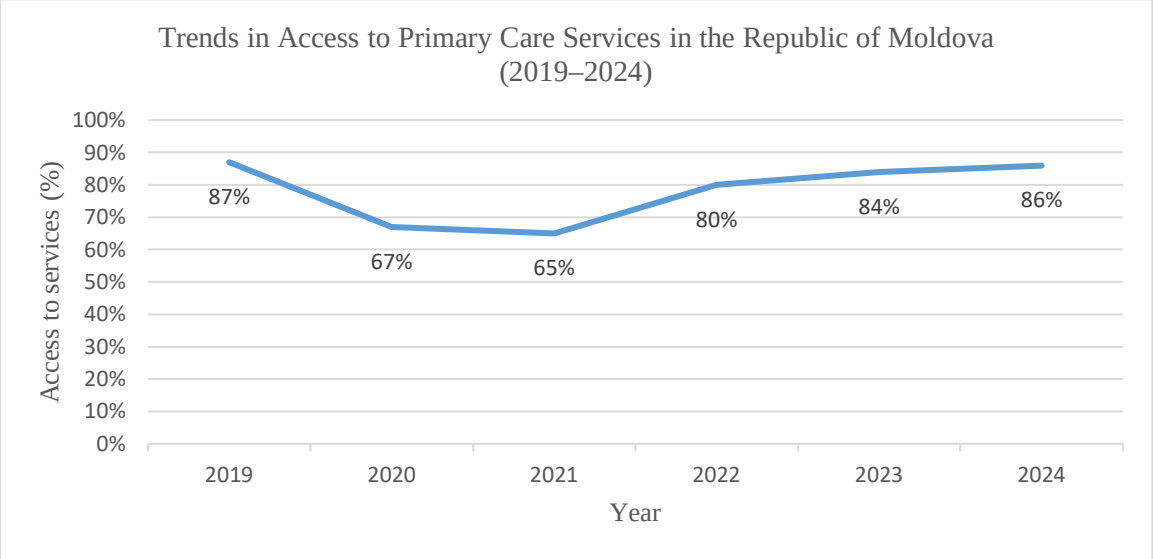

Figure 1. Evolution of access to family medicine services in the Republic of Moldova.

The graph highlights an uneven evolution of access to family medicine services in the Republic of Moldova between 2019 and 2024. In 2019, the level of access reached a pre-pandemic peak (87%), a result of reforms and funding dedicated to primary care. In 2020–2021, a sharp decline to approximately 65% was observed, driven by the COVID-19 pandemic and associated restrictions.

Subsequently, starting in 2022, the trend was upward due to the introduction of telemedicine and the digitization of services, which allowed for a gradual recovery. In 2023–2024, access stabilized at over 85%, approaching pre-pandemic levels but without fully surpassing them.

This trend confirms that **the resilience of the family medicine system** depends on its ability to adapt to crises and integrate technological innovations. However, significant challenges regarding equitable access persist, particularly in rural areas and for socially vulnerable groups.

The authors note that the level of access in the Republic of Moldova is improving, but remains below the Central and Eastern European average, where figures frequently exceed 90% .

1. **Rural-urban inequalities** are more pronounced in the Republic of Moldova than in Western countries, where primary healthcare services are better distributed and financially supported (Ministry of Health of the Republic of Moldova.
2. **Digitalization and telemedicine** have accelerated access in all countries analyzed, including Moldova, but infrastructure and digital literacy remain limited in rural areas[4] .
3. **Common challenges** in the region include a shortage of family doctors, the migration of medical staff to countries with higher salaries, and the growing need for services for chronic diseases and mental health .
4. **The COVID-19 pandemic** has put pressure on primary health care systems, temporarily reducing access to preventive services, but it has also spurred innovation through the implementation of digital services (WHO, 2022).

Comparison of Access to Primary Health Care Services in the Republic of Moldova, Romania, Poland, and Ukraine (2023)

A comparative analysis of access to primary healthcare services in the four countries highlights significant differences between urban and rural areas, as well as variations driven by the socio-economic context and health policies implemented following the COVID-19 pandemic.

Table 2

Comparison of access to primary healthcare services in the Republic of Moldova, Romania, Poland, and Ukraine (2023)

Country	Total access to primary care (%)	Urban access (%)	Rural access (%)	Data source
Republic of Moldova	83	88	77	NBS (2023), Ministry of Health of the Republic of Moldova (2023)
Romania	91	93	89	OECD (2022), Romanian Ministry of Health (2023)
Poland	92	94	90	OECD (2022)
Ukraine	78	83	70	WHO (2022), NBS Ukraine (2023)

Note: *Data refer to estimated access in 2023, post-COVID-19 pandemic*

Source: *National Bureau of Statistics of the Republic of Moldova (2023), Organization for Economic Cooperation and Development (OECD, 2022), Ministry of Health of Romania (2023), World Health Organization (WHO, 2022).*

In **the Republic of Moldova**, the overall level of access (83%) is lower compared to **Romania (91%)** and **Poland (92%)**, but slightly higher than in **Ukraine (78%)**. Urban–rural disparities remain pronounced: 88% in cities versus 77% in villages. This gap reflects inadequate infrastructure and a shortage of family doctors in rural areas, exacerbated by the migration of medical staff and financial constraints (NBS, 2023; Ministry of Health of the Republic of Moldova, 2023).

Romania and **Poland** show a more balanced coverage between urban and rural areas (differences of only 2–4 percentage points), which is due to both well-established health insurance systems and investments in community health centers and in transportation and digital infrastructure [5, 6].

Ukraine has the lowest access, particularly in rural areas (70%), reflecting the cumulative impact of the pandemic and the instability caused by the military conflict. However, the data show an effort to maintain access in cities (83%), where medical infrastructure has received additional support from international organizations [5].

Family medicine is the foundation of the primary health care system in most European countries, being considered essential for ensuring universal access, prevention, and continuous monitoring of patients (OECD, 2022). However, access to and the quality of services vary significantly depending on the level of economic development, national policies, and medical infrastructure.

Table 3

Comparative analysis of access to family medicine in the Republic of Moldova and European countries (2019–2024) .

Country / Region	Access to primary care (%)	Key characteristics	Main challenges
Republic of Moldova	85 (2024)	System in transition, lower access in rural areas, increasing digitization	Limited resources, rural-urban inequalities
Romania	90–95	Developed system, with clear policies supporting family medicine	Migration of doctors, underserved areas
Poland	92–96	Widespread access, investment in primary care and digitization	Regional disparities, aging population
Hungary	90–93	Well-structured system, family doctors involved in prevention	Limited financial resources in rural areas
Germany	95–98	Robust, well-funded system with an emphasis on family medicine	Rising costs, shortage of doctors in rural areas
France	94–97	Widespread access, with strong integration of primary care services	Administrative complexity, regional disparities
Sweden	96–99	Universal access, advanced digital services	High costs, insufficient staff in some areas

Source: *(World Health Organization, 2022; OECD, 2023; Ministry of Health of the Republic of Moldova, 2024).*

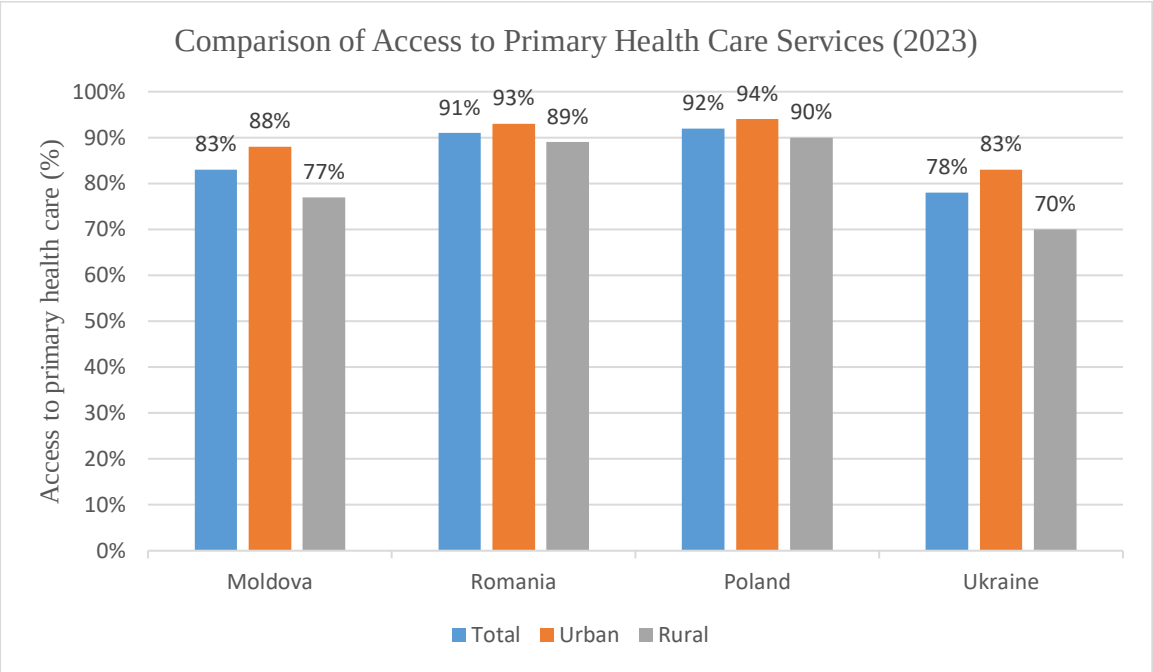

Figure 2. Comparison of access to primary health care services (2023).
Source: *compiled by the authors based on international documents.*

In a regional context, the Republic of Moldova ranks at an intermediate level in terms of access to primary healthcare services, with a total access rate of approximately 83% in the post-pandemic period [7]. This figure indicates significant progress compared to the years preceding the COVID-19 pandemic, a period during which access to healthcare services was severely affected. However, Moldova's performance remains lower than that of countries such as Romania and Poland, where access to primary care is not only more widespread but also more equitably distributed between urban and rural areas . This difference reflects both a better-developed healthcare infrastructure and more robust public health policies and more substantial funding dedicated to primary care in these countries [8].

A common feature of all the countries analyzed is the existence of disparities between urban and rural areas regarding access to medical services [9]. In the case of the Republic of Moldova and Ukraine, these inequalities are more pronounced, highlighting increased difficulties in ensuring equal access in rural areas [10]. These gaps can be attributed to multiple factors, including limited infrastructure, a shortage of specialized medical staff, geographical conditions, and insufficient financial resources allocated to rural areas. This situation leaves the rural population vulnerable, with negative effects on public health and social cohesion.

In contrast, Romania and Poland benefit from robust strategies characterized by sustained investments in family medicine and the accelerated adoption of digital health technologies.These measures facilitate a more equitable distribution of services and contribute to increased quality and patient satisfaction [11]. Digitalization is a key driver in the modernization of the healthcare system, enabling more efficient communication, continuous patient monitoring, and the optimization of medical processes [12].

For the Republic of Moldova, these comparative realities underscore the need for far-reaching reforms and sustained investment in family medicine, with a particular focus on reducing disparities between urban and rural areas. Such an approach involves allocating additional financial resources, developing healthcare infrastructure, strengthening human

capital through training and retention of medical and h e staff, as well as the widespread integration of digital solutions into primary medical practice [13].

Table 4

Trends in access to family medicine services in the Republic of Moldova (2019–2024)

Year	Overall situation	Estimated level of access	Key factors	Specific observations
2019	Increasing access due to reforms and funding in primary health care	87%	Reforms in primary care; dedicated funding programs	Greater coverage in urban areas
2020	Sharp decline in access due to the pandemic	-20% compared to 2019	Lockdown, resources redirected to COVID-19	Rural inequalities have worsened
2021	Continued restrictions and pandemic impact	65–67%	Patient reluctance; system overload	Lowest access during the period analysed
2022	The beginning of recovery through digitalization and telemedicine	80	Online consultations, institutional adaptation	Still below pre-pandemic levels
2023	Infrastructure consolidation and staff training	83–84%	Digital platforms, awareness campaigns	Gradual but uneven growth between rural and urban areas

Source: *compiled by the authors based on international documents.*

The evolution of access to primary care services between 2019 and 2024 reflects the complex dynamics of Moldova's health system, situated at the intersection of structural reforms, the pandemic crisis, and the accelerated process of digitalization. Analysis of the data summarized in Table 4 highlights three distinct phases: pre-pandemic consolidation (2019), the decline caused by the COVID-19 pandemic (2020–2021), and gradual post-crisis recovery (2022–2024) [3].

In 2019, the estimated level of access to family medicine services (87%) indicates a favorable trend, supported by reforms in primary care and financing mechanisms aimed at strengthening community-based services. This period can be interpreted as one of relative institutional maturation, in which family medicine reaffirms its role as the gateway to the healthcare system and a pillar of prevention. However, even in this favorable context, structural differences persisted between urban and rural areas, driven by the unequal distribution of human and infrastructural resources.

The year 2020 marks a significant break in the upward trajectory of access. The estimated decline of approximately 20% compared to 2019 reflects the direct impact of the pandemic on primary care services. Lockdowns, mobility restrictions, and the reallocation of resources toward managing COVID-19 cases led to a reduction in routine consultations, the postponement of preventive services, and a decrease in the population's ability to access care. In rural areas, these effects were amplified by underdeveloped infrastructure and limited access to digital alternatives. Thus, the pandemic not only reduced the overall level of access but also exacerbated existing territorial inequalities.

In 2021, the level of access (65–67%) reached the lowest point of the analyzed period. This phase highlights the cumulative nature of the crisis's effects: the overburdening of medical staff, patients' reluctance to attend in-person consultations, and the depletion of institutional resources. From a systemic perspective, this period can be interpreted as a major test of the healthcare system's resilience. The limited capacity to maintain the continuity of essential primary care services has demonstrated structural vulnerabilities, particularly regarding emergency planning and organizational flexibility.

Starting in 2022, a recovery trend (approximately 80%) is observed, associated with the gradual integration of telemedicine and the digitization of services. Online consultations, electronic appointments, and the use of digital platforms have helped restore contact between doctors and patients. This phase highlights the role of digital transformation as a catalyst for systemic resilience. However, the level of access remains below pre-pandemic levels, suggesting that recovery is gradual and contingent on institutional adaptation and social acceptance of new forms of medical interaction.

The years 2023–2024 indicate a gradual consolidation (83–88%), supported by investments in infrastructure, staff training, and information campaigns. The trend toward approaching pre-pandemic levels suggests a stabilization of primary care services and an internalization of the lessons learned during the crisis. However, the persistence of rural–urban disparities and the shortage of family doctors in certain regions indicate the need for additional structural interventions.

From a conceptual perspective, the analyzed trends can be interpreted through the lens of the relationship between accessibility, resilience, and digitalization. Access to family medicine services is not merely an operational indicator but a barometer of the health system's equity and sustainability. The sharp decline during the pandemic demonstrates this indicator's sensitivity to external shocks, while the subsequent recovery underscores the importance of institutional adaptability.

For public policy, the results suggest several priority strategic directions:

1. Strengthening the human resources in rural areas through financial incentives and retention programs.
2. Expanding digital infrastructure and reducing the technological gap between regions.
3. Permanently integrating telemedicine into the basic service package.
4. Developing crisis planning mechanisms while maintaining the continuity of essential services.

3. Conclusions

To strengthen access to family medicine services in the Republic of Moldova, a medium- and long-term strategy is needed that includes:

1. **Expanding digital infrastructure** and telemedicine platforms across all regions, with a focus on rural areas;
2. **Continuing education for family physicians** in the use of digital technologies and modern methods of communicating with patients;
3. **Implementing additional funding mechanisms** for vulnerable groups to reduce inequalities;
4. **Constant monitoring of access indicators** and adaptation of public policies in line with demographic and epidemiological trends;
5. **Integrating family medicine services** into a broader community health network to more effectively meet the needs of the population.

Through these measures, the family medicine system can become more **resilient, equitable, and patient-centered**, ensuring stable and sustainable coverage even in times of crisis. In conclusion, the 2019–2024 period shows a "decline–recovery" trajectory, characteristic of health systems affected by global shocks. Family medicine in the Republic of Moldova has demonstrated a moderate capacity for adaptation, but the sustainable consolidation of access requires coherent policies, consistent investment, and an integrative approach focused on territorial equity and digital transformation. From a sustainable development perspective, strengthening family medicine remains central to increasing the resilience of the health system and improving the population's quality of life.

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CONCEPTUAL FOUNDATIONS, GENERAL CHARACTERIZATION AND PSYCHOLOGICAL PARTICULARITIES OF HEARING AS A CRIMINAL PROSECUTION ACTION

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Abstract. Examination constitutes the most frequently employed criminal investigative action; however, its conceptual foundations and psychological particularities remain insufficiently systematized in scholarly doctrine. The study proceeds from the hypothesis that a rigorous analysis of the conceptual framework and psychological dimension of examination contributes to enhancing the efficiency of this procedural activity. The research aims to analyze the conceptual foundations, general characterization, and psychological particularities of examination as a criminal investigative procedural act. The methodology combines doctrinal analysis and synthesis, the logico-juridical method, the comparative method, and the systematic and teleological interpretation of criminal procedural norms. The study systematizes doctrinal definitions of examination, establishes its character as an autonomous means of evidence collection, and critically examines the notion of "psychological contact". The research concludes that psychological contact does not constitute a tactical technique, but rather a precondition for applying forensic tactics, offering a novel perspective with direct practical implications for criminal investigation bodies.

Keywords: *examination, statements, criminal prosecution, criminal investigative action, means of evidence, evidentiary process, probative information, witness, aggrieved party, suspect, accused person, free narrative, tactical procedure, factual data, psychological rapport, circumstances of the case.*

Rezumat. Audierea reprezintă cea mai frecvent utilizată acțiune de urmărire penală; cu toate acestea, fundamentele sale conceptuale și particularitățile psihologice rămân insuficient sistematizate în doctrină. Studiul pornește de la ipoteza că o analiză riguroasă a cadrului conceptual și a componentei psihologice a audierii contribuie la eficientizarea acestei activități procesuale. Scopul cercetării constă în analiza fundamentelor conceptuale, a caracterizării generale și a particularităților psihologice ale audierii ca acțiune de urmărire penală. Metodologia îmbină analiza și sinteza doctrinară, metoda logico-juridică, metoda comparativă, precum și interpretarea sistematică și teleologică a normelor procesual-penale. Au fost sistematizate definițiile doctrinare ale audierii, s-a demonstrat caracterul său autonom de colectare a probelor și s-a realizat o analiză critică a noțiunii de ,,contact psihologic". Studiul demonstrează că contactul psihologic nu constituie o tehnică tactică, ci

o condiție prealabilă pentru aplicarea procedeelor criminalistice, oferind o perspectivă nouă cu implicații practice directe în activitatea organelor de urmărire penală.

Cuvinte-cheie: *audiere, declarații, urmărire penală, acțiune de urmărire penală, mijloc de probă, probatoriu, informații pronatorii, martor, parte vătămată, bănuit, învinuit, relatare liberă, procedeu tactic, date de fapt, contact psihologic, circumstanțe ale cauzei.*

1. Introducere

„Ascultarea persoanei care are cunoștință despre o anumită faptă sau împrejurare, în legătură cu cauza penală, respectiv informația obținută este, în opinia autorilor Em. Stancu și T. Manea, de natură să servească aflării adevărului"[1, p.177].

Audierea constituie nu doar o acțiune de urmărire penală eficientă și cea mai frecvent utilizată, ci și una indispensabilă în toate cazurile de efectuare a urmăririi penale. Nu în toate cauzele penale sunt dispuse și efectuate expertize judiciare. De asemenea, investigația poate fi realizată cu succes și fără prezentarea persoanelor sau a obiectelor pentru recunoaștere, fără efectuarea experimentelor judiciare ori a altor acțiuni procesuale prevăzute ca mijloace de colectare a probelor. Însă, în opinia profesorului V. A. Obrazțov, „...nici o cauză penală nu poate fi soluționată fără efectuarea audierilor. Cunoașterea caracteristicilor juridice și criminalistice ale audierii, a particularităților pregătirii și desfășurării diferitelor tipuri de audiere, precum și capacitatea de a le aplica în practică constituie o condiție esențială pentru atingerea scopurilor acestei acțiuni procesuale. Totodată, aceste cunoștințe sunt necesare și în cadrul efectuării altor acțiuni de urmărire penală cu caracter verbal, precum și al acelor acțiuni în a căror structură este inclus, ca element, modul verbal de obținere și verificare a informației cu relevanță criminalistică"[2, p. 35].

În știința procesual-penală, audierea este, de regulă, definită ca o acțiune de urmărire penală care constă în obținerea de la persoana audiată a unor informații privind faptele ce fac parte din obiectul probatoriului în cauză[3, p. 113] sau în obținerea de către organul de urmărire penală a declarațiilor referitoare la circumstanțele care au relevanță pentru soluționarea cauzei penale[4, p. 101].

În doctrină se întâlnesc și alte interpretări ale noțiunii de audiere, care precizează sau explică anumite aspecte ale acestei acțiuni procesuale. De exemplu, A. K. Gavrilov și S. P. Efimicev definesc audierea ca o acțiune a cărei esență constă „în obținerea de către organul de urmărire penală de la persoana audiată a unor informații privind evenimentul infracțiunii, persoanele care au comis-o, natura și mărimea prejudiciului, cauzele și condițiile care au determinat săvârșirea infracțiunii, precum și cele care au favorizat comiterea acesteia, precum și alte circumstanțe care prezintă importanță pentru cauza penală"[5, p. 277].

În opinia autorilor V. Jitariuc și V. Rusu „Audierea reprezintă interacțiunea dintre persoana interogată și reprezentantul organului de urmărire penală, cu scopul de a obține mărturii, adică informații (date, mesaje) despre faptele relevante pentru cauza penală"[6, p. 414]. Cercetătorul M. Gheorghiță descrie audierea ca fiind „...o acțiune de urmărire penală și de tactică criminalistică ce constă în obținerea, în corespundere cu prevederile Codului de procedură penală, de la persoana citată sau prezentată a declarațiilor referitor la circumstanțele și alte date ale faptei cercetate"[7, p. 517]. Autorii T. Osoianu, D. Ostavciuc, Iu. Odagiu și C. Rusnac susțin că „Audierea reprezintă un procedeu probatoriu, al cărui scop este dobândirea și fixarea de către organul de urmărire penală (instanța de judecată), în conformitate cu legislația în vigoare, a declarațiilor audiatului cu privire la informațiile cunoscute de acesta și care face parte din obicetul probatoriului în cauza penală" [8, p. 153].

Profesorul S. Doraș este de părerea că „Imaginațiile celor care au perceput fapte cu semnificație probantă nu pot fi cunoscute altfel decât prin transpunerea lor în cadrul unui proces de comunicare. În justiția penală, susține S. Doraș, acest proces se realizează prin actul procedural de ascultare (audiere), adică prin mobilizarea persoanelor ce dețin date probante privind împrejurăîrile fapte enale pentru a le mărturisi în fața organului de urmărire penală sau a instanței de judecată"[9, p. 358]. B. T. Bezlepkin definește audierea ca „...fiind un dialog oral reglementat de legea procesual-penală, între persoana cu funcție de răspundere în a cărei procedură se află cauza penală și martorul, partea vătămată, bănuitul sau învinuitul, dialog care se desfășoară în scopul obținerii unor date factuale (informații verbale) cu valoare probatorie" [10, p. 226; 11, p. 243].

Nu se poate să nu fim de acord cu autorul menționat în ceea ce privește faptul că audierea reprezintă un dialog, adică „o conversație între două sau mai multe persoane; acțiunea de a asculta și rezultatul acesteia"[12, p. 114], și nu o simplă transmitere unidirecțională de informații de către persoana audiată, fie în formă orală, fie în formă scrisă. Totuși, această definiție nu ia în considerare situațiile în care cercetarea cauzei penale este efectuată de un grup de ofițeri de urmărire penală. În plus, în afara definiției rămân acțiunile privind procedura de consemnare și documentare a desfășurării și rezultatelor audierii (activitatea de atestare, perfectare procedurală).

Operațiunile cognitive în cadrul audierii pot fi efectuate nu doar de persoana care conduce audierea, ci și de alți participanți la aceasta, de exemplu de apărătorul bănuitului sau al învinuitului, care participă la audiere, efectuată la cererea sa sau la cererea bănuitului ori a învinuitului; precum și în cazul audierii martorului, părții vătămate, inculpatului sau expertului în ședința de judecată. În ceea ce privește operațiunile de atestare (procedurale), acestea pot fi realizate, pe lângă organul de urmărire penală, și de persoanele audiate sau de alți participanți la audiere. Astfel, de exemplu, corectitudinea consemnării declarațiilor este confirmată chiar de către persoana audiată.

Trebuie de asemenea menționat că participanții la procesul penal nu au întotdeauna nevoie ca o persoană străină să îi determine să depună declarații. Mai mult, în practică există cazuri în care organele de urmărire penală nu doar că nu îi determină pe bănuiți, învinuiți să depună declarații, dar ignoră și numeroasele cereri prin care aceștia își exprimă dorința de a depune declarații și solicită efectuarea audierii.

Conform legislației în vigoare, audierea poate fi inițiată chiar de către participantul la proces. Astfel, potrivit opiniei lui A. A. Toporcov, „...legea conferă părții vătămate, bănuitului și învinuitului dreptul de a depune declarații. Dreptului acestor participanți de a da declarații corespunde obligația organului de urmărire penală și a instanței de judecată de a obține declarațiile, adică de a audia participantul respectiv la proces. Este evident că, în cazurile în care audierea are loc la cererea părții vătămate, bănuitului sau învinuitului, nu organul de urmărire penală determină participantul la proces să depună declarații, ci, dimpotrivă, participantul însuși determină organul în a cărui procedură se află cauza penală să obțină de la el declarațiile, să asculte informațiile comunicate și să le consemneze conform procedurii legale"[13, p. 101].

2. Materiale și metode

Baza teoretico-metodologică a cercetării privind esența, sarcinile și scopul audierii în procesul penal este constituită din ansamblul conceptelor, principiilor și teoriilor fundamentale dezvoltate în doctrina dreptului procesual penal, coroborate cu reglementările

legale în vigoare și cu practica judiciară relevantă în această materie. Cercetarea se înscrie într-un demers științific riguros, structurat pe două componente esențiale și complementare: fundamentul teoretic și instrumentarul metodologic.

I. Fundamentul teoretic

Fundamentul teoretic al cercetării este constituit din:

a) Teoriile generale ale probei și ale mijloacelor de probă, în special cele referitoare la procedeele probatorii, la funcțiile acestora în mecanismul de administrare a probelor și la rolul lor determinant în aflarea adevărului în procesul penal. Aceste teorii au fost analizate din perspectiva contribuției lor la configurarea cadrului conceptual al audierii ca procedeu probatoriu distinct, cu natură juridică proprie și funcții specifice în economia procesului penal.

b) Doctrina dreptului procesual penal — atât cea națională, cât și cea comparată —, valorificată în scopul identificării și sistematizării principalelor abordări teoretice privind esența juridică, sarcinile funcționale și finalitatea procesuală a audierii. Au fost integrate contribuțiile reprezentative ale autorilor din domeniul dreptului procesual penal care au tratat această instituție din perspectiva teoriei probelor, a garanțiilor procesuale și a principiilor fundamentale ale procesului penal echitabil.

c) Reglementările legale naționale și internaționale aplicabile în materia administrării probelor, inclusiv normele procesual-penale care guvernează efectuarea audierii, interpretate în lumina principiilor legalității, contradictorialității și aflării adevărului. Aceste reglementări au constituit suportul normativ indispensabil pentru evaluarea conformității practicii judiciare cu exigențele procedurale și cu standardele dreptului la un proces echitabil.

d) Practica judiciară relevantă, valorificată ca sursă complementară de cunoaștere și ca instrument de verificare a eficienței aplicative a normelor procesual-penale. Jurisprudența în materie a permis identificarea disfuncționalităților procedurale, a erorilor de identificare și a riscurilor de viciere a probelor obținute prin intermediul audierii, oferind astfel un suport empiric cercetării teoretice.

II. Instrumentarul metodologic

Din punct de vedere metodologic, cercetarea se întemeiază pe o combinație de metode științifice specifice științelor juridice, selectate și aplicate în funcție de natura obiectului de studiu:

e) Metoda analizei și sintezei, utilizată pentru examinarea detaliată a componentelor structurale ale audierii — condiții de admisibilitate, procedură de desfășurare, valoare probatorie — și pentru integrarea acestora într-o viziune unitară și coerentă asupra instituției.

f) Metoda logico-juridică, prin intermediul căreia au fost examinate relațiile de cauzalitate, conexiune și condiționare dintre normele procesual-penale aplicabile și efectele lor practice în cadrul urmăririi penale și al judecății.

g) Metoda comparativă, aplicată în scopul identificării similitudinilor și diferențelor existente între reglementările și practicile judiciare din diferite sisteme de drept procesual penal în materia audierii, cu accent pe garanțiile procesuale și pe standardele de fiabilitate a identificării.

h) Metoda interpretării sistematice și teleologice a normelor de drept procesual penal, utilizată pentru înțelegerea sensului și finalității reglementărilor aplicabile audierii în contextul mai larg al sistemului probator și al principiilor fundamentale care guvernează procesul penal.

3. Discuții și rezultate obținute

În cadrul procedurii de audiere se realizează nu doar atribuțiile participanților la procesul penal de a obține declarații, ci și dreptul acestora de a le face. Prin urmare, audierea, a cărei componentă esențială este depunerea declarațiilor, reprezintă o formă juridică de exercitare a dreptului bănuitului, învinuitului și părții de a face declarații. În plus, stimularea persoanei audiate de a da declarații poate fi realizată nu doar de către reprezentantul organului de urmărire penală, ci și de către bănuit, învinuit însuși.

De exemplu, „stimularea" martorului, a părții vătămate sau a altui învinuit de a depune declarații poate avea loc și în cadrul audierilor efectuate de învinuit împotriva persoanei care îl incriminează, în conformitate cu litera „c" a alineatului 3 al articolului 14 din Pactul Internațional privind Drepturile Civile și Politice[14, pp. 30-50] și litera „d" a alineatului 3 al articolului 6 din Convenția Europeană pentru apărarea drepturilor omului și a libertăților fundamentale[15].

Codul de procedură penală al Republicii Moldova[16] include audierea în rândul acțiunilor de urmărire penală (acțiuni judiciare) - (art. 104-105, art. 111). Conform cerințelor Codului de procedură penală al Republicii Moldova, probe precum declarațiile martorilor, declarațiile părților vătămate, declarațiile bănuiților, declarațiile învinuiților și declarațiile expertului se obțin exclusiv prin intermediul audierii (art. 104, 105, 111 și 153 Cod de procedură penală al Republicii Moldova). Prin urmare, din perspectiva legii, audierea, la fel ca orice altă acțiune de urmărire penală, constituie un mijloc autonom de colectare a probelor.

Audierea, ca mijloc de colectare și verificare a probelor, dispune de tehnici proprii, care pot fi caracterizate drept mijloace de obținere a probelor: tehnici procesuale, tactice și psihologice.

Ținând cont de cele afirmate, despre fiecare acțiune de urmărire penală în parte, inclusiv audierea, se poate spune că reprezintă un mijloc autonom de obținere a informațiilor privind circumstanțele evenimentului investigat, caracterizat prin tehnici specifice de obținere și consemnare a informațiilor corespunzătoare (procesuale, tactice și psihologice), a căror aplicare, în cadrul procesului penal, se încadrează în atribuțiile organelor de urmărire penală și ale instanței de judecată.

Potrivit lui A. P. Râjacov, „Audierea reprezintă un fenomen juridic destul de complex. Aceasta poate și trebuie analizat nu doar ca o acțiune de urmărire penală, ca unul dintre mijloacele prevăzute de lege pentru colectarea și verificarea probelor, ci și din mai multe perspective: 1) ca instituție juridică; 2) ca unul dintre atribuțiile organelor de urmărire penală și ale instanței de judecată; 3) ca formă de manifestare a urmăririi penale, unul dintre mijloacele prevăzute de lege pentru incriminarea persoanelor vinovate de comiterea infracțiunii; 4) ca mijloc procesual de materializare a declarațiilor; 5) ca mijloc de apărare - pentru bănuit, împotriva suspiciunii; pentru învinuit, împotriva acuzării aduse; 6) ca mijloc de protejare a drepturilor și intereselor legale ale victimei infracțiunii"[17, p. 24].

Ca instituție a dreptului procesual penal, audierea reprezintă un ansamblu de norme care reglementează activitatea organului de urmărire penală în ceea ce privește: 1) citarea pentru audiere a tuturor persoanelor a căror participare este considerată necesară, fie conform legii, fie conform aprecierii reprezentantului organului de urmărire penală (activitatea pregătitoare); 2) obținerea, depunerea și consemnarea declarațiilor persoanelor audiate (martori, părți vătămate, bănuiți, învinuiți, experți), inclusiv prin utilizarea mijloacelor științifico-tehnice.

În majoritatea studiilor care abordează problema efectuării audierilor se menționează necesitatea stabilirii unui „contact psihologic". Unii autori oferă o definiții și recomandări privind modul de realizare a acestuia, alții se limitează doar la definiție, iar unii îl menționează doar succint. Mulți indică în mod expres contactul psihologic cu persoana audiată ca element obligatoriu al recomandărilor tactice, o condiție necesară pentru atingerea obiectivelor audierii. În acest sens, S. G. Eremeev și A. F. Karavaev consideră stabilirea contactului psihologic drept „condiția inițială a desfășurării audierii" [18, p. 185].

În plus, A. N. Vasiliev a inclus „stabilirea contactului psihologic între ofițerul de urmărire penală și participanții la acțiunile de urmărire penală" în cadrul grupului de tehnici tactice privind psihologia relațiilor acestuia cu participanții la acțiunile de urmărire penală, tehnici care trebuie aplicate nu doar în timpul audierii, ci și în cadrul oricăror alte acțiuni de urmărire penală bazate pe comunicare[19, p. 60].

Stabilirea contactului psihologic reprezintă un element indispensabil al recomandărilor pentru desfășurarea unei audieri eficiente, indiferent de circumstanțele în care aceasta are loc. În același timp, deși termenul este menționat frecvent, numărul mențiunilor nu se transformă automat într-o calitate corespunzătoare, ba chiar, în multe cazuri, situația este inversă.

Analiza literaturii de specialitate a arătat că noțiunea de „contact psihologic" în criminalistică este adesea folosită ca o expresie atractivă, căreia îi sunt atribuite sensuri extrem de variate, neuniforme între diferiți autori și adesea fără legătură reală între ele. În aceste condiții, este firesc că nu există și nu poate exista o concepție clară privind metodele de stabilire și menținere a contactului psihologic, precum și criterii precise de evaluare a existenței și calității acestuia.

Un factor care adaugă un grad și mai mare de incertitudine îl constituie utilizarea, de către autori, a unor termeni criminalistici diferiți pentru a defini conceptul de „contact psihologic", ceea ce face ca aceste definiții să fie practic incompatibile între ele.

Referindu-se la faptul că în literatura criminalistică conceptul de „contact psihologic" a primit diverse nuanțe și definiții, G. A. Zorin evidențiază următoarele variante de înțelegere, considerându-le necontradictorii între ele:

- condiție a acțiunii de urmărire penală;
- mijloc tactic sau metodă tactică;
- procedeu tactic;
- metodă tactică;
- etapă a acțiunii de urmărire penală;
- operațiune tactică (combinație);
- stare favorabilă a reprezentantului organului de urmărire penală sau a interlocutorului său;
- element al tacticii și strategiei criminalistice;
- abordare tactică centrată pe persoană[20, p. 332].

Această enumerare poate fi completată cu abordările lui A. N. Vasiliev și M. P. Maliutin, care utilizează termenii de „sarcină tactică"[19, p. 61] și, respectiv, „obiectiv tactic"[21, p. 114].

Definirea conceptului de „contact psihologic" prin utilizarea unei asemenea terminologii criminalistice specializate pare a fi necorespunzătoare, deoarece poate crea o imagine eronată asupra esenței sale. În literatura de specialitate se remarcă controversă[22, p. 277] față de abordarea precum că „contactul psihologic, în sine, nu constituie o tehnică de ordin tactic"[23, p. 56].

Formulând conceptul de „contact psihologic" ca o relație profesională și coordonată între reprezentantul organului de urmărire penală și martor, parte vătămată, bănuit sau învinuit, care se dezvoltă pe baza poziției procesuale corecte a reprezentantului organului de urmărire penală și a comportamentului persoanei audiate, corespunzător sau necontradictoriu cu obiectivele urmăririi penale, G. G. Dospulov subliniază, de asemenea, că „...acesta nu poate fi considerat o tehnică tactică a audierii" [24, p. 17].

Or, merită să fim de acord cu opinia potrivit căreia „...în spatele acestei categorii se află o stare particulară a relațiilor, care se formează în cursul comunicării interpersonale, o atmosferă specială favorabilă schimbului constructiv de informații și realizării altor obiective în cadrul activității de pregătire și desfășurare a acțiunii de urmărire penală" [24, p. 16].

Astfel, contactul psihologic nu reprezintă o tehnică criminalistică independentă, ci mai degrabă o condiție pentru aplicarea altor tehnici dezvoltate de tactica criminalistică. De exemplu, E. A. Ignatenko consideră contactul psihologic „..ca fundament pentru utilizarea tehnicilor tactice de influență" [25, p. 94].

Deși suntem de acord cu faptul că contactul psihologic servește drept „bază pentru aplicarea" diferitelor tehnici criminalistice, ridică obiecții opinia lui M. M. Șamsutdinov, care îl consideră „una dintre combinațiile tactice eficiente utilizate în cadrul audierii"[26, p. 187].

La rândul său, I. I. Aminov consideră că „Stabilirea contactului psihologic reprezintă una dintre etapele desfășurării audierii, etapă în cadrul căreia reprezentantul organului de urmărire penală trebuie să creeze condițiile care să asigure dorința persoanelor audiate de a intra în comunicare cu el"[27, p. 233].

Din diverse motive, nu pare a fi justificată delimitarea stabilirii contactului psihologic ca etapă separată a desfășurării audierii. În sprijinul acestei obiecții, este util să-l citățm pe autorul N. I. Porubov, care subliniază: „Contactul psihologic nu este o etapă separată a audierii și nici o tehnică tactică a acesteia. El trebuie să însoțească întregul parcurs al audierii, iar pentru stabilirea lui este necesară aplicarea unui set de tehnici tactice, determinate de cursul audierii, circumstanțele cauzei, existența probelor și personalitatea celui audiat"[28, p. 41].

Controversată este și definiția contactului psihologic propusă de M. P. Malyutin, care îl consideră prima țintă tactică a audierii, „a cărei atingere generează relații între reprezentantul organului de urmărire penală și persoana audiată, care favorizează obținerea de declarații adevărate și credibile, respectând în același timp normele legale și etice"[21, p. 114].

În concepția care prezintă contactul psihologic ca scop, adică ca un rezultat care trebuie atins, se neglijează necesitatea menținerii sale și probabilitatea ca acesta să fie ușor perturbat. În plus, comparând definițiile oferite de diferiți autori, se remarcă frecvent confuzia între însăși noțiunea de „contact psihologic" (ca anumită caracteristică, condiție sau stare a comunicării) și „stabilirea contactului psihologic" (ca proces orientat spre atingerea acestuia). În acest sens, V. G. Lukașevici a subliniat necesitatea analizării contactului psihologic pe două planuri: ca relații specifice care se formează între participanții la audiere și ca activitate de creare a acestor relații, desfășurată sub formă de comunicare[29, p. 36].

Având în vedere cele menționate mai sus, este necesară stabilirea unei delimitări clare și evitarea confuziei între noțiunile de „contact psihologic" și „stabilirea contactului psihologic", întrucât primul reprezintă o caracteristică a unor condiții specifice, pe când al doilea trebuie înțeles ca un proces de pregătire și activitate orientat spre atingerea acestor condiții.

În plus, considerând contactul psihologic în cadrul audierii ca un rezultat al acțiunilor deliberate, precum și ca o stare și caracteristică a condițiilor de comunicare profesională,

acesta nu trebuie să fie definit prin terminologia adoptată în tactica criminalistică. În mod similar, la formularea definiției „stabilirea contactului psihologic", trebuie evitată folosirea termenilor tactico-criminalistici, chiar dacă există tentația de a considera anumite tehnici psihologice de creare a contactului drept tehnici tactice, ceea ce ar permite în mod eronat clasificarea stabilirii contactului psihologic drept o combinație tactică. Totodată, trebuie diferențiate clar tehnicile utilizate pentru realizarea contactului psihologic de cele care vizează influențarea psihologică a persoanei audiate.

Se consideră că la aceste tehnici trebuie să fie incluse recomandările și metodele dezvoltate în cadrul psihologiei sociale, psihologiei comunicării și programării neurolingvistice. Înțelegerea esenței lor psihologice va contribui la aplicarea cât mai eficientă a acestora, creând condițiile favorabile pentru utilizarea ulterioară a tehnicilor speciale criminalistice, dezvoltate în cadrul compartimentului tacticii criminalistice.

4. Concluzii

Analiza conceptuală a audierii în calitate de acțiune de urmărire penală evidențiază rolul deosebit pe care această activitate procesuală îl are în mecanismul administrării probelor și în procesul de stabilire a adevărului în cauza penală. Studiul aspectelor teoretice și practice ale audierii permite constatarea faptului că aceasta reprezintă una dintre cele mai frecvent utilizate modalități de obținere a informațiilor relevante pentru investigarea infracțiunilor, având o importanță majoră în clarificarea circumstanțelor faptelor cercetate și în conturarea tabloului probator al cauzei. Totodată, cercetarea realizată demonstrează că audierea nu poate fi redusă la o simplă procedură formală de consemnare a declarațiilor unei persoane. Din punct de vedere procesual și tactic, această acțiune implică un ansamblu complex de activități desfășurate de organul de urmărire penală, care presupun dialogul cu persoana audiată, perceperea și analiza informațiilor comunicate, precum și consemnarea acestora în formele prevăzute de lege. În acest sens, audierea se caracterizează printr-o interacțiune directă între subiectul care conduce activitatea de urmărire penală și persoana audiată, interacțiune ce are drept scop obținerea unor informații cât mai complete și veridice despre faptele și împrejurările relevante pentru cauză.

Un element definitoriu al audierii îl constituie modalitatea de exprimare a declarațiilor de către persoana audiată. Acestea pot fi prezentate sub forma unei relatări libere, care oferă posibilitatea expunerii neîntrerupte a faptelor percepute, sau sub forma răspunsurilor la întrebările adresate de către organul de urmărire penală. Ambele modalități au o importanță practică deosebită, întrucât permit clarificarea unor aspecte esențiale ale cauzei și contribuie la completarea informațiilor necesare pentru elucidarea circumstanțelor infracțiunii. De asemenea, rezultatele audierii capătă valoare procesuală doar în măsura în care declarațiile obținute sunt fixate în mod corect și complet, în conformitate cu cerințele legislației procesual-penale. Consemnarea fidelă a declarațiilor, precum și confirmarea exactității acestora de către persoana audiată, reprezintă o garanție importantă a autenticității și fiabilității informațiilor obținute în cadrul acestei acțiuni de urmărire penală. Astfel, audierea se conturează ca o acțiune procesuală complexă, care îmbină elemente juridice, tactice și organizatorice și care are un rol determinant în activitatea de investigare a infracțiunilor. Eficiența acestei activități depinde nu doar de respectarea cerințelor procedurale prevăzute de lege, ci și de modul în care organul de urmărire penală reușește să valorifice dialogul cu persoana audiată și să asigure reflectarea fidelă a informațiilor obținute în actele procesuale.

Prin urmare, audierea rămâne un instrument esențial al procesului penal, contribuind în mod direct la realizarea unei cercetări complete și obiective a faptelor infracționale.

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THE DEPARTMENT OF ARCHITECTURE ON THE 60TH ANNIVERSARY OF ITS ACTIVITY WITHIN THE TECHNICAL UNIVERSITY OF MOLDOVA

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Abstract. The present paper reflects a study on the evolution and impact of the educational activities carried out by the Department of Architecture (DA), Faculty of Urbanism and Architecture (FUA), Technical University of Moldova (TUM), over a period of 60 years. It includes a set of scientific research methods such as documentation, analysis of scientific sources, photo documentation, case studies, comparison, and interpretation of results. The article analyzes and briefly presents key aspects regarding the initial training process of architecture students from the perspective of promoting creativity and developing professional competencies through the use of emerging technologies in architecture. It highlights modern methods for the graphic and digital representation of projects, emphasizes the importance of studying risk factors in design, and describes the role of manually crafted volumetric models as tools for synthesis and conceptual expression. Furthermore, the paper addresses the relevance of sustainable architecture in the context of social, cultural, and economic challenges, which justify the need to integrate the principles of sustainable architecture into the university curriculum. It also showcases teaching activities carried out within DA, FUA, TUM, which demonstrate the institutional commitment to quality education in shaping and cultivating the aesthetic sensitivity of architecture students. In conclusion, the DA has distinguished itself through an exceptional historical path, marked by remarkable achievements and successes that have significantly influenced the progress of contemporary architecture both nationally and internationally.

Keywords: *initial training, university, department, quality education, architecture student.*

Rezumat. Articolul reflectă un studiu privind evoluția și impactul activității educaționale a Departamentului Arhitectură (DA), Facultatea Urbanism și Arhitectură (FUA), Universitatea Tehnică a Moldovei (UTM), pe parcursul a 60 de ani și include un ansamblu de metode de cercetare științifică precum: *documentarea, analiza surselor științifice, fotofixări, studii de caz, compararea și interpretarea rezultatelor etc.* În articol sunt analizate și expuse succint aspecte importante, privind procesul de formare inițială a studenților-arhitecți din perspectiva promovării creativității și a dezvoltării competențelor profesionale prin utilizarea tehnologiilor emergente în arhitectură; sunt valorificate metodele moderne de reprezentare

grafică și digitală a lucrărilor; este descrisă importanța cercetării factorilor de risc în proiectare și a realizării manuale a machetelor volumetrice drept instrumente de sinteză și expresie conceptuală. De asemenea, este abordată relevanța arhitecturii durabile în contextul provocărilor sociale, culturale și economice ce justifică necesitatea integrării principiilor arhitecturii sustenabile în curricula universitară. Totodată, sunt prezentate activități didactice desfășurate în cadrul DA, FUA, UTM, care demonstrează angajamentul instituțional pentru *educația de calitate* în formarea și cultivarea sensibilității estetice a studenților-arhitecți. Concluzionând, DA s-a remarcat printr-un parcurs istoric excepțional, însoțit de succese și realizări frumoase, ce au influențat semnificativ progresul arhitecturii contemporane atât la nivel național, cât și internațional.

Concepte-cheie: *formare inițială, universitate, departament, educație de calitate, student-arhitect.*

In postmodern society, universities, in addition to their formative and cultural role, assume the responsibility of providing high-quality educational and scientific services, significantly contributing to the enhancement of the intellectual, professional, and sustainable capital of society. Thus, in the context of the development of the European educational area, the Bologna Process [1] represents an important strategic initiative aimed at ensuring the convergence of higher education systems in Europe by identifying and mutually recognizing qualifications, developing a culture of quality, initiating and implementing academic mobility, etc. Moreover, the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG), developed by ENQA (European Association for Quality Assurance in Higher Education) [2], provide a set of principles and quality assurance standards designed to guide the effective implementation of educational activities in higher education institutions within the European area.

Our country adheres to these principles, which stipulate the confirmation and recognition of academic excellence through the issuance of national policies for the development and assurance of quality in higher education [3], based on the European Higher Education System. Likewise, student-centered learning represents a fundamental prerogative of universities that support the creation of a flexible educational environment adapted to the individual needs of the learner, fostering their active, reflective, and autonomous participation alongside academic staff in the process of progressive knowledge acquisition, the development of cognitive competencies, practical and research skills, as well as axiological and behavioral abilities.

Therefore, the Technical University of Moldova (TUM) aligns itself with all European and national legislative requirements and undertakes to implement quality standards [4] in higher education, to promote educational policies oriented toward continuous learning/lifelong education [5], ensuring the transparency of educational processes and strengthening the connections between the university and various fields of professional practice.

The analysis of theoretical and praxeological benchmarks, as well as discussions with teachers who have worked and continue to work at the Department of Architecture, with architects, students, etc., allowed us to establish that the School of Architecture (currently the Department of Architecture) in our country, having reached its 60th anniversary, has built an image of an academic environment of excellence, a promoter of architectural education based on tradition, yet open to innovation and contemporary international cultural

influences. In this context, extensive research has been carried out, including a set of scientific research methods such as documentation, analysis of scientific sources, photo documentation, case studies, comparison and interpretation of results, all aimed at achieving the predefined objectives.

It is important to mention that currently, within the Technical University of Moldova (TUM), one of the largest and most prestigious departments of the institution operates – the Department of Architecture, formerly the Chair of Architecture, the only School of Architecture (SA) in the Republic of Moldova, with a valuable academic tradition reflected in its educational, scientific, and cultural activities, carried out by its faculty members, students, and alumni. The SA was founded in 1964, along with the establishment of the Serghei Lazo Polytechnic Institute in Chișinău (now the Technical University of Moldova), under the name of the Chair of Architecture and Engineering Constructions, which operated within the Faculty of Engineering and Construction. However, the first cohort of students admitted to the Architecture specialization dates back to 1965, marking the official beginning of the initial training of architectural specialists in the Republic of Moldova [6, 7].

Over the course of six decades of activity, the Department of Architecture has become a benchmark in training future architects, benefiting from the contribution of a multidisciplinary academic team composed of architects, engineers, urban planners, researchers, and visual artists, who have significantly supported the implementation of a high-quality educational process focused on integrating artistic, cultural, and technological values into architectural practice. In this context, the analysis of the educational and research activities of the Department of Architecture within the Technical University of Moldova offers an eloquent example of balance between academic tradition and openness to innovation.

Over time, the leadership of the Chair of Architecture, and later the Department of Architecture, has been ensured by highly experienced university professors, among whom the following stand out: Smirnov Victor, Voițehovschi Valentin, Morgun Broneslav, Bognibov Eughenii, Ianovici Adriana, Zolotuhin Alexandr, Șargorodschi Mihail, Head of CSPAC, Ph.D. in Technical Sciences, Gaidaș Vladimir, Oleinic Svetlana, Lupașcu Valeriu, Carpov Aurelia, and Munteanu Angela (Figure 1).

Figure 1. Managers of the Department of Architecture (DA) [8].

In addition to academic management, a significant number of full-time and adjunct professors have contributed to promoting the image and prestige of the Department of

Architecture (DA) through their teaching and scientific activities, including: Lebedev Serghei, Borozan Sergiu, Grițenco Ivan, Bognibov Anatolii, Luchianov Nicolae, Nesterov Tamara, PhD, associate professor, Taras Iaroslav, PhD in architecture, Cerednicova Olga, Strijacov Vitalii, Ischimji Nicolae, Chiosa Victor, Borovschii Vasilii, PhD in architecture, Iamșcicova Nina, Kozlovschi Ivan, PhD in architecture, Kuzi Anatolii, PhD, associate professor, Bosenco Grigorii, Smolin Evghenii, Iațiuc Vitalie, Andrusceac Constantin, Cerbari Aliona, Diomina Elena, Naval Teodor, Ciocanu Sergius, PhD, associate professor, Severin Sergiu, Rejep Veceslav, Grișco Valerii, Garconița Serghei, Bulat Gheorghe, Cojocaru Gheorghii, Sorochina Ala, Nicorici Asea, Apostol Silvia, Suvorova (Iotova) Violeta, Gulipa Serghei, Besciotnîi Ivan, PhD, associate professor, Samborschi Nicolai, Verstiuc Veceslav, Tiutiun Tatiana, Romanciuc Tatiana, Cojocaru Victor, Traci Mihai, Zasavițchii Iurii, Benderskaia Valentina, PhD in architecture; Garconița Rita, Storojenco Alexandru, Buimistru Tatiana, PhD, associate professor; Prodan Alexandru, Zestrea Elena, Iachimov Natalia, Șargorodscaia Tatiana, Trofimov Silvia, Șestacovschi Andrei, Șestacovschi Anastasia, Rusu Alexandru, Șveț Liliana, Grozavu Nistor, PhD, associate professor; Andronovici Diana, Tronciu Sergiu, PhD, associate professor, Carcea Ala, Grati Sorina-Nicoleta, Aricova Elena, Gavriliuc Evghenii, Melnic Loredana, Grinceac Elena, Harea Olga, PhD, associate professor; Bulat Maria, Ivanov Valeriu, Ivanov Ludmila, Andronic Radu, Negruţa Igor, Nițî Ion, Nițî Viorica, Tofan Alexandru, Studzinski Irina, Kaţel Evghenii, Rusu Ana, Arapu Veronica, Bernic Lia, Radevici Irina, Maistru Dragomir, Rabei Andrei, Olari Alexandru, Raețchi Iana, Ciobanu Adriana, Mîrza Anatol, Valicov Ion, and others (Figure 2).

Figure 2. The teaching staff of the Architecture Department, 1975–1977–1993 [9].

At the same time, the development of the educational process (artistic and aesthetic) was ensured by numerous renowned visual artists, among whom are: Alexandr Petricenco, Head of the Department of Drawing and Special Training (CDPS), Ion Jumati, Robert Derbenţev, Ion Chitoroagă, Valerii Malearenco, Nicolae Nedealcov, Constantin Musteață, Veaceslav Torpan, Nicolai Țemenco, Valentin Nejivov, Elena Frunze, Victor Drebot, Master of Arts, Mariana Hadji-Bandalac and Svetlana Melnic, Angela Munteanu, PhD in arts, Natalia Podlesnaia, PhD in arts, Tatiana Filipski, PhD in educational sciences, etc. [10, 11].

Also, international collaborations, particularly with the academic environment in Romania, have expanded through the involvement of Romanian professors in the educational process, recognized for their scientific and professional activity in the fields of architecture, urban planning, and art education. Among them, we can mention: Augustin Ioan, PhD arch., professor, Tiberiu Florescu, PhD arch., professor, Andrei Mitrea, PhD arch., Emil Ivănescu, PhD arch., Sergiu Nistor, professor, PhD arch., Alexandru-Ionuț Petrișor, Professor, PhD in urban planning, Mihai-Corneliu Drișcu, professor, PhD arch., Emil-Dragoș Ciolacu-Miron, PhD, associate professor, Ștefania-Raluca Bădescu, PhD, associate professor, Mihai Danciu, PhD in urban planning, Adrian Ghencea, PhD eng., ALLBIM NET SRL, Bucharest, Romania, etc.

The process of evaluating and completing architectural studies has benefited, over the years, from Chairpersons of the Integrated Studies Bachelor's Examination Committee (CEL) with a high level of expertise and professional authority, such as: Kurți Robert, Kolotovkin Anatolii, Mednek Valentin, Șoihet Semyon, Apostolov Igor, Modîrcă Vlad, Eremciuc Vasile, Kalujac Maxim, Ivănescu Emil, PhD arch., Povar Iurie, President of the Union of Architects of the Republic of Moldova, etc.

Starting from the concept of a proactive institution, by promoting a pro-quality and pro-innovation educational culture, the major objective of the DA integrated studies and its teaching staff, TUM, is shaped along two essential dimensions: education and architecture [12, 13].

In this context, it is necessary to emphasize that the DA within TUM follows a well-defined path regarding the education and professionalization of students, through the continuous updating of the curricula [14], in line with the requirements of contemporary sustainable architecture. The educational process is oriented towards an inter-, pluri-, and transdisciplinary approach, which involves the efficient combination of specialized theory with practical applicability, with emphasis placed on the development of students' technical and creative skills.

Thus, architecture students acquire knowledge, skills, competencies, values, and attitudes specific not only to architecture but also to related fields, which are essential for the development of functional and aesthetically coherent projects based on modern and sustainable construction methods, techniques, and technologies. Furthermore, the graphic or coloristic representation of students' creations, or architectural concepts, can only be realized from an inter-, pluri-, and transdisciplinary perspective, which involves the interaction of formal, non-formal, and informal education, constituting a new paradigm in education [15, pp. 62-66, apud 12, p. 294].

In the context of the 60th anniversary of the School of Architecture, we conducted an analysis of the academic performance of the 2,487 graduates of the Architecture program, who have contributed to shaping contemporary architecture in the Republic of Moldova and abroad, as reflected in Figures 3, 4, 5, 6, and 7.

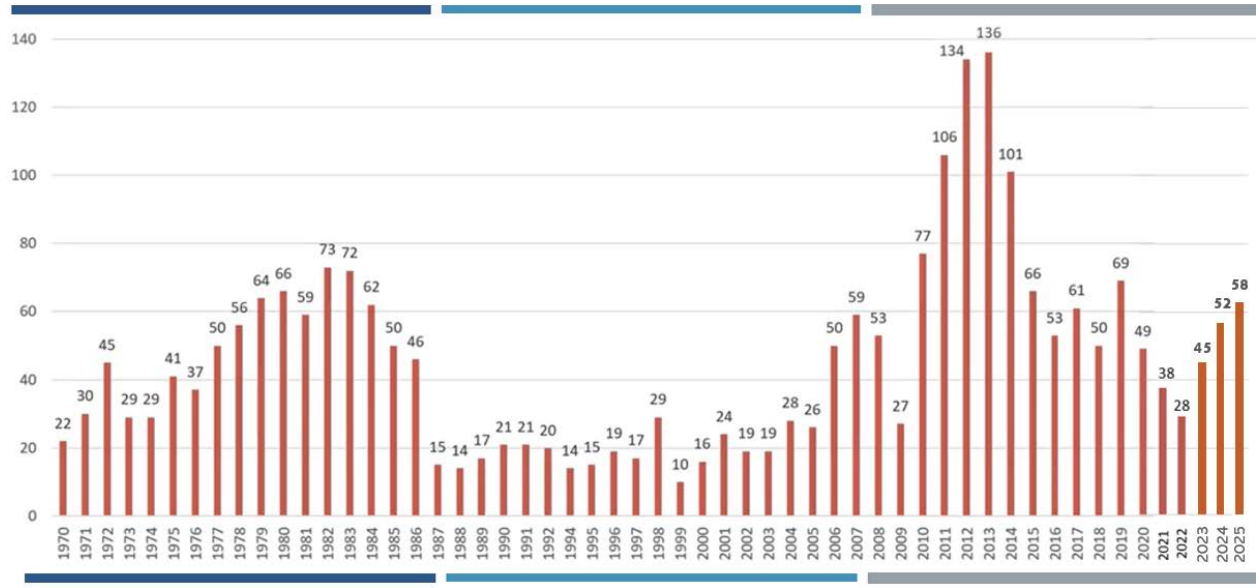

Figure 3. Academic Performance of the School of Architecture, Graduates from 1970–2025.
(author Angela Munteanu).

Figures 4, 5, 6, 7. Graduates of the Integrated Study Program 0731.1 Architecture, class of 2022 [16].

Given that the development and implementation of a modern architectural project require the active involvement of students in building their own knowledge across multiple dimensions, the Department of Architecture (DA) at TUM organizes and conducts a wide range of educational, research, and creative activities carried out in a blended format (both in-person and online).

Figures 8, 9, 10. Curricular and extracurricular educational activities carried at the Department of Architecture [16].

These activities are aimed at professional development and the interdisciplinary training of students and faculty, such as: scientific-practical conferences on the design of eco-friendly buildings and the use of intelligent energy efficiency systems, which ensure the construction of sustainable public buildings oriented towards improving quality of life, etc. (Figures 8, 9, 10). At the same time, methodological seminars are supported by invited specialists from higher education institutions in Romania, Kazakhstan, Italy, Malta, Turkey, China, etc. (Figures 11, 12), focusing on facilitating the exchange of experience through best educational and scientific practices.

Figures 11, 12. Methodological seminars with invited specialists from various fields at the Department of Architecture [17, 18, 19].

Additionally, students, guided by professors, are encouraged to participate with artistic works, architectural and urban planning projects, conceptual models, visual installations, etc., in national and international competitions or exhibitions (Figure 13).

Moreover, the Department of Architecture (DA) organizes and participates in meetings with prominent figures—architects, researchers, engineers, urban planners, and visual artists—which significantly foster the motivation and strengthen the professional aspirations of architecture students, providing optimal conditions for interdisciplinary collaboration, opportunities for interaction with authentic values, accumulation of experience, and personal and professional development.

Figure 13. Architectural projects and creative works of architecture students and graduates [16].

The exchange of academic experience for architecture students through active participation in academic mobility programs and internships alongside international students contributes both to enhancing educational prospects for acquiring knowledge, skills, and practical abilities, and to developing intercultural competencies. Equally important is the involvement of faculty members in international study and research programs conducted on institutional platforms such as Erasmus+ or Horizon (Figure 14), which promote the transfer of best pedagogical practices, the updating of curricular content, and alignment with global architectural trends, aiming at the development of a relevant and competitive educational discourse.

Figure 14. Erasmus+ program experience of faculty members and architecture students [20, 21].

Figure 15. Faculty staff of the Department of Architecture [22].

Professional internships, included in the curriculum of the Department of Architecture (DA) and carried out within the framework of bilateral collaboration agreements between universities, cultural institutions, economic sectors, etc., play an important role in the training of future architects. These internships focus on the practical application of knowledge and aim at developing technical, professional, and transversal competencies. This form of learning is decisive in shaping the value-oriented profile of future specialists capable of meeting the specific academic requirements of the architectural field.

To complement the educational process, a series of scientific and pedagogical works have been developed by the faculty members of the department (Figure 15), and published in specialized scientific journals, national and international conference volumes, or UTM collections. These works include theoretical and methodological references regarding current research directions and innovative trends in architecture and urban planning, as applied in postmodern architecture. Thus, students have access to relevant and up-to-date sources that contribute to the development of intellectual capacities, the broadening of professional horizons, and the deepening of knowledge in various interdisciplinary fields. Additionally, participation in writing activities, collaboration on articles, or attending scientific conferences stimulates investigative thinking, reinforcing autonomy, responsibility, and social interaction—essential factors in the design process.

Conclusions

In conclusion, it should be noted that the Department of Architecture of the Faculty of Urbanism and Architecture FUA, TUM, over its six decades of activity, has promoted an educational culture oriented towards quality and innovation. Its activity has been marked by continuous academic advancement, reflected in the achievements of future architects, who have accumulated a remarkable record of diplomas and distinctions at various national and international competitions, as well as by the steady increase in the number of architecture students, demonstrating the department's capacity to adapt to contemporary social, cultural, and technological transformations.

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