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MARKETING, ADVERTISING AND PR

Instagram as Infrastructure of Kazakhstani National Identity and the Potemkin Nation Brand Paradox

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Abstract. Instagram in Kazakhstan has moved beyond the status of a lifestyle platform and has become a dense public infrastructure where national identity is photographed, negotiated, contested and bureaucratically processed. The article examines this transformation through a three-level model: citizen - local executive head - state. At the citizen level, Instagram turns everyday experience into public evidence: a broken pavement, a procurement scandal, a language meme, an ecological habit or a post about gendered shame. At the local executive head level, the platform becomes a visible test of local executive bedel, since administrative authority is judged not only by position but also by response, speed and credibility. At the state level, Instagram functions as an instrument of nation branding and soft power, yet this visual strategy produces a paradox when the polished national image is compared with domestic experience. The article introduces the concept of the Potemkin nation brand paradox: a condition in which a country's image is attractive for external audiences but provokes irony among citizens who recognize the gap between promotional aesthetics and everyday governance. The analysis draws on verified platform statistics, legal sources, academic literature on digital nationalism and nation branding, and documented Kazakhstan cases such as «ProTenge», «Protest Körpe», eco-activism and municipal Instagram communication. The findings show that Instagram has become an infrastructure of Kazakhstani national identity because it connects visibility, bedel, post-Soviet memory, civic evidence and state image-making in one platform field.
Keywords: *Instagram, Kazakhstan, national identity, digital nationalism, nation branding, soft power, post-Soviet communication, civic evidence.*

Introduction

Kazakhstan's national identity is now produced not only in school textbooks, state ceremonies, television speeches or diplomatic events. It is also produced in Instagram stories, comment threads, reels, municipal complaint posts, activist screenshots, influencer captions and patriotic visual campaigns. A young user posts a video in Kazakh and receives encouragement from strangers. A resident tags an «akimat»

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account under a photograph of an open manhole. An eco-blogger explains why waste sorting is not a fashionable hobby but a civic obligation. A ministry publishes polished images of modern Kazakhstan for foreign audiences. In the same feed, a citizen posts a sarcastic comment asking why the beautiful image does not match the street, hospital, school, bus stop or public office nearby.

This simultaneity is the starting point of the article. Instagram does not simply reflect Kazakhstan's identity. It rearranges the conditions under which identity becomes visible. Before platform communication, the citizen needed access to formal media, public hearings, letters to state bodies or personal networks to make a claim visible. Instagram lowers this threshold. It gives the citizen a camera, a caption, a tag, a comment and an audience. The act may be small. Yet when repeated by millions of users, it forms a new infrastructure of public recognition.

The scale is already national. DataReportal's Digital 2026: Kazakhstan report states that Instagram had 13.1 million users in Kazakhstan in late 2025 [1]. This figure matters because Instagram's audience is not a narrow elite public. It crosses age, language, class, region and profession, although access and influence remain uneven. The platform is where a part of Kazakhstan sees itself being seen. A wedding aesthetic, a mountain trip, a complaint against an «akimat», a discussion of language shame, a public procurement post, a charity campaign or a tourism reel may all become fragments of the national image.

The legal environment confirms that digital platforms are no longer outside the state's institutional attention. The Law of the Republic of Kazakhstan "On Online Platforms and Online Advertising" dated July 10, 2023 No. 18-VIII regulates relations connected with online platforms operating in Kazakhstan and online advertising [2]. The law is important not only as a regulatory document. It shows that online platforms have become part of the state's information architecture. The state recognizes their power, requires legal representation for large platforms, regulates illegal content and expects interaction between platforms and authorized bodies. Instagram therefore operates at the intersection of social life, law, public administration and symbolic politics.

The analytical problem becomes sharper when Instagram is viewed through the cultural concepts of «беделі» and «абырой».

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In Kazakh public culture, bedel means socially recognized authority, weight and credibility. Abıroy refers to honour, dignity and reputation. These concepts are not ornamental. They shape how citizens judge public figures, elders, officials, influencers, activists and institutions. In a platform environment, bedel is no longer attached only to formal status. It must be performed and tested. A local executive head may hold office, but his or her digital bedel depends on visible responsiveness. An activist may lack office, but gain bedel through evidence and consistency. A state may promote an attractive national brand, but lose abıroy if citizens read that image as staged.

The post-Soviet context gives this problem a historical depth. Public communication in post-Soviet societies has long been marked by the tension between official display and lived reality. The Russian term «показуха» captures the logic of staged performance for superiors: a model school prepared before inspection, a freshly painted façade before a delegation, a carefully arranged meeting where the audience already knows what may be said. The Potemkin village metaphor belongs to the same symbolic field. In contemporary platform society, Instagram becomes the place where such façade-making can be both reproduced and exposed. The state can publish an impressive image, but the citizen can publish the surrounding context.

This article introduces the concept of the «Potemkin nation brand paradox». The concept denotes a situation in which the country's image is aesthetically strong, internationally legible and visually persuasive, yet domestic audiences respond with irony because they compare the promotional image with everyday governance. The paradox does not mean that the image is entirely false. Kazakhstan genuinely has spectacular landscapes, modern urban spaces, dynamic youth, multilingual culture, strong digital habits and visible international ambitions. The paradox begins when these real strengths are presented as a seamless national brand while citizens experience unresolved contradictions: corruption, inequality, bureaucratic distance, environmental problems, gendered policing, media restrictions or poor service quality.

The aim of the article is to explain why Instagram has become infrastructure of Kazakhstani national identity and how this infrastructure operates through the three levels of citizen, local executive head and state. The working

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hypothesis is that Instagram strengthens national identity when citizen evidence, local executive head responsiveness and state branding reinforce each other. When these levels diverge, Instagram does not merely support the nation brand. It reveals the gap inside it.

Literature Review

Instagram and nationalism in Kazakhstan have already attracted serious scholarly attention. Diana T. Kudaibergenova's article "The body global and the body traditional: a digital ethnography of Instagram and nationalism in Kazakhstan and Russia" is especially important because it shows that Instagram is not a neutral gallery of personal images. It is a place where acceptable behaviour, bodily expression, gendered respectability and fear of losing national culture are negotiated in authoritarian and post-Soviet contexts [3]. Kudaibergenova's argument is valuable because national identity appears not only through state symbols, but through the body, dress, beauty, comment, accusation and shame. Instagram produces visible bodies, and visible bodies become sites of national judgement.

This argument is directly relevant to Kazakhstan's platform culture. A woman's public self-presentation may be read as modernity, Westernization, religious modesty, national pride, excessive visibility or moral violation. A man's public performance may be interpreted through success, consumption, patriotism or bureaucratic proximity. In this environment, Instagram becomes a visual court of national authenticity. The platform does not invent this moral economy. It intensifies it by making judgement fast, public and archived.

The religious dimension further complicates the picture. Laura Toktarbekova, Sholpan Zhandossova and Madina Bektenova examine Kazakh Muslim women's visual religious identity and Islamic agency on Instagram, showing how piety, aesthetics, entrepreneurship and gendered visibility are brought together in digital space [4]. Their work matters because it demonstrates that national identity in Kazakhstan cannot be analysed only through secular state narratives. Religion, especially in its visual and gendered forms, becomes part of the public negotiation of who may represent Kazakhstani modernity. Instagram allows Muslim women to build authority outside older institutional channels. This authority is not only religious. It is social, educational, aesthetic and

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entrepreneurial.

Nation branding scholarship brings the state back into the analysis. Sabina Insebayeva's "Imagining the Nation: Identity, Nation Building and Foreign Policy in Kazakhstan" argues that nation branding became a permanent feature of Kazakhstan's state discourse and that image-building projects, media exposure and spectacular urbanization were used to cultivate a positive international image [5]. This point is crucial because Instagram did not create Kazakhstan's concern with image. It inherited and accelerated a pre-existing state strategy. The difference is that earlier image-making was more controllable: international media campaigns, mega-events, diplomatic forums and capital-city architecture could be planned from above. Instagram is less stable. It lets the state speak, but it also lets citizen's answer.

Adrien Fauve's article "Global Astana: nation branding as a legitimization tool for authoritarian regimes" adds a sharper political dimension [6]. In Fauve's reading, Astana is not only a city; it is a legitimizing image of state capacity, modernization and futurity. The city's architecture is designed to be seen. Instagram converts this architectural symbolism into endlessly reproducible content: skylines, ministries, boulevards, forums, night lights, monumental perspectives. Yet the photogenic quality of state modernity is double-edged. A skyline can impress foreign audiences and still produce domestic irony if citizens compare it with regional inequality, infrastructural weakness or public distrust.

Erica Marat's "Nation Branding in Central Asia: A New Campaign to Present Ideas about the State and the Nation" situates Kazakhstan within a broader regional struggle for international recognition [7]. Central Asian states had to overcome external invisibility, stereotypes and the reductive label of "the stans." Kazakhstan's branding efforts therefore emerged from a real geopolitical need: to be recognized as sovereign, modern and strategically important. Instagram expands this recognition struggle into everyday culture. Food videos, travel reels, language memes, wedding aesthetics and local business accounts all contribute to the international image, even when they are not coordinated by the state.

Simon Anholt's concept of competitive identity is useful because it separates national reputation from simple advertising. Anholt argues that a country's image is shaped by policy, culture, people, tourism, exports, governance and

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investment behaviour, not merely by logos or slogans [8]. This principle is central for the Potemkin nation brand paradox. A state can design a beautiful campaign, but if policy and lived experience contradict the image, the brand weakens. Instagram makes this contradiction visible faster than traditional media. A polished video can be reframed by one citizen post that shows what the campaign leaves outside the frame.

Joseph S. Nye Jr.'s soft power theory also remains relevant. Nye defines soft power as the ability to obtain desired outcomes through attraction rather than coercion or payment [9]. In the Instagram age, attraction becomes decentralized. The state is not the only source of Kazakhstan's soft power. A Kazakh-language creator, a musician, a designer, an eco-activist, a chef, an urban photographer, a religious educator or an investigative journalist may create more credible attraction than an official campaign. This is not because state communication is always false. It is because platform audiences often trust lived fragments more than institutional polish.

The literature therefore converges on a central insight: national identity is not transmitted whole from the state to society. It is assembled through visual practices, moral expectations, institutional performances and public interpretation. The main gap in the existing scholarship is that the citizen, local executive head and state levels are rarely analysed together. Studies of digital nationalism often focus on bodies, gender and online conflict. Studies of nation branding often focus on the state and external audiences. Studies of governance focus on institutions and regulation. Instagram in Kazakhstan connects all three. That connection is the article's main analytical field.

Materials and Methods

The article uses a mixed qualitative and quantitative approach. The empirical logic is not built on private scraping of Instagram accounts. The quantitative layer uses published platform-reach data, including DataReportal's estimate of 13.1 million Instagram users in Kazakhstan in late 2025 [1]. Platform-reach data are treated carefully. They are not equivalent to the exact number of unique active citizens because advertising tools may include methodological limitations, age restrictions, duplicate identities or platform-defined reach. Yet they are valid for estimating

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communicative scale and comparing platform infrastructures.

The legal-institutional layer uses the 2023 Law "On Online Platforms and Online Advertising" [2]. This source establishes that online platforms are part of the regulatory field of Kazakhstan's information policy. It also helps explain why Instagram is not only cultural space, but also a governed environment where content, complaints, representation and moderation become legally significant.

The scholarly layer includes academic literature on digital nationalism, religious agency, nation branding, competitive identity and soft power [3], [4], [5], [6], [7], [8], [9]. The case-based layer includes ProTenge as a citizen-level anti-corruption account [10], Almaty «akimat»'s Instagram communication as an akim-level responsiveness case [11], Protest Körpe as a cultural protest case [12], eco-activism as an everyday civic identity case [13], internet shutdown and platform regulation as state-level trust problems [14], [15], Kazakh-language platform practice as an identity case [16], and Threads referendum discussion as a comparative platform case [17].

The analytical unit is the communicative episode. Each episode is examined according to four indicators:

Table 1

Indicator	Meaning	Analytical question
Visibility	The degree to which a claim becomes publicly observable	What becomes visible on Instagram?
Bedel transfer	The movement of authority from office to performance or evidence	Who gains credibility and why?
Responsiveness	The reaction of institution or audience to a visible claim	Does visibility produce action?
Potemkin gap	The distance between official image and domestic experience	Does the image generate pride or irony?

Three formulas are used to make the analysis technically clearer.

$$\mathrm{PRR}_i = \frac{U_i}{P} \times 100$$

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Here, PRR_i is the platform reach ratio for platform i, U_i is the reported number of users or reachable identities, and P is the population base used for interpretation. If Instagram reached 13.1 million users and the implied population base is approximately 20.8 million, then:

$$PRR_{Instagram} = \frac{13.1}{20.8} \times 100 = 62.98\% \approx 63\%$$

This calculation supports the classification of Instagram as a mass national platform rather than a niche communication channel.

$$ARC = \frac{R_s}{R_t} \times 100$$

Here, ARC is the akim responsiveness coefficient, R_s is the number of solved or answered appeals, and R_t is the total number of appeals. If a municipal account reports that 85 out of 100 Instagram appeals are solved, then:

$$ARC = \frac{85}{100} \times 100 = 85\%$$

This formula is used conceptually because the public case reports a high rate of problem-solving through Instagram, but not a full raw administrative dataset.

$$PNBG = B_e - E_d$$

Here, PNBG is the Potemkin nation brand gap, B_e is the intensity of external brand expectation, and E_d is the credibility of domestic experience. The formula is conceptual and intended for future empirical testing. A high PNBG means that the country's outward-facing image is much stronger than the citizen's perception of everyday institutional reality. A low PNBG means that the brand is supported by lived experience and therefore produces less irony.

Results

The first empirical result is scale. Instagram's 13.1 million user reach in Kazakhstan in late 2025 means that the platform operates at the level of national infrastructure

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[1]. It is not infrastructure in the same way as roads, electricity or mobile broadband. It is infrastructure in the communicative sense: people organize visibility, recognition, complaint, prestige and participation through it. A citizen does not need to describe every detail of a local problem in bureaucratic language. A photo, a geotag and an «akimat» tag may be enough to create public pressure.

Table 2

Digital indicators of Instagram's infrastructural role

Indicator	Verified value	Analytical meaning
Instagram users in Kazakhstan	13.1 million	Mass visual public sphere
Estimated population ratio	about 63%	National-level reach
Legal regulation of online platforms	Law No. 18-VIII, 2023	Platforms are part of state information policy
Main communicative affordance	image, story, reel, tag, comment	Everyday evidence becomes public
Main political tension	visibility versus control	The platform supports both branding and critique

The table shows that Instagram's infrastructural role is produced by a combination of scale, affordance and institutional recognition. A platform with millions of users but no civic use would remain entertainment infrastructure. A platform with civic use but no mass reach would remain activist niche media. Instagram in Kazakhstan has both: mass reach and civic-institutional penetration.

The diagram shows that Instagram is not alone in Kazakhstan's platform ecology. TikTok has a larger reported adult reach, and Threads has become important as a space for more text-based and critical expression. Yet Instagram remains distinctive because it combines visual identity, influencer culture, business pages, municipal accounts, activist documentation and state branding. It is less ephemeral than TikTok and more image-oriented than Threads. For national identity, this combination is decisive. Kazakhstan is not only argued on Instagram. It is shown.

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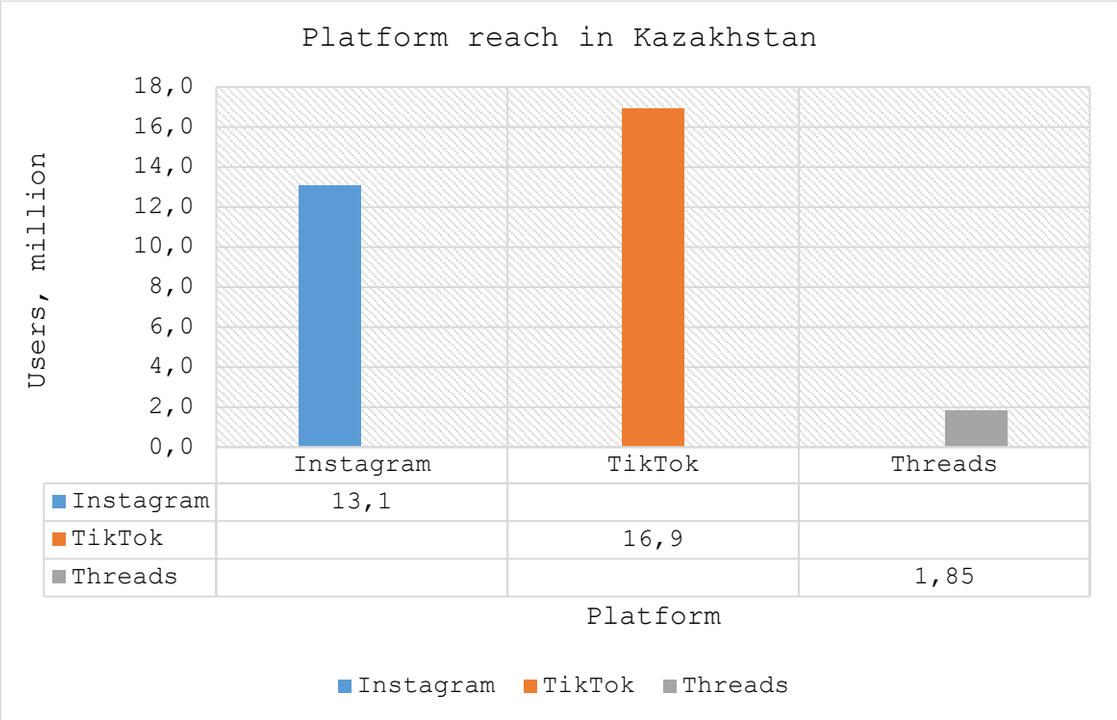

Figure 1. **Platform reach in Kazakhstan**

At the citizen level, Instagram converts ordinary experience into public evidence. This is visible in anti-corruption activism. Open Contracting Partnership documented the ProTenge case, where journalist Jamilya Maricheva used Instagram to make public procurement understandable to ordinary audiences; the account had about 80,000 followers and helped stop suspicious public purchases worth US$500,000 [10]. This case is important because procurement is usually hidden behind technical language. ProTenge translated it into a visible civic drama: public money, inflated prices, absurd purchases, screenshots, comments, anger and collective verification.

The civic meaning is larger than one account. ProTenge changes the citizen's role from passive taxpayer to platform auditor. A follower learns that public procurement is not a distant administrative procedure. It is a field where public money can be wasted, defended or questioned. Instagram becomes a school of fiscal citizenship. Its stories and posts create a practical lesson: national identity includes responsibility for public resources.

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Table 2.

Citizen-Level Instagram Practices and Their Contribution to National Identity Formation

Practice	**Instagram form**	**National identity function**
Public procurement monitoring	Screenshots, contract fragments, short explainers, polls	Citizen as taxpayer, auditor and controller of public spending
Urban problem reporting	Tagged photos, geolocation, comments, direct appeals	Citizen as local co-owner of urban space
Environmental activism	Stories, eco-guides, swap events, recycling campaigns	Citizen as ethical caretaker of shared environment
Protest symbolism	Hashtags, visual campaigns, symbolic objects, avatar frames	Citizen as rights-bearing participant in public life
Kazakh-language content	Memes, captions, reels, grammar posts, everyday jokes	Citizen as linguistic agent and cultural transmitter
Religious self-presentation	Visual piety, modest fashion, educational posts, family ethics	Citizen as moral actor in a plural public sphere
Gender and dignity discourse	Testimonies, awareness posts, campaign visuals, comments	Citizen as defender of dignity, safety and social justice
Civic fact-checking	Screenshots, comparisons, source links, correction posts	Citizen as verifier of public claims and official narratives
Local memory and heritage	Archival images, family stories, craft symbols, place-based posts	Citizen as carrier of cultural continuity
Everyday soft power	Travel posts, food images, city aesthetics, hospitality scenes	Citizen as informal producer of Kazakhstan's external image

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This table matters because it expands the meaning of national identity. National identity is often treated as a matter of symbols: flag, anthem, history, territory, ethnic memory. Instagram does not remove those symbols, but it adds a civic layer. A citizen who monitors procurement, sorts waste, speaks Kazakh online, supports a protest symbol or tags an «akimat» is also producing national identity. The country becomes not only something to be celebrated, but something to be repaired.

Eco-activism demonstrates the same logic through daily habits. The Astana Times interview with Kamila Akimbekova shows how Instagram helped turn conscious consumption, waste sorting and the Darmarka exchange initiative into visible public practices [13]. This kind of activism does not look as dramatic as mass protest. It is quieter. But it touches the moral fabric of citizenship. Throwing away usable clothes, ignoring waste sorting or treating mountains as picnic background without responsibility becomes a question of civic abıroy. Instagram helps transform private habits into public norms.

Protest Körpe adds a cultural dimension. Colleen Wood's account of the Protest Körpe campaign shows how supporters of Asya Tulesova used Instagram to create a "newsfeed quilt" through images of quilt squares connected to the traditional Kazakh körpe [12]. The campaign is analytically strong because it breaks the assumption that tradition belongs mainly to official ceremonies. Here tradition became a civic technology. The quilt did not merely decorate protest. It gave protest a local form, one that was domestic, recognizable, soft in material but firm in political meaning.

The citizen level therefore contests the Potemkin brand in two ways. First, it produces counter-evidence: documents, videos, screenshots, complaints. Second, it produces counter-symbols: körpe, Kazakh-language memes, eco-habits, feminist posts, religious aesthetics. Citizens do not simply reject the nation brand. They compete to define what the nation should mean.

The local executive head level is the hinge between everyday citizenship and state power. In Kazakhstan's administrative structure, the local executive head represents local executive authority. In cultural terms, the local executive head also carries bedel. Citizens expect competence, visibility, problem-solving and symbolic

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closeness. Instagram changes the way this expectation is tested.

The Almaty case is useful because it shows the early institutional recognition of Instagram as a feedback channel. Baribar Media reported in 2016 that then Almaty local executive head Bauyrzhan Baybek described Instagram as one of the cheapest ways to establish communication with the population; the «akimat» account had nearly 90,000 followers, and Baybek stated that about 85% of appeals had been solved [11]. The detail is important. The platform was not framed only as publicity. It was framed as administrative contact.

The logic can be expressed through the akim responsiveness coefficient:

$$\text{ARC} = \frac{R_s}{R_t} \times 100$$

If R_s=85 solved appeals and R_t=100 total appeals, then:

$$\text{ARC} = 85\%$$

This does not prove the full effectiveness of akim PR across Kazakhstan. It shows the political meaning of visible responsiveness. A high response rate, if verified and sustained, can increase local bedel. A low response rate, especially under public comments, can damage bedel. In the Instagram environment, silence is visible. Delay is visible. A generic answer is visible. A solved problem is visible too.

Table 3.

Local executive head PR as digital bedel

Dimension	**Traditional bureaucracy**	**Instagram bureaucracy**
Complaint entry	Written appeal, office visit	Photo, tag, direct message, comment
Evidence	Inspection act	Citizen image or video
Time pressure	Procedural deadline	Public expectation of quick response
Authority	Position and hierarchy	Visible problem-solving
Reputation	Internal report	Public comment memory
Failure mode	File remains unanswered	Silence becomes screenshot

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The local executive head level also reveals a risk. Instagram responsiveness can become selective and theatrical. A highly visible complaint in Almaty may receive immediate attention, while a similar problem in a rural district remains unseen. A viral post may be solved faster than a formal petition. An local executive head may publish repairs as content, turning governance into a sequence of visual "before-after" stories. Some of this is useful. Citizens want repairs. Yet if the underlying administrative system remains weak, Instagram becomes a stage for episodic response rather than structural service quality.

This is the municipal version of the Potemkin paradox. The image of responsiveness may be real in individual cases, but still decorative if it does not change planning, budgeting, procurement, maintenance and accountability. A repaired manhole is good. A city where residents must publicly shame the bureaucracy to repair manholes is a different matter.

At the state level, Instagram becomes part of Kazakhstan's soft-power and nation-branding architecture. The state must communicate the country to multiple audiences: citizens, investors, tourists, students, diplomats, diaspora communities and foreign media. Instagram is attractive because it compresses complex messages into immediate visual forms. A mountain landscape says "nature." A skyline says "modernity." A national costume says "heritage." A business forum says "investment." A clean airport says "order." A young bilingual speaker says "future."

Nation branding literature shows that this strategy has deep roots in Kazakhstan. Insebayeva describes how image-building projects became a permanent part of state discourse [5]. Fauve connects Astana's global image to regime legitimation [6]. Marat places Kazakhstan inside a broader Central Asian campaign to present new ideas about the state and nation [7]. The state's Instagram practices therefore should not be treated as random posting. They are part of a longer historical effort to secure recognition.

The problem begins when recognition is pursued through visual coherence more than institutional credibility. Anholt's competitive identity theory suggests that reputation depends on the alignment between image and behaviour [8]. Nye's soft power theory also implies that attraction cannot be built only by message control [9]. If political values and policies are not attractive, culture alone cannot compensate

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indefinitely. Instagram intensifies this test because citizens can answer the state's image with lived evidence.

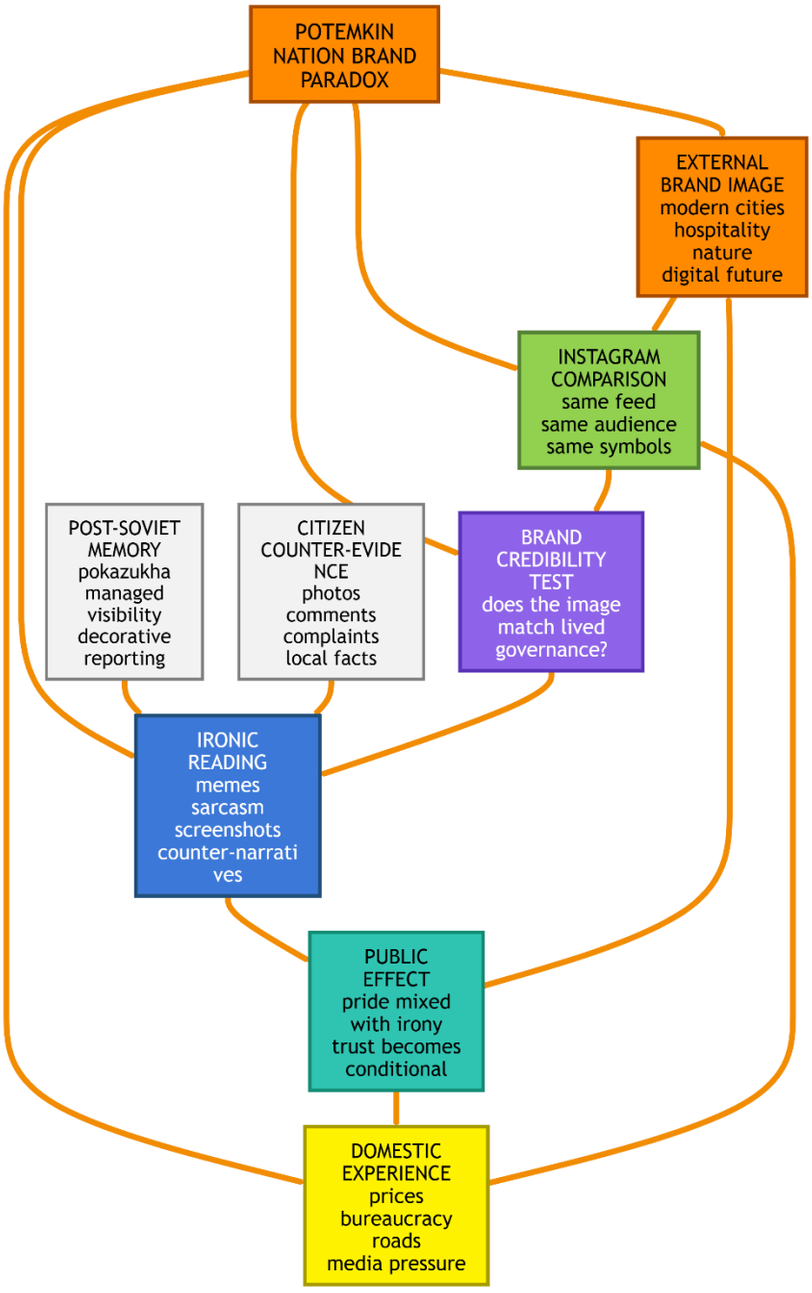

Figure 2. **Visual Gap Between National Branding and Domestic Experience**

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The diagram shows why Instagram is so dangerous for decorative branding. The external image and domestic experience no longer circulate in separate media systems. They meet in the same feed. A user may see a tourism reel and immediately below it a complaint about infrastructure. A state campaign may say "digital future," while a citizen remembers the January 2022 shutdown. A city account may post a repaired park, while comments ask about another district. The national brand becomes a public test rather than a finished product.

The Potemkin nation brand paradox is intensified by information control. Pavlina Pavlova's OpenGlobalRights analysis of Kazakhstan's January 2022 events describes internet throttling and shutdown as a politically costly information-control practice that disrupted services, reporting, banking and everyday digital life [14]. This episode matters for Instagram because it showed that digital infrastructure could be suspended under crisis conditions. For citizens, the shutdown weakened the credibility of "digital Kazakhstan" narratives. A digital state that can disconnect citizens during unrest creates a deep trust contradiction.

Freedom House's Freedom on the Net 2024 report classifies Kazakhstan as "Not Free" in internet freedom and describes legal and practical restrictions affecting online expression [15]. This does not mean Instagram is empty of civic life. It means civic life develops under caution. Users learn to code criticism, use humour, repost through private channels, screenshot disappearing content and choose topics carefully. The platform becomes a semi-open public sphere: visible enough for mobilisation, constrained enough to encourage self-censorship.

This structure produces a particular post-Soviet platform culture. Citizens do not always confront the state directly. They often use irony. Irony is not only humour. It is a survival form of public interpretation. A sarcastic comment under a polished campaign says: "We see the image, but we also see what it hides." The Potemkin brand paradox depends precisely on this double vision.

Language, gender and the social texture of national identity

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Kazakh-language content is one of the most important signs that Instagram has become identity infrastructure. Tamila Olzhbaekova's 2026 Times of Central Asia article argues that TikTok, Instagram and Threads are turning Kazakh into a language of memes, stories, self-irony, flirting, debates, local humour and personal expression, rather than only a school subject or official norm [16]. This shift is crucial. A language becomes socially strong not only when people know it, but when they can joke, complain, desire, argue and think publicly in it.

Instagram supports this shift because it tolerates imperfection. A user can post mixed Kazakh-Russian speech, informal grammar, urban slang or regional expression. This may irritate purists, but it also reduces fear. A language that appears only in official speeches can feel heavy. A language that appears in memes becomes breathable. National identity gains everyday warmth.

Gender complicates the picture. Women constitute a major part of Instagram's adult audience in Kazakhstan, and the platform is central for women's entrepreneurship, religious self-presentation, activism, beauty culture, motherhood discourse and public education. Yet the same visibility exposes women to moral policing. Kudaibergenova's work on gendered nationalism [3] and Toktarbekova, Zhandossova and Bektenova's work on Muslim women's Instagram agency [4] show that the female body and female voice remain key sites where "tradition" and "modernity" are debated.

This model captures the core result of the article: Instagram in Kazakhstan does not belong to a single communicative actor and cannot be explained as a simple channel of state messaging, civic activism or municipal public relations. It is used simultaneously by citizens, local executive heads and the state, but each actor enters the platform with a different expectation of visibility. Citizens use Instagram to transform everyday experience into public evidence: a damaged road, an unanswered complaint, a procurement scandal, a language meme, a personal story of injustice or a small act of civic care. For them, the platform is valuable because it gives ordinary observation a public form and allows private dissatisfaction to become socially recognizable.

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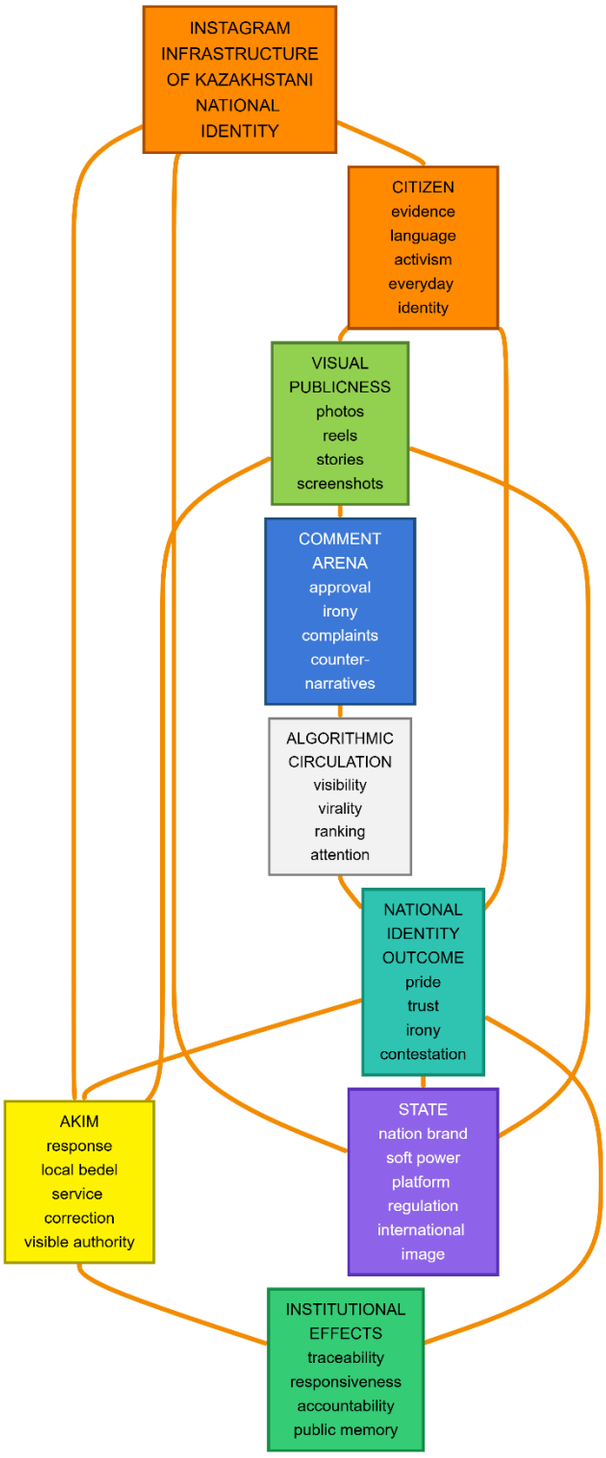

Figure 3. **Three-level Instagram infrastructure of national identity**

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Local executive heads use Instagram in a different way. Their main task is not only to publish information, but to protect and reproduce local administrative bedel through visible responsiveness. A local executive head is judged by citizens not simply as a formal office-holder, but as a public actor whose authority must be confirmed through reaction, explanation and problem-solving. When a complaint receives a clear answer, when a repair is shown with evidence, or when a local problem is acknowledged without bureaucratic evasion, Instagram can strengthen trust in local executive leadership. When the response is delayed, vague, decorative or absent, the same platform weakens authority because silence also becomes visible.

The state uses Instagram at a broader symbolic level. Its interest lies in national coherence, external attractiveness and soft-power legitimacy. Through official accounts, tourism imagery, cultural campaigns and digital development narratives, the state presents Kazakhstan as modern, hospitable, stable, culturally rich and future-oriented. Yet this symbolic work becomes vulnerable when citizens compare the polished national image with domestic experience. Instagram places these layers in one feed: the beautiful country, the complaining citizen, the responding or silent local executive head, and the state narrative. National identity therefore emerges not from one message, but from the friction between evidence, authority and image. This is precisely where the Potemkin nation brand paradox appears: the national brand may look persuasive from outside, while citizens read it through everyday governance, memory, irony and lived comparison.

Discussion

The findings show that Instagram has become infrastructure of Kazakhstani national identity because it combines visibility, credibility and comparison. The citizen can make evidence visible. The local executive head can convert response into bedel. The state can convert images into soft power. But the same infrastructure also allows citizens to compare these levels and identify contradictions.

This comparison is the central mechanism of the Potemkin nation brand paradox. A polished national image is not automatically rejected. Many citizens may feel pride when Kazakhstan appears modern, beautiful and globally visible. The problem emerges when pride is mixed with disbelief.

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Citizens may admire the mountains, city lights and cultural symbols, while asking why the same state cannot solve mundane problems. This mixed reaction is the emotional structure of the paradox: pride plus irony, attachment plus distrust, recognition plus distance.

The concept of bedel explains why the paradox is culturally powerful. In a society where public authority depends on reputation, a gap between word and action damages more than technical efficiency. It damages honour. A state, an local executive head or an influencer may have formal visibility, but visibility without credibility becomes risky. Instagram multiplies that risk because the audience remembers. Screenshots preserve contradictions. Comments accumulate collective judgement. A deleted post may circulate again. Digital memory weakens the old bureaucratic habit of waiting until a scandal disappears.

The post-Soviet background explains the sensitivity to staging. Citizens have historical reasons to suspect decorative performance. A freshly painted façade before a visit, an arranged audience, an overproduced report, a beautiful but empty slogan - these are not abstract metaphors. They are familiar communicative forms. Instagram does not remove them. Sometimes it reproduces them through over-curated official pages. But Instagram also equips citizens to expose them. The platform is both a factory of façades and a camera pointed behind the façade.

At the local executive head level, the findings show that local executive communication can work only if it produces institutional consequences. A responsive Instagram account may increase trust, but only if response is consistent, trackable and not limited to viral cases. Otherwise, local executive head PR becomes another form of performance. The citizen sees the post, but not the system. The repair happens, but the cause remains.

At the state level, nation branding must become less aesthetic and more evidentiary. The strongest future brand for Kazakhstan will not be the most polished one. It will be the one that citizens can recognize without sarcasm. This does not mean the state should stop promoting tourism, investment, culture or digital development. It means promotional claims should be anchored in visible policy delivery. A campaign about green Kazakhstan should be supported by waste infrastructure. A campaign about digital Kazakhstan should be supported by stable access and digital

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rights. A campaign about modern citizenship should be supported by gender safety, language confidence and responsive governance.

Practical recommendations

First, «akimat» Instagram accounts should move from reactive communication to accountable service dashboards. Each public complaint should receive a visible category, deadline, responsible department and completion status. This would reduce dependence on virality and protect citizens without large audiences.

Second, state branding campaigns should include citizen evidence rather than only official aesthetics. A repaired road, a transparent procurement case, a successful waste sorting initiative or an open-data project can produce stronger credibility than a generic promotional reel.

Third, Kazakh-language digital creativity should be supported without excessive formal correction. Language revival on Instagram depends on everyday use, humour and experimentation. Over-policing linguistic purity may reproduce shame and reduce participation.

Fourth, women creators and activists require stronger protection from online harassment. If women are central to Instagram's public culture, national identity cannot be credible while women's visibility is punished through shame, threats or moral policing.

Fifth, the Potemkin nation brand gap should be measured. Ministries, «akimat»s and researchers can compare official campaign sentiment with citizen comment sentiment, complaint frequency, repair rates and trust indicators.

Table 4.

Policy recommendations by level

Level	Main risk	Corrective action	Expected effect
Citizen	Evidence ignored	Public tracking of complaints	Stronger civic trust
«Akim» - local executive head	Performative responsiveness	Response dashboard and deadlines	Higher local bedel
State	Over-polished branding	Claims linked to policy indicators	Lower Potemkin gap
Language	Official stiffness	Support informal Kazakh content	More natural language use

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Gender	Moral policing	Protection of women creators	More inclusive identity
Tourism	Decorative image	Infrastructure-backed promotion	More credible soft power

Future research directions

Future research should develop a systematic dataset of Instagram posts from citizen accounts, «akimat» accounts and state-branding accounts. The dataset should code topic, language, visual style, engagement, sentiment, institutional response and comment tone. A comparative design can test whether citizen posts receive more trust than official posts, whether Kazakh-language content produces different engagement patterns from Russian-language or English-language content, and whether visual patriotism generates pride, irony or silence.

Algorithmic visibility needs separate investigation. Instagram does not show posts neutrally. It ranks, recommends and suppresses content according to opaque platform logic. If activist evidence circulates less widely than lifestyle branding, the national identity field becomes uneven. If emotional or sarcastic posts travel faster than institutional explanations, public trust may be shaped by outrage dynamics. These questions require mixed methods: digital ethnography, platform analytics, interviews and controlled content observation.

A second direction concerns regional inequality. Almaty and Astana dominate digital visibility, but Kazakhstan's national identity cannot be reduced to metropolitan Instagram. Future research should examine how residents of smaller cities, mono-towns and rural districts use Instagram to negotiate local belonging and state distance. The Potemkin paradox may be stronger outside major cities, where polished national images are compared with weaker infrastructure.

A third direction concerns cross-platform identity. TikTok, Instagram and Threads now perform different cultural functions. TikTok accelerates emotion and performance. Instagram stabilizes visual identity and reputation. Threads enables more direct textual criticism. A serious study of Kazakhstani digital nationalism should compare these platforms rather than treating social media as one homogeneous sphere.

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A fourth direction concerns the measurement of bedel. Surveys and interviews could test whether citizens assign more credibility to official position, professional expertise, civic evidence, moral reputation or platform popularity. Such research would clarify whether digital bedel is replacing, supplementing or merely imitating older forms of authority.

Conclusion

Instagram has become infrastructure of Kazakhstani national identity because it connects the citizen, the local executive head and the state in one visual-public field. At the citizen level, it turns everyday experience into evidence and gives ordinary users tools to participate in defining the country. At the local executive head level, it tests local authority through responsiveness and visible problem-solving. At the state level, it supports nation branding and soft power, but also exposes the distance between promotional image and lived governance.

The «Potemkin nation brand» paradox captures this contradiction. Kazakhstan can look beautiful on Instagram and still provoke domestic irony if citizens feel that the image is stronger than the institution behind it. The paradox is not anti-national. It is a demand for a more credible national image. Citizens do not necessarily reject pride. They reject being asked to admire a façade without seeing repair behind it.

The strongest digital nation brand for Kazakhstan will not be built by perfecting visual surfaces alone. It will be built when citizen evidence is treated as a governance resource, local executive head responsiveness becomes systematic, Kazakh-language creativity becomes ordinary, women's visibility becomes safer, and state branding is linked to measurable public delivery. Instagram has made national identity more fragile, but also more honest. In that honesty lies its political and scholarly value.

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PEDAGOGY AND EDUCATION

Specific Characteristics of Intelligent Information Technologies in the Innovative Governance of Philological Education: Navigating Complexities of the Warmi Environment

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Abstract. The article explores the features and specifics of the application of intelligent information technologies in innovative management of philological education in the WARMI environment. The directions of intellectualization of educational management are determined, the possibilities of natural language processing technologies, Big Data and generative artificial intelligence are revealed. Special attention is paid to the prospects of hybrid intelligent technologies as the basis for adaptive and human-centric development of philological education.
Keywords: *pedagogy; philological education; intelligent information technologies; innovative management; digital transformation; artificial intelligence; natural language processing; Big Data; hybrid intelligent technologies; adaptive management; WARMI environment; systemic risks.*

Introduction.

The modern transformation of education is taking place in conditions of significant environmental complexity [1], characterized by accelerating change, increasing uncertainty [2], increasing turbulence, the emergence of new forms of systemic risks and the constant complication of the relationships between technological, economic [3], social, cultural and institutional factors. These processes are especially noticeable in the field of higher education, where digitalization is no longer limited to the implementation of individual information systems, but is gradually transforming into a complex intellectualization of educational, management and research processes [4]. In this context, the WARMI concept of the environment acquires special importance, which

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considers the modern space of functioning of educational organizations as a dynamic, multi-component and difficult to predict system, in which uncertainty, turbulence and systemic risks can simultaneously affect the goals, resources, processes and results of educational activities.

Philological education occupies a special position in this system: its content is related not only to the transfer of knowledge about language, literature, culture and communication, but also to the development of interpretative, analytical, critical, communicative and research competencies. At the same time, modern philology is increasingly interacting with digital linguistics, computational linguistics [5], corpus research, natural language processing, text mining [6], big data, generative artificial intelligence and automated decision support systems. Therefore, the digital transformation of philological education should be considered not only as a technological update of the educational process, but also as a change in the principles of its organization, management, quality assessment and development.

In these conditions, traditional information technologies, which mainly provide storage, transmission and processing of data, are gradually giving way to intelligent information technologies [7], capable of analyzing large arrays of heterogeneous information, identifying hidden patterns, recognizing the context, forming forecasts, supporting decision-making and adapting to changes. Their application creates the prerequisites for the transition from a predominantly administrative-reactive model of philological education management to an intellectual, adaptive and proactive model.

Therefore, the relevance of the study is determined by the need for a theoretical understanding of the features of the application of intelligent information technologies in the management of philological education, since the specificity of humanitarian knowledge places additional requirements on digital tools. Here it is not enough to ensure only the speed of information processing or the automation of individual operations. It is necessary to take into account the semantic complexity of language, the contextuality of interpretation, the cultural conditionality of the text, the variability of human communication, the ethical limitations of the use of artificial intelligence and the need to maintain the leading role of the teacher and researcher.

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Thus, the main goal of this article is to systematically identify the features and specifics of intellectual information technologies in innovative management of philological education, taking into account the complex and complex conditions of the WARMI environment.

Main Part.

I. WARMI-external environment and intellectualization of philological education management.

Modern philological education is developing in conditions of a complicated external environment, which is characterized by dynamic uncertainty, turbulence, acceleration of technological changes and growth of systemic risks. Within the framework of the WARMI concept, such an environment is considered as a complex, interconnected and difficult to predict system, in which changes in technological, social, economic, institutional and cultural factors can quickly transform the conditions of functioning of educational organizations.

For philological education, this transformation is especially important due to the active development of digital linguistics, computer text processing, corpus research, artificial intelligence, automatic translation and generative technologies. Therefore, the management of educational programs can no longer rely mainly on static indicators and reactions to problems that have already arisen. A transition to adaptive and proactive management based on constant monitoring, intellectual analysis, forecasting and prompt correction of decisions is necessary.

II. Intelligent information technologies as the basis of innovative management.

Intelligent information technologies differ from traditional information systems in their ability not only to store and process information, but also to identify patterns, analyze large arrays of heterogeneous data, predict changes, form recommendations and support decision-making. These include machine learning, intelligent data analysis, natural language processing, Big Data technologies, expert and recommender systems, generative artificial intelligence and intelligent analytics.

In the management of philological education, their importance is manifested at three interrelated levels. At the operational level, they automate individual educational and administrative operations; at the tactical level, they

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provide quality analysis, problem identification and recommendation generation; at the strategic level, they support forecasting and scenario modeling of the development of educational programs. Therefore, intelligent technology should be considered not as a separate digital tool, but as an element of a single information and analytical infrastructure of an educational organization.

III. Specificity of the application of intelligent technologies in philological education.

The specificity of philological education is due to text-centricity, semantic ambiguity of language, contextuality of interpretation and cultural conditioning of communication. As a result, intelligent technologies must work not only with the formal characteristics of the text, but also take into account its semantic, genre, discursive and cultural context.

Technologies for natural language processing, intelligent analysis of texts and corpus data are especially promising. They allow to identify linguistic patterns, thematic and stylistic structures, typical errors, connections between texts and the dynamics of the use of language units. However, quantitative analysis cannot completely replace humanitarian interpretation. The final assessment of the results should remain with the teacher or researcher.

Thus, the main feature of the intellectualization of philological education is the need to combine algorithmic information processing with expert, critical and interpretative analysis.

IV. Main directions of application of intelligent information technologies.

Intelligent technologies can be used to analyze educational data, monitor student success and activity, early detection of educational difficulties and formation of personalized recommendations. Recommendation systems are able to adapt educational materials, texts, tasks and educational trajectories to the individual needs of students.

Natural language processing and text mining open up possibilities of automated work with written tasks, corpora, scientific publications and educational materials. Generative artificial intelligence can support the creation of tasks, language practice, modeling of communicative situations, preparation of draft materials and research search. In this case, mandatory verification of the reliability and quality of the generated content is required.

At the level of educational program management,

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intelligent systems can identify gaps and duplications in the content of disciplines, analyze the compliance of competencies with the requirements of the professional environment, evaluate the effectiveness of educational components, and support decision-making regarding their updating.

V. Prospects for hybrid intelligent information technologies.

A particularly promising direction is the development of hybrid intelligent information technologies that combine the capabilities of several approaches [8]: machine learning, natural language processing, expert systems, big data, generative artificial intelligence, formal rules and expert knowledge of a teacher or researcher.

The advantage of the hybrid approach is the ability to combine the computational performance of algorithms with the contextual and professional competence of a person. This is fundamentally important for philological education, since an automated system can effectively detect statistical and semantic patterns, but their philological interpretation often requires taking into account the cultural, historical, genre and communicative context.

Hybrid systems are promising for the creation of intelligent educational assistants, adaptive learning platforms, intelligent analysis of written works, corpus research, automated support of scientific activity, personalization of educational trajectories and intelligent management of educational programs. In the future, they can become the basis for the formation of human-machine educational ecosystems, in which artificial intelligence does not replace the teacher, but expands his analytical and organizational capabilities.

VI. Adaptive management and systemic risks.

In the WARMI environment, adaptability becomes the key principle. An intelligent management system should provide a continuous cycle: monitoring the environment - data collection - intellectual analysis - identification of risks and deviations - forecasting - formation of alternatives - decision-making - result evaluation - adjustment.

This approach allows you to move from reactive to proactive management, in which potential problems are identified before they turn into crisis situations. Intellectual early warning mechanisms are especially important, capable of detecting changes in educational

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outcomes, student needs, professional environment requirements and technological environment.

At the same time, it is necessary to take into account the risks of technological dependence, low data quality, algorithmic bias, violation of academic integrity and excessive technologization of humanities education. Therefore, intelligent technologies should be implemented based on the principles of transparency, expert verification, academic responsibility and preserving the humanitarian nature of philological knowledge.

VII. Conceptual provisions of innovative management of philological education.

Innovative management of philological education in the WARMI environment should be built as a single adaptive system that connects environmental monitoring, educational data, intelligent analytics, forecasting and management decisions. At the same time, the teacher and the student should remain active participants in the management circuit.

The transition from the digitalization of individual functions to the intellectual transformation of the education system is fundamentally important. Its result should not be maximum automation, but an increase in the ability of the educational organization to timely recognize changes, adapt to them, reduce systemic risks and at the same time use technological changes as a source of innovative development.

In this context, hybrid intelligent information technologies are one of the most promising areas for the further development of philological education, as they allow combining the advantages of artificial intelligence, analytical technologies, formalized knowledge, and professional human expertise.

Conclusions.

The analysis shows that intelligent information technologies are becoming one of the key tools for innovative management of philological education in a complex and dynamic external environment. Their importance is determined not so much by the ability to automate individual educational operations as by the ability to ensure the transition to management based on continuous data analysis, forecasting, intellectual support of decisions and adaptation to changes.

The specificity of the application of intelligent technologies in philological education is determined by text-centricity, semantic ambiguity, cultural conditioning, a high

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role of interpretation and the need to combine quantitative and qualitative methods of analysis. Therefore, intelligent systems should be considered primarily as tools for expanding the professional capabilities of the teacher, researcher and the student.

In the context of the WARMI-concept of the environment, the adaptive nature of intelligent management becomes of particular importance. An educational organization must be able to timely detect changes in external conditions, assess their potential consequences, predict risks, form alternative scenarios and promptly adjust the educational strategy. This involves a transition from a predominantly reactive management model to a proactive model based on intelligent monitoring and forecasting.

Promising areas of intellectualization are intelligent analytics of educational data, natural language processing technologies, recommender systems, artificial generative intelligence, intelligent support of scientific research, prediction of educational outcomes and scenario modeling of the development of educational programs. It is their complex hybrid application that can increase flexibility, personalization, efficiency and validity of management decisions.

At the same time, intellectual transformation is accompanied by new technological, information, ethical and academic risks. Therefore, the effectiveness of intelligent technologies should be assessed not only by the speed and accuracy of information processing, but also by the reliability of data, transparency of algorithms, peer review capabilities, adherence to academic integrity and preservation of the humanitarian specificity of philological education.

Thus, innovative management of philological education in the WARMI environment should be considered as an adaptive human-centric system in which intelligent information technologies provide information collection and analysis, forecasting, risk identification and support for management decisions, while a person retains the key function of meaningful interpretation. It is the combination of intelligent technologies, professional competence and adaptive management that creates the basis for sustainable innovative development of philological education in conditions of dynamic uncertainty, turbulence and systemic risks.

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PEDAGOGY AND EDUCATION

Нашар Еститін Оқушыларды Мектепке Бейімдеудің Озық Тәжірибелері

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Аннотация. Мақалада нашар еститін оқушыларды мектепке бейімдеудің халықаралық озық тәжірибелері қарастырылады. АҚШ, Финляндия, Ұлыбритания, Австралия тәжірибелеріне талдау жасалып, олардың жеке білім беру бағдарламасын әзірлеу, қолжетімді акустикалық және коммуникациялық орта қалыптастыру, ассистивті технологияларды пайдалану, командалық қолдау көрсету, әлеуметтік қатысу мен оқушының дербестігін дамыту бағыттарындағы ерекшеліктері айқындалады. Шетелдік тәжірибелерді салыстыру негізінде нашар еститін оқушылардың табысты бейімделуінің негізгі шарттары жүйеленіп, оларды білім беру тәжірибесінде қолданудың маңыздылығы негізделеді.
Түйін сөздер: *нашар еститін оқушылар, мектепке бейімдеу, білім беру.*

Қазіргі таңда Қазақстандағы білім беру жүйесіндегі өзекті мәселелердің бірі ерекше білімді қажет ететін балаларға қолайлы жағдайлар жасай отырып сапалы білім беру мәселесі болып табылады. Осы мақсатта тек білім беруге қатысты уәкілетті орындар ғана емес, сонымен қатар, әлеуметтік, медициналық құзыреттіліктер бойынша уәкілетті орындардың жұмылдырылуы байқалады. Демек, тақырып өзекті әрі заманауи шешімдерге мұқтаж деп тұжырымдауға негіз бар.

Ресми статистика көздеріне сүйенер болсақ, 2026 жылғы дерек бойынша елдегі ерекше білімді қажет ететін балалардың саны 238 мыңнан асып отыр (01.01.2026 ж. дерек бойынша). Статистика ұсынған автор пікіріне сүйенсек, жыл сайын ерекше білімді қажет ететін балалардың арту тенденциясы байқалады. Елімізде ерекше білімді қажет ететін балалардың ең үлкен тобын мектеп жасындағы балалар құрайды (шамамаен 40%). Демек, тек қана әлеуметтендіру мәселесімен қоса оларды мектепке дайындау мәселесі де қатар зерттелуі тиіс. Себебі, мектепке сәтті дайындық – «ерекше» балалардың қолжетімді әрі қолайлы білім алуының басты кепілі.

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Қазіргі білім беру жүйесінде ерекше білім беру қажеттіліктері бар балалардың сапалы білім алуына және білім беру ортасына толыққанды қатысуына жағдай жасау маңызды міндеттердің бірі болып табылады. Осы тұрғыда нашар еститін оқушылардың мектепке бейімделуі олардың оқу әрекетіне қатысуын, құрдастарымен және педагогтермен қарым-қатынасын, әлеуметтік ортаға кірігуін қамтамасыз ететін маңызды педагогикалық үдеріс ретінде қарастырылады. Есту қабілетінің төмендеуі ақпаратты қабылдау, сөйлеу тілін түсіну және коммуникация орнату барысында белгілі бір қиындықтар туындатуы мүмкін, сондықтан мектеп ортасын оқушының жеке қажеттіліктеріне сәйкес ұйымдастыру ерекше мәнге ие.

Қазіргі отандық және халықаралық тәжірибеде нашар еститін оқушыларды мектепке бейімдеудің бірқатар тиімді тәсілдері қалыптасқан. Олардың қатарына қолжетімді білім беру ортасын ұйымдастыру, заманауи есту және ассистивті технологияларды пайдалану, оқу материалдарын визуализациялау, педагогикалық қолдау көрсету, құрдастарымен өзара әрекеттесуді дамыту және ата-аналармен жүйелі серіктестік орнату жатады. Осыған байланысты нашар еститін оқушыларды мектепке бейімдеудің озық тәжірибелерін зерделеу және олардың тиімді тетіктерін анықтау инклюзивті білім беру сапасын арттырудың өзекті бағыттарының бірі ретінде қарастырылды.

Нашар еститін оқушыларды мектепке бейімдеу әлемдік білім беру тәжірибесінде баланың білім беру ортасына физикалық қосылуымен ғана шектелмей, оның оқу ақпаратына қолжетімділігін, коммуникациялық белсенділігін, әлеуметтік қатысуын және психологиялық жайлылығын қамтамасыз ететін кешенді үдеріс ретінде қарастырылады. Әртүрлі елдердің тәжірибесінде осы мақсат ортақ болғанымен, оны жүзеге асыру тетіктерінде белгілі бір ерекшеліктер қалыптасқан. Бірқатар мемлекеттерде жеке білім беру бағдарламасына басымдық берілсе, екіншілерінде қолжетімді мектеп ортасын қалыптастыру, ерте қолдау, педагогтердің арнайы даярлығы немесе ассистивті технологияларды пайдалану жетекші бағыт ретінде көрінеді. Сондықтан халықаралық тәжірибелерді салыстыра қарастыру нашар еститін оқушыларды мектепке бейімдеудің тиімді ұйымдастырушылық-педагогикалық шарттарын анықтауға мүмкіндік береді.

Аталған бағыттағы жүйелі тәжірибелердің бірі Америка Құрама Штаттарында қалыптасқан. АҚШ моделінің басты ерекшелігі – нашар еститін оқушының қажеттіліктерін жеке бағалау және соның негізінде Individualized Education Program (IEP) – жеке білім беру бағдарламасын әзірлеу. IDEA

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заңнамасына сәйкес естімейтін және нашар еститін балалардың тілдік және коммуникациялық қажеттіліктері, олардың пайдаланатын коммуникация тәсілі, құрдастарымен және педагогтермен тікелей қарым-қатынас жасау мүмкіндігі, академиялық деңгейі мен қажетті арнайы қызметтері білім беру бағдарламасын жоспарлау кезінде ескерілуі тиіс.

Осыған байланысты американдық тәжірибеде нашар еститін екі оқушыға бірдей қолдау көрсету міндетті емес. Бір оқушы үшін мұғалімнің дауысын тікелей есту құрылғысына жеткізетін қашықтағы микрофондық немесе FM/DM жүйесі жеткілікті болуы мүмкін, ал екінші балаға субтитр, мәтіндік транскрипция, сурдоаударма немесе қосымша арнайы педагогикалық қолдау қажет болуы ықтимал. АҚШ Білім департаментінің ұсынымдары коммуникациялық құралдарды баланың жеке қажеттілігіне сәйкес анықтау қажеттігін көрсетеді. Демек, АҚШ тәжірибесінің ерекшелігін «баланы қолданыстағы жүйеге бейімдеу» емес, «қолдау жүйесін нақты баланың қажеттілігіне сәйкестендіру» қағидасымен сипаттауға болады.

Жеке қолдауға негізделген бұл тәсіл Финляндияның тәжірибесінде біршама өзгеше мазмұнда жалғасады. Фин моделінің ерекшелігі – қажетті көмекті мүмкіндігінше баланың күнделікті білім алатын табиғи ортасында ұйымдастыру. Инклюзивті қағидалар бойынша оқушының қатысуы мен білім алуына кедергі келтіретін факторларды азайтып, қажетті педагогикалық қолдауды өз мектебінде және құрдастарымен бірге білім алу барысында көрсетуге басымдық беріледі.

Финляндия тәжірибесінде нашар еститін баланы үнемі жеке немесе арнайы ортаға бөліп шығару негізгі шешім ретінде қарастырылмайды. Керісінше, жалпы сыныптағы оқыту тәсілдері баланың мүмкіндігіне қарай икемделеді. Мұғалім ауызша ақпаратты визуалды материалдармен толықтырады, негізгі нұсқауларды жазбаша береді, сабақ құрылымын алдын ала түсінікті етеді және оқушының топтық жұмысқа қатысуына жағдай жасайды. Мұнда қолдаудың мақсаты оқу тапсырмасын орындауға көмектесумен қатар, баланың өз сыныбына және мектеп қауымдастығына тиесілілік сезімін сақтау болып табылады. Сондықтан Финляндия тәжірибесінің айрықша белгісі ретінде қолдаудың оқушының күнделікті білім беру ортасына кіріктірілуін көрсетуге болады.

Финляндияда әлеуметтік қатысуға берілетін басымдық Ұлыбритания тәжірибесінде білім беру ортасының коммуникациялық және акустикалық қолжетімділігін қамтамасыз ету идеясымен толықтырылады. Мұнда «deaf-friendly school», яғни естімейтін және нашар еститін оқушыларға қолайлы мектеп

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ортасын қалыптастыруға ерекше назар аударылады. Бұл тәсілдің негізгі идеясы – баланың оқуындағы қиындықтарды тек есту қабілетінің төмендеуімен түсіндірмей, мектеп ортасында сол қиындықтарды күшейтетін кедергілердің бар-жоғын анықтау. Мәселен, сыныптағы фондық шу, жаңғырық, бірнеше адамның бір мезгілде сөйлеуі, мұғалімнің оқушыға арқасымен тұрып сөйлеуі немесе жарықтың жеткіліксіздігі ақпаратты қабылдауды күрделендіруі мүмкін. Ұлыбританиядағы тиісті нұсқаулықтарда акустикалық ортаның сапасы есту қабілеті бұзылған оқушылардың білім алуына ықпал ететін маңызды фактор ретінде қарастырылады.

Осы себепті британдық тәжірибеде сыныптың физикалық ортасын дұрыс ұйымдастыру педагогикалық бейімдеудің бір бөлігі болып табылады. Нашар еститін оқушы мұғалімнің жүзін анық көретіндей орналасуы, мұғалім сөйлеу кезінде оқушыға қарап тұруы, жаңа терминдер мен негізгі ақпарат визуалды түрде ұсынылуы, бейнематериалдар субтитрмен сүйемелденуі маңызды. Топтық талқылауда оқушылардың кезекпен сөйлеуі және кімнің сөйлеп тұрғанын анық көрсету де коммуникациялық кедергілерді төмендетеді. Бұл тәжірибенің маңызды тұсы – оқушының мүмкіндігін шектейтін факторды баланың өзінен ғана емес, білім беру ортасынан іздеу.

Сонымен қатар британдық модельде педагогтің балаға қатысты жоғары академиялық күтулерін сақтау маңызды. Есту қабілетінің төмендеуі интеллектуалдық мүмкіндіктің төмендігін білдірмейтіндіктен, оқу бағдарламасының мазмұнын негізсіз жеңілдету тиімді бейімдеу ретінде қабылданбайды. Оның орнына оқу материалын ұсыну формасын өзгерту, ақпаратқа қосымша визуалды қолжетімділік беру және қажетті техникалық құралдарды пайдалану ұсынылады. Осылайша, Ұлыбритания тәжірибесінің ерекшелігі оқу талаптарын төмендетуден гөрі, сол талаптарға қол жеткізудегі кедергілерді азайтуға бағытталуымен сипатталады.

Мектеп ортасын қолжетімді етуге бағытталған бұл ұстаным Австралия тәжірибесінде командалық қолдау және технологиялық қамтамасыз етумен ұштасады. Австралиялық тәжірибеде нашар еститін баланың бейімделуі тек сынып мұғалімінің жауапкершілігі ретінде қарастырылмайды. Оған жалпы білім беретін сынып педагогі, арнайы педагог, есту саласындағы мамандар, ата-ана және қажет болған жағдайда басқа да қызмет өкілдері қатысатын кешенді қолдау жүйесі тән. Командалық жұмыс барысында баланың есту мүмкіндігімен қатар оның оқу жетістігі, коммуникациялық белсенділігі, әлеуметтік қарым-қатынасы және техникалық құралдарды пайдалану тиімділігі

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бақыланады.

Австралия тәжірибесінде ассистивті технологиялардың педагогикалық қолдаумен сабақтастығы да маңызды. Жеке есту аппараттары мен кохлеарлық имплантармен қатар қашықтағы микрофон жүйелерін, субтитрленген цифрлық материалдарды және визуалды ақпарат көздерін қолдану оқу үдерісіндегі ақпараттық кедергілерді азайтады. Алайда техникалық құрылғының болуы жеткілікті деп есептелмейді. Мұғалім оның баланың оқуына қалай әсер ететінін түсінуі, сабақ барысында дұрыс қолдануы және техникалық құралдың тұрақты жұмыс істеуін бақылауы қажет.

Австралиялық тәсілдің тағы бір ерекшелігі – өтпелі кезеңдерді алдын ала жоспарлау. Баланың мектепке алғаш келуі, басқа сыныпқа ауысуы немесе білім берудің келесі деңгейіне көшуі бейімделудің жаңа кезеңі ретінде қабылданады. Сондықтан оқушы жаңа ортаға келгенге дейін оның қажеттіліктері туралы ақпаратты педагогтерге жеткізу, ата-анамен және мамандармен бірлескен кездесу өткізу, сыныптың акустикалық жағдайын бағалау және қажетті техникалық құралдарды алдын ала дайындау маңызды. Мұндай алдын ала ұйымдастырылған қолдау жаңа ортада туындайтын коммуникациялық және психологиялық қиындықтардың алдын алуға мүмкіндік береді.

Сонымен бірге халықаралық тәжірибелер нашар еститін оқушының академиялық және әлеуметтік бейімделуін бір-бірінен бөліп қарастыруға болмайтынын дәлелдейді. Оқушы мұғалімнің түсіндірмесін жақсы қабылдағанымен, құрдастарымен коммуникацияға қатыса алмаса, оның мектепке толық бейімделуі туралы айту қиын. Сол сияқты сыныптағы әлеуметтік қарым-қатынасы жақсы болғанымен, оқу ақпараты қолжетімсіз болса, білім беру нәтижесіне қол жеткізу мүмкіндігі шектеледі. Сондықтан тиімді модель академиялық қолжетімділік, коммуникациялық еркіндік, әлеуметтік қатысу және эмоционалдық жайлылықтың бірлігін қамтамасыз етуі тиіс.

Осы тұрғыдан шетелдік озық тәжірибелерді отандық білім беру жүйесіне бейімдеу барысында бірнеше өзара байланысты бағытқа басымдық беру орынды. Олар – нашар еститін оқушының қажеттіліктерін мектепке келген кезден бастап кешенді бағалау; жеке қолдау бағытын белгілеу; сыныптың акустикалық және визуалды қолжетімділігін қамтамасыз ету; ассистивті технологияларды оқу үдерісіне жүйелі енгізу; мұғалімдерді арнайы әдістемелік даярлықтан өткізу; құрдастар арасындағы қолдаушы коммуникациялық ортаны қалыптастыру; ата-аналар мен мамандарды командалық жұмысқа тарту және баланың өзіндік дербестігін дамыту. Аталған бағыттардың жүйелі жүзеге

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асырылуы нашар еститін оқушының мектепке бейімделуін жекелеген түзету шараларының жиынтығы емес, баланың білім алуға, қарым-қатынасқа және мектеп өміріне толыққанды қатысуына мүмкіндік беретін тұтас педагогикалық жүйе ретінде ұйымдастыруға негіз болады.

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POLITICAL SCIENCE AND PUBLIC ADMINISTRATION

Caught Between Blocs: Georgian Foreign Policy and the Politics of Regional Integration

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Abstract. This paper examines Georgia's critical positioning between a European future and a return into Russia's orbit, analyzing how this geopolitical dilemma has placed the country on the new international agenda. The central research question asks: How does Georgia navigate between competing regional integration models—European and Eurasian—while pursuing national interests in an era of renewed great power competition? The study argues that Georgia's transitional position reflects the tension between its constitutional commitment to Euro-Atlantic integration and the persistent structural pressures drawing it back toward Russia's sphere of influence, making it a pivotal case study in contemporary international relations. The findings reveal that Georgia occupies a precarious position where its symbolic importance as a democracy between Europe and Russia confronts the reality of geopolitical pressures and domestic political transformation.
Keywords: *Georgia, European integration, Russian influence, regional integration models, South Caucasus, post-Soviet transitions.*

Introduction

Georgia's post-Soviet trajectory represents one of the most compelling and unresolved geopolitical narratives in the contemporary international system. Situated at the crossroads of Europe and Asia, the country has spent more than three decades oscillating between aspirations of Western integration and the gravitational pull of its Soviet past and Russian-dominated regional architecture. Since the Rose Revolution of 2003, Georgia formally embraced a Euro-Atlantic orientation, inscribing NATO and European Union (EU) membership as constitutional goals—a commitment that was reaffirmed in the 2024 constitutional amendments. Yet, as

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this article argues, the gap between constitutional aspiration and geopolitical reality has widened considerably in recent years, rendering Georgia's strategic orientation increasingly uncertain.

The significance of Georgia's positioning extends well beyond its borders. In an era of renewed great power competition, the South Caucasus has re-emerged as a contested geopolitical space in which the European Union, Russia, and increasingly Türkiye and China vie for influence [1]. Georgia stands at the intersection of these competing forces. Its choices—and the constraints imposed upon them—offer critical insights into the limits of European transformative power and the resilience of Russian regional hegemony. This article examines three interrelated factors that determine Georgia's trajectory: domestic political developments, EU enlargement conditionality, and Russia's multi-dimensional strategy of influence.

Domestic Political Dynamics and the European Integration Paradox

The internal political landscape of Georgia has proven to be both the engine of and the greatest impediment to European integration. The ruling Georgian Dream party, in power since 2012, has exhibited an increasingly ambivalent relationship with the Euro-Atlantic project. While officially committed to EU membership, the government's legislative actions have repeatedly raised alarms in Brussels. The adoption of the so-called "foreign agents" law in 2024—widely compared to a Russian analogous piece of legislation—triggered mass protests in Tbilisi and sharp condemnation from the European Parliament, effectively freezing Georgia's EU candidate status process [2].

This paradox—where a government rhetorically committed to Europe passes legislation antithetical to European democratic standards—reflects a deeper tension within Georgian society. Surveys consistently indicate that the overwhelming majority of the Georgian public supports EU and NATO membership, with approval ratings above 80% [3]. Yet electoral outcomes have produced a government that, whether by design or by institutional capture, systematically narrows the space for civil society and independent media—prerequisites of EU accession conditionality. The 2024 parliamentary elections and their disputed aftermath further illustrated this

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cleavage between popular pro-European sentiment and the trajectory of governmental policy.

Scholars of post-Soviet democratization have described this phenomenon as "competitive authoritarianism"—a regime type in which formal democratic institutions coexist with systematic incumbent advantages that undermine their substance [4]. Georgia under Georgian Dream increasingly fits this characterization, placing it in ambiguous territory where democratic backsliding and European aspirations coexist uncomfortably.

European Union Enlargement Policy and Conditionality Mechanisms in the South Caucasus

The EU's approach to Georgia must be understood within the broader context of its Eastern Partnership (EaP) policy, established in 2009 to foster political association and economic integration with six post-Soviet states. Among the EaP countries, Ukraine and Moldova advanced most rapidly toward candidate status following Russia's full-scale invasion of Ukraine in February 2022, which injected new urgency into the EU's enlargement agenda. Georgia, despite being granted candidate status in December 2023, subsequently saw that status frozen—a direct consequence of the democratic backsliding described above.

The EU's conditionality mechanisms operate on the assumption that the prospect of membership constitutes a sufficiently powerful incentive to induce domestic reforms—a logic that proved highly effective in Central and Eastern Europe during the 1990s and 2000s [5]. However, the South Caucasus presents a significantly more complex environment. The combination of unresolved territorial conflicts (Abkhazia and South Ossetia remain under Russian effective control), economic dependencies on Russia, and governments with mixed reform incentives substantially weakens the EU's transformative power. Georgia is geographically non-contiguous with EU territory, which reduces the immediacy of membership prospects and, consequently, the leverage of conditionality.

A comparative glance at Ukraine and Moldova is instructive. Both countries have moved forward on accession chapters despite being engaged in active or recent conflicts, primarily because their governments have demonstrated a

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credible reform trajectory and political will. Georgia, by contrast, has sacrificed conditionality compliance for domestic political consolidation, revealing that EU leverage is contingent not merely on the attractiveness of membership, but on the political calculations of governing elites [6].

Russia's Multifaceted Strategy of Influence in Georgia

Russia's influence over Georgia operates through multiple, interlocking channels that together constitute a formidable structural constraint on Tbilisi's strategic autonomy. The most visible instrument remains the occupation of Abkhazia and South Ossetia, which followed the 2008 August War—a conflict that demonstrated Russia's willingness to use military force to prevent Georgia's NATO membership and punish Western-oriented leadership [7]. The occupied territories represent a permanent security vulnerability and a coercive tool that Moscow deploys implicitly in any negotiation about Georgia's Western trajectory.

Beyond hard security, Russia employs sophisticated soft power and economic instruments. Georgia's economic entanglement with Russia—through remittances, trade in wine and mineral waters, and the significant Russian tourist inflow that has expanded since 2022 as Russians relocated to avoid sanctions and mobilization—creates constituencies within Georgia that benefit from good relations with Moscow. Russian-owned or Russian-aligned media and political financing channels have also been identified as factors in Georgian domestic discourse [8]. The Georgian Orthodox Church, an institution of immense social authority in Georgian society, has historically maintained warm relations with the Russian Orthodox Church, providing an additional vector of cultural influence that operates largely outside formal diplomatic channels [9].

Russia's strategy toward Georgia is not premised on the expectation of reintegration into a formal Eurasian bloc—Tbilisi has resolutely rejected the Eurasian Economic Union—but rather on managed ambiguity: keeping Georgia outside both the EU and NATO while ensuring that its governments remain sufficiently cautious as not to actively challenge Russian regional interests. This strategy of "integration prevention" [10] has proven effective, demonstrating that great power influence need not take the form of direct control to substantially constrain a smaller state's strategic choices.

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Conclusion

Georgia's contemporary predicament illuminates a broader truth about the limits of liberal international order in contested post-Soviet spaces. The country possesses a pro-European citizenry, a constitutional Euro-Atlantic vocation, and a signed Association Agreement with the EU—yet it finds itself today further from meaningful European integration than at any point in the past decade. This outcome is the product not of a single failure but of the interaction among three distinct forces: a governing elite that has instrumentalized Euro-Atlantic rhetoric while undermining its prerequisites; an EU whose transformative leverage is contingent on the political will of domestic actors and diminished by geographic distance; and a Russia that has mastered the art of "managed disruption," using a combination of hard security threats, economic ties, and soft power to arrest Georgia's Western trajectory without the costs of direct annexation.

Georgia's case offers important comparative lessons for scholarship on post-Soviet transitions and European enlargement. It demonstrates that candidate status alone, absent sustained political will and reduced geopolitical vulnerability, cannot serve as a sufficient anchor for democratic consolidation. It also highlights the need for the EU to develop more differentiated and resilient instruments of engagement for countries operating under acute geopolitical pressure—moving beyond the binary of full accession versus frozen process toward more creative forms of deep partial integration that can provide real benefits and real incentives even in the absence of a clear membership horizon.

Ultimately, Georgia remains a country in transition—but the direction of that transition is no longer as predictable as it once appeared. Whether its citizens' profound European aspirations can be translated into durable institutional realities will depend on the convergence of internal democratic renewal, credible EU engagement, and a shift in the regional security environment. Until those conditions align, Georgia will remain one of contemporary international relations' most instructive and unresolved geopolitical puzzles.

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PHILOLOGY AND LINGUISTICS

International Vocabulary of English Origin in Educational Discourse: Equivalence, Adaptation, and Translation Aspects

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Abstract. The rapid development of globalization, digital communication, and international educational cooperation has significantly increased the influence of English on educational discourse worldwide. English-origin international vocabulary has become an essential component of modern educational communication because it facilitates academic interaction, scientific collaboration, and the exchange of educational resources. At the same time, the integration of English lexical units into national languages raises important linguistic and translation issues related to equivalence, adaptation, and terminology standardization. This study examines the characteristics of English-origin international vocabulary in educational discourse with particular attention to the Kazakh language. The research investigates translation strategies, semantic equivalence, lexical adaptation, and the role of borrowed terminology in educational texts. Examples from textbooks, academic publications, and digital educational platforms demonstrate how international vocabulary functions within the contemporary educational environment. The findings indicate that complete lexical equivalence is not always achievable because of linguistic and cultural differences between English and Kazakh. Consequently, translators employ various strategies, including borrowing, calque, descriptive translation, and functional substitution. The study also highlights the importance of terminology standardization for ensuring consistency in educational communication and improving the quality of translation.
Keywords: *educational discourse, English-origin international vocabulary, equivalence, adaptation, translation, terminology, borrowing, educational translation.*

Introduction

Educational discourse has undergone substantial transformation during the last two decades as a result of globalization, technological innovation, and the expansion of international academic cooperation. Educational institutions increasingly rely on English as the primary language of scientific communication, digital learning platforms, research collaboration, and professional development. Consequently, English-origin international vocabulary has

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become deeply integrated into educational systems across many countries, including Kazakhstan.

The growing number of English borrowings reflects not only linguistic change but also the development of new educational concepts, teaching methodologies, digital technologies, and international standards. Terms such as curriculum, assessment, competence, digital literacy, blended learning, webinar, feedback, and portfolio are now widely used in educational documents and academic communication. Many of these lexical items have no exact traditional equivalents in Kazakh and therefore require careful adaptation and translation.

Educational discourse represents a dynamic communicative environment in which terminology performs not only an informative but also a cognitive and organizational function. The successful transmission of educational knowledge depends on the accurate translation and interpretation of specialized vocabulary. Therefore, the issues of lexical equivalence and adaptation have become increasingly significant in translation studies and applied linguistics.

Equivalence is generally understood as the degree to which the meaning and communicative function of a lexical unit in the source language are preserved in the target language. However, because languages differ in their lexical systems, grammatical structures, and cultural contexts, translators frequently encounter situations where complete equivalence is impossible. In such cases, adaptation becomes a practical solution that enables effective communication while preserving the conceptual meaning of the original term. In Kazakhstan, educational reforms, multilingual education, and digital transformation have accelerated the incorporation of English-origin terminology into official educational documents, university curricula, scientific publications, and online learning resources. This process requires linguists and translators to establish consistent principles for terminology adaptation that respect both international standards and the norms of the Kazakh language.

The relevance of this research is determined by the increasing importance of translation quality in educational communication and the continuing expansion of international vocabulary in modern educational discourse. Understanding the mechanisms of equivalence and adaptation contributes to improving translation practices, terminology management, and intercultural communication within the educational sphere.

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The purpose of this study is to analyze the features of English-origin international vocabulary in educational discourse and to identify the principal strategies of achieving equivalence and adaptation in translation.

The objectives of the study are:

- to define the concept of English-origin international vocabulary in educational discourse;
- to examine theoretical approaches to equivalence and lexical adaptation;
- to identify translation strategies applied to educational terminology;
- to analyze examples from contemporary educational discourse in Kazakhstan;
- to evaluate the influence of international vocabulary on educational communication and translation practice.

The object of the research is English-origin international vocabulary functioning in modern educational discourse.

The subject of the research is the processes of equivalence, adaptation, and translation of English-origin lexical units into Kazakh within educational contexts.

The study employs qualitative and comparative methods, discourse analysis, descriptive analysis, and terminology analysis. These methods enable the identification of semantic, structural, and functional characteristics of international educational vocabulary as well as the evaluation of translation strategies used in contemporary educational texts.

2. Literature Review

The study of international vocabulary, lexical borrowing, equivalence, and translation has become increasingly significant in contemporary linguistics due to globalization and the rapid expansion of intercultural communication. English has established itself as the dominant language of science, technology, business, and education, resulting in the widespread adoption of English-origin terminology by many languages. Educational discourse, in particular, demonstrates a high concentration of international lexical units because educational reforms, digital technologies, and international academic cooperation require the use of unified terminology.

According to Baker (2018), equivalence remains one of the central concepts in translation studies. She argues that translators should not only preserve the lexical meaning of a term but also reproduce its communicative function within

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the target culture. Educational terminology frequently presents challenges because many English concepts are closely associated with specific educational systems and therefore require cultural and linguistic adaptation.

House (2018) emphasizes that translation quality depends on achieving functional equivalence rather than merely replacing words with their dictionary counterparts. In educational discourse, the translator must consider the expectations of teachers, students, researchers, and policymakers to ensure that translated terminology remains understandable and professionally acceptable.

Scholars in terminology studies have also highlighted the increasing role of international vocabulary in higher education. Cabré (2020) notes that specialized terminology evolves continuously under the influence of scientific innovation and international collaboration. Consequently, educational terminology requires systematic standardization to maintain consistency across academic publications, textbooks, and legislative documents.

The concept of lexical adaptation has received considerable attention in modern linguistic research. Adaptation refers to the process by which borrowed lexical units become integrated into the phonetic, grammatical, orthographic, and semantic systems of the recipient language. Haugen's classical theory of borrowing remains relevant because it distinguishes between direct borrowing, loan translation, semantic borrowing, and hybrid formations. Contemporary studies demonstrate that these mechanisms continue to operate actively in educational terminology.

Within the Kazakh linguistic context, researchers have investigated the influence of globalization on terminology development. Suleimenova and other Kazakh linguists emphasize that the expansion of English-origin terminology reflects the modernization of the national education system. However, they also stress the necessity of preserving linguistic norms while adapting foreign lexical units into Kazakh.

Digitalization has significantly accelerated the dissemination of international vocabulary. The COVID-19 pandemic particularly contributed to the widespread use of terms such as online learning, blended learning, webinar, learning management system (LMS), digital literacy, and remote assessment. These concepts rapidly entered educational discourse in many countries, including Kazakhstan, where they became common in official educational documents and

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university practice.

Several studies indicate that translators employ different strategies depending on the linguistic characteristics of individual terms. Vinay and Darbelnet's translation procedures continue to influence modern translation practice. These include borrowing, calque, literal translation, transposition, modulation, equivalence, and adaptation. Educational terminology often requires a combination of these strategies because complete lexical correspondence rarely exists.

Borrowing remains one of the most productive strategies. Terms such as portfolio, webinar, and mentor are frequently transferred into many languages with only minor phonetic or orthographic modifications. Such borrowings facilitate international communication because specialists recognize the terminology regardless of national linguistic differences.

Calque is another productive strategy in educational translation. Through calque, the structural components of the source-language term are translated literally into the target language while preserving the conceptual meaning. For example, the English expression distance learning corresponds to the Kazakh equivalent қашықтан оқыту, which successfully reflects the original concept while conforming to the grammatical norms of the target language.

Descriptive translation becomes necessary when no direct equivalent exists. Instead of introducing unfamiliar borrowings, translators may explain the meaning of a concept using descriptive phrases. Although this approach increases text length, it enhances comprehension, particularly for students and non-specialist readers.

Functional substitution represents another important translation strategy. Rather than translating lexical units literally, translators replace them with culturally or institutionally appropriate concepts that perform similar communicative functions within the educational system.

Recent studies also demonstrate the growing influence of artificial intelligence on educational translation. Machine translation systems and AI-assisted terminology management have considerably improved translation efficiency. Nevertheless, human translators remain indispensable because educational terminology often contains contextual, semantic, and cultural nuances that automated systems cannot fully interpret.

Overall, the reviewed literature confirms that

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equivalence and adaptation are complementary rather than competing concepts. Successful translation of educational terminology depends on balancing semantic accuracy, linguistic naturalness, and communicative effectiveness. As English continues to dominate international education, further research is required to develop consistent principles for translating and adapting international vocabulary within national educational systems, including Kazakhstan.

3. Research Methodology

This research employs a qualitative approach supported by comparative and descriptive methods to investigate the equivalence and adaptation of English-origin international vocabulary in educational discourse. The study focuses on lexical units used in contemporary Kazakh educational materials and examines the strategies applied in their translation and adaptation.

The research material consists of educational documents, secondary school textbooks (Grades 7–11), university teaching materials, academic publications, and digital educational resources issued in Kazakhstan. These sources were selected because they reflect the current use of international educational terminology in both traditional and digital learning environments.

The following research methods were applied:

- Descriptive analysis to identify the semantic and structural characteristics of English-origin international vocabulary.
- Comparative analysis to compare English terms with their Kazakh equivalents.
- Discourse analysis to examine the functioning of lexical units within educational communication.
- Terminological analysis to identify translation strategies and adaptation mechanisms.

The analysis focused on identifying the most frequently used English-origin terms and classifying them according to the translation strategy employed. Particular attention was paid to the preservation of meaning, communicative function, and compliance with the norms of the Kazakh language.

4. Results and Discussion

The analysis demonstrates that English-origin international vocabulary occupies an increasingly important place in modern educational discourse. The influence of globalization, digital education, and international academic cooperation has contributed to the rapid dissemination of

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English terminology across all educational levels.

The study identified four principal translation strategies used in Kazakh educational discourse:

1. Direct borrowing;
2. Loan translation (calque);
3. Descriptive translation;
4. Functional equivalence.

The choice of strategy depends on the semantic complexity of the term, its frequency of use, and the existence of an established equivalent in the Kazakh language.

Table 1.

Examples of English-Origin Educational Vocabulary and Their Kazakh Equivalents

English term	Kazakh equivalent	Translation strategy
Curriculum	Оқу бағдарламасы	Functional equivalence
Assessment	Бағалау	Functional equivalence
Feedback	Кері байланыс	Calque
Digital literacy	Цифрлық сауаттылық	Calque
Portfolio	Портфолио	Borrowing
Webinar	Вебинар	Borrowing
Online learning	Онлайн оқыту	Borrowing + adaptation
Competence	Құзыреттілік	Functional equivalence
Inclusive education	Инклюзивті білім беру	Borrowing + calque
Learning outcomes	Оқу нәтижелері	Functional equivalence

The findings indicate that functional equivalence is the most frequently applied strategy in official educational documents because it ensures clarity and consistency for teachers and students. Borrowing is mainly used for newly introduced concepts that have become internationally recognized.

For example, the term portfolio has entered Kazakh educational discourse without significant modification. Instead of creating a new lexical equivalent, educational institutions have adopted the international form because it is widely understood within academic communities.

Similarly, webinar has become a common term after the expansion of online education. Although descriptive translations are theoretically possible, the borrowed form remains more practical and internationally recognizable.

The analysis also revealed that some English concepts require semantic adaptation rather than literal translation.

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The word competence, for instance, is translated as құзыреттілік, which accurately reflects the educational meaning within the Kazakh pedagogical context.

Digital transformation has significantly increased the number of English borrowings in educational discourse. Terms such as e-learning, digital platform, Google Classroom, Moodle, Zoom, and Learning Management System (LMS) are now commonly used in educational practice. Their widespread adoption illustrates the growing integration of global educational technologies into Kazakhstan's education system.

However, the increasing use of borrowed terminology also creates challenges. Different educational institutions occasionally employ different translations for the same concept, leading to inconsistency in educational documents. Therefore, terminology standardization remains an important task for linguists, translators, and educational policymakers.

Another significant finding concerns the role of context in achieving equivalence. Certain English terms possess multiple meanings depending on the educational situation. Consequently, translators must consider not only dictionary definitions but also the communicative purpose of the text.

Overall, the findings confirm that the successful translation of English-origin international vocabulary requires a balanced combination of semantic accuracy, linguistic adaptation, and functional appropriateness. These principles contribute to effective educational communication and facilitate Kazakhstan's integration into the international academic community.

5. Conclusion

The present study examined the equivalence, adaptation, and translation of English-origin international vocabulary in modern educational discourse. The findings demonstrate that globalization, digitalization, and international academic cooperation have considerably increased the use of English educational terminology in Kazakhstan. Consequently, translators, educators, and terminology specialists face the challenge of ensuring accurate and consistent translation while preserving the linguistic norms of the Kazakh language.

The analysis revealed that functional equivalence, borrowing, calque, and descriptive translation are the principal strategies employed in translating English-origin educational terminology. Among these, functional equivalence is the most productive because it preserves both the semantic

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content and communicative function of educational concepts. Borrowing remains common for internationally recognized terms such as portfolio, webinar, and online learning, while calque is frequently used for transparent compound terms such as digital literacy and feedback.

The study also showed that complete lexical equivalence is not always possible because educational systems, linguistic structures, and cultural contexts differ. Therefore, lexical adaptation plays a crucial role in integrating international terminology into Kazakh educational discourse. Effective adaptation ensures that borrowed terms remain understandable, linguistically acceptable, and functionally appropriate for teachers, students, and researchers.

Furthermore, the growing influence of digital technologies and artificial intelligence has accelerated the spread of English-origin vocabulary in educational communication. This trend emphasizes the need for unified terminology policies and cooperation among linguists, translators, educators, and policymakers to standardize educational terminology and improve translation quality.

The results of this research contribute to translation studies, terminology studies, and educational linguistics by providing a systematic analysis of English-origin international vocabulary in the educational domain. The findings may also serve as a practical resource for translators, textbook authors, researchers, and higher education institutions involved in multilingual educational communication.

Future research may investigate the use of artificial intelligence in educational translation, compare the adaptation of English terminology across different Turkic languages, and analyze the evolution of international educational vocabulary in digital learning environments.

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PHILOLOGY AND LINGUISTICS

Peculiarities of Big Data Application in Contemporary Linguistics: Navigating Turbulence, Uncertainty and Systemic Risks Through Shiva and Warmi Frameworks

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Abstract. The article explores the features and specifics of Big Data technologies in modern linguistics in the context of the dynamics of uncertainty, turbulence and systemic risks. The potential of Big Data for the analysis of large-scale and dynamic language data, the development of digital philology, the detection of language trends and weak signals is revealed. The need for the integration of Big Data, artificial intelligence and traditional philological methods within the framework of the SHIVA and WARMI concepts of the modern external environment is substantiated.
Keywords: *modern linguistics; computational linguistics; Big Data; digital philology; artificial intelligence; machine learning; natural language processing; language data; uncertainty dynamics; turbulence; systemic risks; SHIVA concept; WARMI concept; digital transformation.*

INTRODUCTION.

Modern socio-economic systems (in particular, the sphere of science and education) are currently developing in conditions of qualitatively more complicated external environment, characterized by the dynamics of uncertainty [1], high turbulence of information processes and increased systemic risks. The transformation of the digital environment [2] significantly changes not only the methods of creating, storing and distributing linguistic information, but also the methodology of its scientific research itself [3]. Modern linguistics gains access to unprecedented in volume, speed of formation, diversity and dynamism of arrays of text and multimodal data [4], which creates an objective need for new tools for their intellectual processing [5]. In these

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conditions, Big Data technologies become not just a technical means of analyzing large arrays of information [6], but an important element of modern scientific methodology, ensuring the transition from local and mainly qualitative analysis of linguistic phenomena to large-scale, dynamic and multidimensional study of language [7].

The use of Big Data is becoming particularly relevant in the context of the conceptual transition from relatively stable models of VUCA and BANI environments to more complex representations of the modern world, which within the framework of SHIVA and WARMI concepts emphasize the interconnectedness of instability, high speed of change, hyper-information saturation, multiplicity of risks, multiplicity of risks. For modern linguistics, this means that language must be considered not as a system of relatively stable structures, but also as a dynamic information system, constantly changing under the influence of social, technological, economic, cultural and communication factors [8]. Traditional methods of linguistic analysis retain their fundamental importance, but their capabilities are insufficient for processing digital corpora, social media, news streams, electronic communications, multimedia content and other sources, the volume of which is constantly growing. Big Data allows you to analyze such arrays [9] using automated collection, integration, storage, cleaning, structuring and intelligent processing of data. This creates conditions for detecting hidden patterns, stable correlations, language trends and weak signals that may be invisible when using traditional sampling methods [10].

The relevance of the study is determined by the need for a systematic understanding of the features and specifics of Big Data technologies in relation to modern linguistics, as well as determining their capabilities and limitations in conditions of high uncertainty, turbulence and systemic risks of the external environment [11]. That is why the current goal of this article is to identify the key features of the use of Big Data technologies in modern linguistics and determine their methodological potential for the development of digital philology in the conditions of SHIVA and WARMI environments.

MAIN PART.

Big Data as a technological basis for the transformation of modern linguistics.

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PHILOLOGY AND LINGUISTICS

Big Data is a set of technologies and methods for working with data characterized by large volume, high rate of receipt, diversity, heterogeneity and dynamism. This is especially important for linguistics, since digital communication constantly forms huge arrays of text, speech and multimodal information. The objects of research are digital corpora, social networks, blogs, news streams, electronic documents, speech transcripts, messages and other sources. Their analysis allows us to move from limited samples to large-scale research of speech processes, to identify frequency changes, new constructions, semantic shifts and features of communication behavior. At the same time, Big Data does not replace traditional linguistic interpretation, but expands its empirical capabilities. The most productive is a hybrid model that combines automated quantitative analysis with qualitative interpretation of the results by a philologist.

Specificity of Big Data speech languages.

The specificity of Big Data in linguistics is determined by the complexity of language, its contextuality, polysemy, variability and cultural conditioning. Linguistic data are characterized by heterogeneity, the presence of noise, incompleteness, multilingualism, multimodality and constant variability. Temporal dynamics is of particular importance. Linguistic patterns identified in one time interval may change in the future, therefore modern research should take into account not only the state of the language, but also the direction of its transformation. In the conditions of SHIVA and WARMI concepts, language can be considered as a kind of indicator of environmental changes. The dynamics of vocabulary, discourses, word frequency and semantic connections allows us to detect weak signals of social and informational transformations.

Basic Big Data technologies in modern linguistics.

The technological basis of modern digital linguistics includes the collection and integration of large arrays of linguistic data, their distributed storage and processing, intellectual analysis and visualization of results. Of particular importance are natural language processing, machine learning, and artificial intelligence technologies used for text classification, clustering, entity extraction, topic modeling, sentiment analysis, and semantic relationship discovery. Visual analytics allows us to represent language processes using graphs, networks, and semantic models. Thus, Big Data forms a complex technological ecosystem that combines

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the collection, storage, processing, modeling, visualization, and interpretation of language information.

Big Data and the development of digital philology.

The integration of Big Data contributes to the transition of digital philology to a large-scale and technologically advanced study of language. Their application is promising for corpus and computational linguistics, sociolinguistics, discourse analysis, stylistics, terminology, lexicography and translation studies. Big data allows us to study the dynamics of vocabulary, the spread of neologisms, the change in word meanings, the transformation of discourses and the peculiarities of the linguistic behavior of various social groups. Dynamic language analysis is especially promising, which allows not only to record changes, but also to identify emerging trends. In the future, this creates opportunities for building intelligent language platforms that combine corpora, artificial intelligence, machine learning, semantic analysis and visualization.

Big Data in the conditions of the SHIVA-concept of the external environment.

The SHIVA-concept focuses on the high speed of change, uncertainty, interconnectedness of processes and the need for constant adaptation. For linguistics, this means the need to work with constantly updated flows of linguistic information. Big Data creates technological prerequisites for the formation of dynamic corpora and practically continuous monitoring of linguistic processes. The detection of weak signals becomes especially important: changes in word frequency, the emergence of new concepts or transformations of discursive connections can indicate larger-scale changes in the social environment. Therefore, Big Data in the SHIVA environment performs not only a descriptive, but also a diagnostic and prognostic function.

Big Data in the context of the WARMI concept and systemic risks.

The WARMI concept increases attention to the complexity of the environment, the interconnectedness of processes and the multiplicity of risks. Linguistic information under such conditions becomes part of a broader system of socio-informational interactions and can reflect social tensions, value transformations and changes in communication models. Big Data allows you to compare linguistic data with social, economic, cultural and technological factors, which creates the basis for interdisciplinary analysis. However, digital

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data is not completely neutral: it depends on the characteristics of platforms, algorithms, user behavior, and the structure of information flows. Therefore, a statistically revealed pattern requires mandatory philological and contextual interpretation.

Methodological limitations and risks of using Big Data.

One of the main problems is the quality of the source data. Unrepresentative, incomplete or biased arrays can lead to erroneous conclusions even when using perfect algorithms. Another significant limitation is the algorithmic dependence of the results, especially when analyzing ambiguity, irony, metaphors and culturally specific expressions. Issues of confidentiality, ethics and protection of personal data are important, since the analysis of digital communication can affect the private lives of users. In addition, there is a risk of technological reductionism, in which complex humanitarian phenomena are reduced to quantitative indicators. Therefore, Big Data should be used as a tool to expand philological analysis, and not as its complete replacement.

Prospects for the development of Big Data technologies in modern linguistics.

The promising development of Big Data is associated with the formation of intelligent self-learning systems that combine big data, machine learning, artificial intelligence, generative language models, graph technologies and semantic networks. Dynamic digital corpora are especially promising, capable of automatically updating and recording language changes in almost real time. Multimodal analysis, combining text, speech, images and video, also has significant potential. In the conditions of SHIVA and WARMI environments, the importance of adaptive analytical systems that can change analysis parameters following data transformation is increasing. Such systems can be used for early detection of language trends, discursive changes and information risks.

CONCLUSIONS.

Big Data technologies are becoming one of the key factors in the transformation of modern linguistics and digital philology, as they provide the opportunity to analyze large-scale, dynamic, heterogeneous and multimodal arrays of linguistic information. Their use makes it possible to significantly expand the empirical base of philological research, to move from limited samples to a large-scale

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analysis of the linguistic environment, and to reveal regularities that are difficult to detect using traditional methods.

The specificity of linguistic Big Data is determined by the complexity of the language itself: its contextuality, ambiguity, variability, cultural conditioning and constant variability. Therefore, the application of Big Data requires a combination of computational methods with traditional philological approaches, which provide meaningful interpretation of the obtained results.

In terms of SHIVA and WARMI concepts, Big Data acquires additional methodological significance. They make it possible to consider language as a dynamic indicator of environmental changes, detect weak signals of the transformation of social discourse, track accelerating linguistic processes, and form prerequisites for forecasting new trends.

At the same time, the expansion of technological capabilities is accompanied by the growth of methodological, ethical and informational risks. Unrepresentativeness of data, algorithmic distortions, privacy issues and the risk of excessive quantitative reduction of humanitarian knowledge require a critical and systematic approach to the use of Big Data.

Thus, the most promising is the hybrid paradigm of modern linguistics, in which Big Data, artificial intelligence, machine learning and intelligent analytics are integrated with fundamental methods of philological research. In the future, this may lead to the formation of an adaptive digital philology capable not only of analyzing already accumulated language information, but also of promptly monitoring, explaining and forecasting language transformation in conditions of high uncertainty, turbulence and systemic risks of the modern external environment.

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No 307

LITERARY STUDIES

Knowledge-Based Information Technologies in Contemporary Literary Studies Amid Conditions of Dynamic Uncertainty, Turbulence and Systemic Risks (Shiva and Warmi Perspectives)

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Abstract. The article explores the features and specifics of the application of Knowledge-Based IT in modern literary studies in the context of the dynamics of uncertainty, turbulence and systemic risks. The possibilities of ontologies, knowledge graphs, expert systems and hybrid intelligent technologies for structuring and analyzing literary knowledge are revealed. The prospects of integrating KB-IT, NLP, machine learning and large language models within the framework of SHIVA and WARMI concepts of the external environment are substantiated.
Keywords: *digital philology; knowledge-based IT; literary studies; digital literary studies; digital humanities; artificial intelligence; knowledge graphs; ontologies; semantic analysis; machine learning; NLP; large language models; literary studies; SHIVA; WARMI; uncertainty; turbulence; systemic risks.*

Introduction.

Modern philology is developing in conditions of fundamental environmental complexity [1], which is characterized by the dynamics of uncertainty, acceleration of changes, information overload, technological turbulence and increased systemic risks [2]. These processes directly affect not only the practice of communication and language analysis, but also literary studies as a branch of humanities knowledge focused on the study of the literary text, literary processes, authorial strategies, intertextual connections and cultural dynamics. In the conditions of SHIVA and WARMI concepts of the external environment, traditional methods of literary research require supplementation with intelligent information

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technologies capable of working with large arrays of heterogeneous data, revealing hidden patterns and supporting research decision-making in conditions of incompleteness and variability of information.

Of particular importance in this context is Knowledge-Based IT (KB-IT) - a class of intelligent information technologies [3], in which the central resource is not only an array of data, but also structured knowledge: concepts, categories, rules, semantic relations, subject models, expert assessments and logical dependencies [4]. This is especially important for literary studies [5], since a literary text is a complex multi-level object in which meaning is formed through the interaction of linguistic, plot, compositional, stylistic, cultural, historical and intertextual components [6]. Therefore, simple quantitative analysis of the text is not enough: technologies are needed that can take into account the context, semantics, knowledge of the literary process and expert interpretations [7].

The relevance of the application of Knowledge-Based IT in modern literary studies is also due to the transition from a predominantly text-centric research model to an integrated digital model [8], which combines methods of Digital Humanities, artificial intelligence, natural language processing, ontological modeling, semantic networks, expert systems and intelligent analysis. Unlike technologies focused mainly on processing large amounts of information, KB-IT allows you to formalize and use knowledge about literary objects and the relationships between them, creating a basis for intelligent search, classification, interpretation and prediction [9].

So, the purpose of the article is to systematically identify the features and specifics of Knowledge-Based IT in modern literary studies, taking into account the dynamics of uncertainty, turbulence and systemic risks of the external environment, which is conceptualized using SHIVA and WARMI approaches. To achieve the goal, it is necessary to determine the specifics of knowledge as an intellectual resource of literary research, reveal the functional capabilities of KB-IT, establish their difference from predominantly data-driven technologies, determine the directions of application in literary studies, and substantiate the prospects for their development in an unstable external environment.

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Main Part.

Knowledge-Based IT as the intellectual basis of digital literary studies. Knowledge-Based IT (KB-IT) is an intelligent information technology in which data processing is carried out on the basis of structured knowledge: concepts, categories, rules, semantic relationships, expert assessments and subject models. This is especially important for literary studies, since a literary text is a complex multi-level object, the content of which is determined by the interaction of linguistic, semantic, stylistic, cultural, historical and intertextual components. KB-IT allows you to move from simple processing of digital texts to intelligent processing of literary knowledge. Their technological basis is knowledge bases, ontologies, semantic networks, knowledge graphs, expert systems, inference rules and hybrid models of artificial intelligence.

The specifics of literary knowledge as an object of intellectualization. Literary knowledge is characterized by multilevel, contextuality, interpretative ambiguity and a significant share of expert knowledge. The same text can be studied simultaneously at the lexical, semantic, stylistic, plot, narratological, intertextual and historical-cultural levels. Therefore, KB-IT should provide a representation of different types of knowledge and the connections between them. A particular complexity is created by the multitude of interpretations: an intellectual system should not replace the literary scholar with a single automatically generated conclusion, but should provide a space for reasoned interpretations. A hybrid representation of formalized and partially formalized expert knowledge also becomes essential.

Knowledge-Based IT and the transition from data-driven to knowledge-driven literary studies. Traditional digital technologies mainly provide storage, search and statistical processing of texts. The data-driven approach allows for the identification of quantitative patterns, but does not in itself explain their literary significance. KB-IT forms an additional knowledge-driven level that connects the results of automatic analysis with literary categories, semantic models and expert knowledge. The most promising is their combination with machine learning and NLP, in which algorithms detect patterns in large arrays of texts, and knowledge-based components provide their semantic interpretation. Thus, a cycle is formed: data → analysis → detection of patterns → comparison with knowledge → interpretation → replenishment of

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the knowledge base.

Main areas of application of KB-IT in literary studies. One of the key areas is the ontological modeling of the literary subject area, which includes authors, works, genres, characters, motifs, themes, literary movements, artistic techniques and cultural and historical contexts. An important role is played by graphs of literary knowledge, which allow representing works and objects related to them in the form of a network of semantic relations. This creates opportunities for identifying intertextual connections, literary influences, thematic intersections and the dynamics of the literary process. Also promising are intelligent semantic search, automated genre and stylistic classification, analysis of motifs and intertextuality, reconstruction of authorial strategies and intellectual support of scientific search. KB-IT can help literary scholars in forming samples, searching for sources, systematizing research and building conceptual maps.

Specificity of KB-IT in the conditions of SHIVA-concept of the external environment. Within the framework of SHIVA-concept, the external environment is characterized by high uncertainty, fragmentation, acceleration of changes and the need for constant adaptation. Therefore, literary knowledge should be considered as a dynamic system, and not as a static information repository. KB-IT should ensure constant updating of knowledge, take into account new research, terminological changes and alternative interpretations. Of particular importance are working with incomplete and contradictory knowledge, fixing the origin of information and distinguishing facts and interpretations. The most important principle becomes human-in-the-loop: an intellectual system expands the research capabilities of a literary scholar, but does not replace his critical thinking and interpretative competence.

Specificity of KB-IT in the conditions of WARMI-concept of the environment. WARMI-concept emphasizes the interaction of uncertainty, turbulence and systemic risks, which increase the instability of the modern information environment. For literary studies, this is the need to create not only intelligent, but also stable, adaptive and understandable information systems. The main risks include incomplete corpora, errors in the source data, algorithmic elimination, knowledge obsolescence, incorrect interpretation of the text and excessive dependence of the researcher on automatic

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recommendations. Therefore, KB-IT should ensure the transparency of sources, clarity of results, the possibility of audit and critical review.

Hybrid architecture of Knowledge-Based IT in literary studies. Promising KB-IT can include several interconnected levels: digital sources and corpora; NLP and machine learning; knowledge layer with ontologies, thesauri and knowledge graphs; mechanisms for semantic search and logical inference; user level of interaction with the literary scholar. A special perspective is the integration of KB-IT with large language models. With a specialized knowledge base, LLM can act as an intelligent interface for searching, comparing, and interpreting information, and the knowledge layer can provide subject-specific relevance and verifiability of results. Thus, a hybrid intelligent research environment [10] that combines KB-IT, NLP, machine learning, knowledge graphs, LLM, and human expertise becomes promising.

Main advantages and limitations of KB-IT application. The main advantages of KB-IT include the systematization of various literary knowledge, intelligent semantic search, identification of hidden connections, support for intertextual analysis, integration of various sources, and increased reproducibility of research procedures. At the same time, there are limitations associated with the difficulties of formalizing artistic meaning, ambiguity, metaphoricity, irony, and cultural conditioning of the text. Excessive formalization can simplify complex interpretations or impose a predetermined system of categories. Therefore, it is advisable to evaluate the effectiveness of KB-IT not by the level of automation, but by the ability to expand the intellectual capabilities of a literary scholar, while preserving the interpretive nature of humanitarian knowledge.

Conclusions.

Knowledge-Based IT forms a promising intellectual basis for digital literary studies, as it allows to move from the predominant processing of digital data to the structuring, integration and intelligent use of literary knowledge. Their fundamental specificity lies in the combination of data, semantic models, expert knowledge, inference rules and intelligent algorithms.

Unlike data-driven technologies, which are focused on identifying statistical patterns, KB-IT provides the ability to take into account the subject context, semantic

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relationships, literary categories and expert interpretations. This makes them especially significant for the analysis of literary texts as complex multi-level objects, the meaning of which is reduced to a set of statistical indicators.

It has been established that the most promising direction is the hybridization of Knowledge-Based IT, machine learning, NLP, knowledge graphs and large language models. Such integration allows combining the ability of algorithms to process large arrays of texts with the ability of knowledge-based systems to ensure semantic structuring, clarity and subject-matter relevance of results.

In the case of SHIVA and WARMI environmental concepts, the dynamism, adaptability, stability and clarity of KB-IT acquire special importance. Literary knowledge bases should be considered not as static repositories, but as dynamic systems capable of being updated, taking into account alternative interpretations, recording the origin of knowledge and adapting to changes in the research space.

The human-AI-knowledge collaboration model becomes promising, in which artificial intelligence performs the functions of searching, structuring, comparing and generating research hypotheses, and the literary scholar conceptualizes the problem, critically verifies and interprets the results. This approach allows preserving the fundamental principle of humanitarian research - the plurality and argumentation of interpretations - while significantly expanding its technological capabilities.

Thus, Knowledge-Based IT in modern literary studies should be considered not simply as a set of digital tools, but as a new intellectual infrastructure of philological knowledge, ensuring the transition to semantically-oriented, hybrid and adaptive digital literary studies. In the conditions of dynamics of uncertainty, turbulence and systemic risks, it is the ability to integrate knowledge, data, algorithms and human expertise that becomes one of the key factors for the sustainable development of modern literary studies.

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MEDICINE AND PHARMACY

Динаміка Змін Показників Холодової Алодинії в Динаміці Нейротоксичності, Індукованої Роздільним та Сумісним Введенням Паклітакселу та Цисплатини

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Анотація. Хіміотерапевтичні препарати широко використовуються в клініці при лікуванні раку. Проте, за умов хіміотерапії можуть розвиватися серйозні побічній ефекти, які суттєво знижують ефективність лікування раку. Мета роботи – визначення показників холодової алодинії в динаміці нейротоксичності, індукованої роздільним та сумісним введенням паклітакселу та цисплатини. Доведено розвиток больової реакції та порушення сомато-сенсорної чутливості в динаміці відтворення хіміотерапевтичної нейротоксичності, ініційованої роздільним та сумісним уведенням паклітакселу та цисплатину. Більша вираженість нейротоксичного ефекту реєструється при сумісному введення паклітакселу та цисплатину вже на 14-й добі. Співставні порушення чутливості виявлялися при роздільному введенні паклітакселу та цисплатину, починаючи з 28-ї доби досліду. Ефекти порушення чутливості тривали до кінця досліду. Автор вважає, що отримані дані з обов'язковим морфологічним підтвердженням є експериментальним підґрунтям доцільності клінічного тестування нової патогенетичної схеми фармакокорекції нейротоксичності, ініційованої введенням хіміотерапевтичних препаратів.
Ключові слова: *паклітаксел, цисплатин, хіміотерапевтично індукована периферична нейропатія, холодова алодинія, патофізіологічні механізми.*

Хіміотерапія є одним із ефективних способів лікування злоякісних пухлин [1]. При достатньо вираженій канцеропатичній активності, застосування хіміотерапевтичних препаратів є тривалим, що забезпечує ефект кумуляції, наслідком чого є низка побічних ефекті та ускладнень, які суттєвим чином змінюють тактику лікування значної кількості онкологічних хворих [2, 3].

Хіміотерапевтично індукована периферична нейропатія (ХІПН) є одним із ймовірних ускладнень протипухлинної терапії, що розвивається у значної кількості пацієнтів, яким уводять паклітаксел або цисплатин. В разі розвитку такого ускладнення суттєво погіршується якість життя онкологічних хворих та

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доводиться змінювати або корегувати протипухлинну терапію [4]. При цьому в організмі пацієнтів, додатково до маніфестації специфічного онкологічного процесу, розвиваються певні функціональні розлади, ініційовані токсичним впливом хіміотерапевтичних препаратів, наслідком яких є формування функціональної дезінтеграції органів та систем організму [5-8].

Важливим є розуміння патофізіологічних механізмів ХІПН, оскільки нейротоксичність, спричинена хіміотерапією, може впливати на будь-який нейрон в організмі безпосередньо та опосередковано і таким чином може значно змінювати клінічну маніфестацію основного захворювання. Відомими є схожі каскадні патофізіологічні механізми запального процесу та больової реакції, вираженість якої суттєвим чином детермінує клінічний перебіг пухлинного процесу у хворих [9]. Важливим вважаємо функціонування циклічних взаємообтяжуючих патогенетичних ланцюгів за механізмом «зачарованого кола», грунт яких становить взаємна зворотна модуляція вираженості запальної та больової реакції.

В разі отримання адекватних результатів за умов експериментальної нейротоксичності, ініційованої введенням хіміотерапевтичних препаратів, ми плануємо в подальшому серію експериментальних досліджень, спрямованих на розробку патогенетично обґрунтованої схеми фармакокорекції проявів центральної та периферичної нейротоксичності.

Мета роботи – визначення показників холодової алодинії в динаміці нейротоксичності, індукованої роздільним та сумісним введенням паклітакселу та цисплатини.

Матеріал і методи дослідження. Досліди були проведені за умов хронічного експерименту на щурах лінії Вістар, які утримувалися за умов віварію. Утримання, обробка та маніпуляції з тваринами проводились відповідно із «Загальними етичними принципами експериментів на тваринах», ухваленими П'ятим національним конгресом з біоетики (Київ, 2013).

Периферичну нейротоксичність відтворювали роздільним та сумісним уведенням паклітакселу (ПК) та цисплатини (ЦП) [10]. Розрізняли 4 дослідні групи по 30 щурів в кожній. 1 група – уведення ПК. 2 група – уведення ЦП. 3 група – сумісне введення ПК та ЦП. Була також контрольна група тварин без жодних фармакологічних впливів.

За щурами з початку досліду та введення хіміотерапевтичних препаратів спостерігали протягом 120 діб [11]. Холодову алодинію в щурів визначали через 1, 7, 14, 28, 60, 90 і 120 діб після введення хіміотерапевтичних препаратів та оцінювали при розміщенні тварин на металевій поверхні T=0°C [12].

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Вираженість цього тесту визначали за середнім часом, при якому тварина ушкоджену кінцівку тримала на вазі протягом 1 хв перебування тварини у тест-камері.

Отримані дані обчислювали статистично із застосуванням параметричного критерію Бонферонi.

Отримані результати та їх обговорення.

При приміщенні інтактних щурів на холодну металеву поверхню вони уникали контакту лапами з цією поверхнею в середньому на 1.8-4.1 сек (Рис. 1). За умов сумісного введення піддослідним тваринам ПК та ЦП вже на 14 добу досліду величина досліджуваного показника дорівнювала 12.7±1.3 сек, що в 4.9 разів перевищувало аналогічний контрольний показник та відповідні показники, які реєстрували в щурів із роздільним уведенням двох хіміотерапевтичних препаратів (в усіх випадках $p<0.05$).

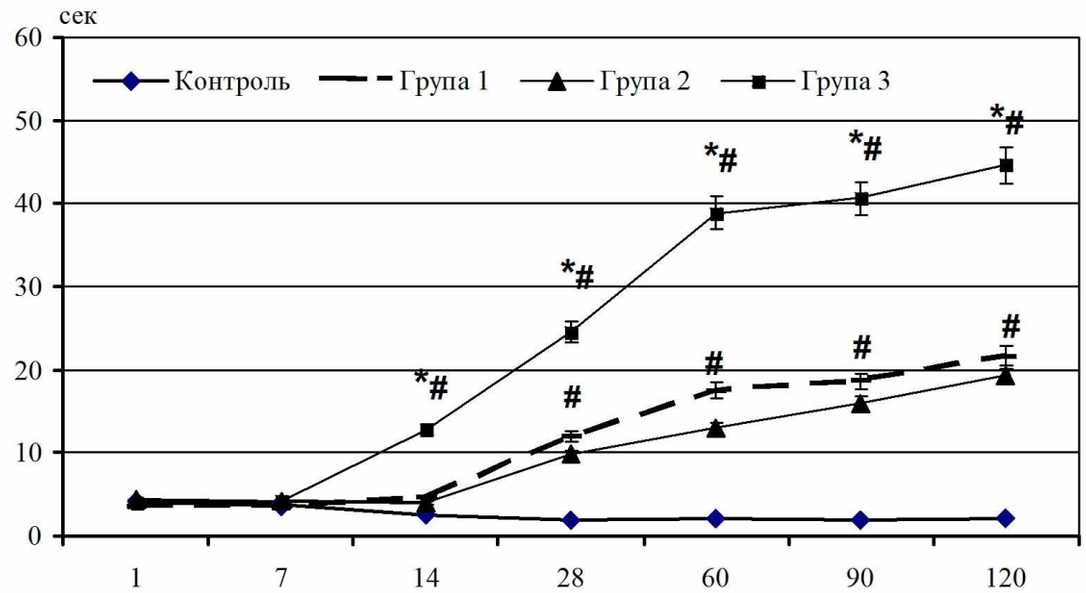

Рисунок 1. **Зміни холодової алодинії в щурів в динаміці експериментальної нейротоксичності, ініційованої роздільним та сумісним уведенням цисплатини та паклітакселу**

Позначення:
за віссю ординат – час відсутності контакту з охолодженою поверхнею металевої пластинки у сек;
за віссю абсцис (1, 7, 14, 28, 60, 90 і 120) – доби проведення досліду.
Примітки:
– $p<0.05$ – достовірні відмінності досліджуваних показників порівняно з відповідними значеннями у щурів контрольної групи;
* – $p<0.05$ – достовірні відмінності показників порівняно з відповідними значеннями у щурів із роздільним введенням паклітакселу та цисплатини.

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У щурів із роздільним уведенням досліджуваних хіміотерапевтичних препаратів статистична розбіжність виявлялася на 28 добі досліду, коли тривалість відсутності контакту з металевою поверхнею була в 6.7 разів (при введенні ПК) і в 5.4 рази (при введенні ЦП) більше при порівнянні з аналогічними показниками при контрольних вимірюваннях ($p<0.05$). Виявлена спрямованість змін величини досліджуваного показника в щурів із роздільним уведенням ПК та ЦП тривала до 120-ї доби досліду.

Отримані дані свідчать про розвиток вираженої больової реакції в щурів в динаміці відтворення хіміотерапевтичної нейротоксичності, що з фундаментальної точки зору висвітлює залежні від часу порушення сомато-сенсорної чутливості при введенні протипухлинних препаратів. Це підтверджується результатами тесту холодової алодинії, що унеможливлює невірну трактовку отриманих фактичних даних. За таких модельних умов нам вдалося зафіксувати вираженість досліджуваних чутливих порушень та часовий інтервал їх розвитку, зважаючи на методологічну побудову досліду із роздільним та сумісним уведенням ПК та ЦП.

Нами було зареєстровано більшу вираженість нейротоксичного ефекту при сумісному введенні хіміотерапевтичних препаратів, що підтверджується розвитком статистично залежних відмінностей на 14-й добі досліду. Співставні порушення чутливості в якості корелятів нейротоксичності, ініційованої роздільним уведенням ПК та ЦП, виявлялися, починаючи з 28-ї доби досліду.

Відзначені ефекти порушення чутливості у тесті холодової алодинії тривали до кінця досліду, що ми вважаємо додатковим аргументом вираженої, агресивної та тривалої (інерційної) нейротоксичності при призначенні ПК та ЦП.

При обговоренні звернемо увагу на методологічній побудові досліду. У клінічній онкології поєднання таксанів і сполук платини вважається стандартним підходом до лікування пухлин яєчників, шийки матки та немалоклітинного раку легень. Такі хіміотерапевтичні схеми спричиняють виражену нейротоксичність за рахунок сумарного впливу кількох механізмів: порушення аксонального транспорту, енергетичної дисфункції, активації мікроглії, цитокінових змін і ушкодження ендотелію [13-15]. Експериментальні дані підтверджують синергічний характер токсичності цієї комбінації. Доведено поглиблену структурну деградацію периферичних нервових волокон за умов одночасного застосування ПК й ЦП [16]. Встановлено центральні прояви нейротоксичності, зокрема дизрегуляція цитокінів та факторів

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росту [17-19], порушення метаболізму кінауренінів [20] та нейромедіаторні порушення [21-24].

Нейротоксичність, спричинена хіміотерапією, може впливати на будь-який нейрон в організмі безпосередньо [9, 25-27] та опосередковано (шляхом пошкодження глії, через запалення [9, 28-31] і, таким чином, може суттєвим чином змінювати клінічну маніфестацію основного захворювання. Цікавим моментом є доведене співіснування патогенетичних механізмів канцерогенезу та хронічного дифузного низькоінтенсивного запалення [32]. З цього чітко виходить прозапальний механізм в якості одного із провідних патогенетичних механізмів ХІПН, відштовхуючись від чого вкрай логічно припустити протизапальні механізми реалізації нейропротекторних лікувальних та профілактичних заходів при досліджуваній патології.

З фундаментальної точки зору виявлені порушення периферичної сомато-сенсорної чутливості мають аналогічні експериментальні та клінічні кореляти за умов гострого запального синдрому [29, 33], що, по-перше, підтверджує наше початкове логічне припущення про спільні патофізіологічні механізми запальної відповіді та больової реакції, і, по-друге, висвітлює взаємозв'язки між канцерогенезом, запаленням та сенсорними дисфункціями у вигляді дизестезій. Подібні патофізіологічні зауваження вважаємо важливими з точки зору перспективної розробки фармакологічної корекції та/або профілактики нейротоксичності, ініційованої введенням хіміотерапевтичних препаратів.

Висновки.

У щурів в динаміці відтворення хіміотерапевтичної нейротоксичності, ініційованої роздільним та сумісним уведенням ПК та ЦП, реєструються виражена больова реакція та порушення сомато-сенсорної чутливості.

При визначенні холодової алодинії реєструється більша вираженість нейротоксичного ефекту за умов сумісного введення ПК та ЦП, що підтверджується розвитком відмінностей на 14-й добі досліду.

Співставні порушення чутливості в якості корелятів нейротоксичності, ініційованої роздільним уведенням ПК та ЦП, виявлялися з 28-ї доби досліду.

Ефекти порушення чутливості тривали до кінця досліду, що ми вважаємо додатковим аргументом вираженої, агресивної та тривалої (інерційної) нейротоксичності при призначенні паклітакселу та цисплатину.

Ретельне експериментальне дослідження нервової дисфункції

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при застосуванні хіміотерапевтичних препаратів в режимах моно- і політерапії з обов'язковим патоморфологічним підтвердженням є базисом, який дозволить обґрунтувати ефективність нової патогенетичної схеми фармакокорекції нейротоксичності, ініційованої введенням хіміотерапевтичних препаратів.

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GEOLOGY, MINERALOGY AND SOIL SCIENCE

Modern Dynamics of the Lankaran–Astara Shoreline Under Caspian Sea-Level Decline

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Abstract. The continuing decline of the Caspian Sea level is increasingly reshaping the coastal zone of Azerbaijan. This paper examines the modern dynamics of the Lankaran-Astara shoreline, with emphasis on the geomorphological response of the southern coastal sector to sea-level fall. The study is designed as an analytical synthesis rather than a presentation of newly measured shoreline distances. Recent peer-reviewed studies, remote-sensing research from the Azerbaijani Caspian coast, current field-monitoring information, and preliminary space-geodetic evidence are integrated to identify the dominant processes controlling shoreline migration. Basin-wide studies show that the Caspian Sea has been in a persistent declining phase since the mid-1990s, while recent work demonstrates that reduced river inflow and increasing evaporative losses act together in the contemporary negative water balance. For the Lankaran-Astara coast, the expected first-order response is seaward migration of the land-water boundary and exposure of former shallow-water surfaces, especially where coastal gradients are low. However, the response is spatially heterogeneous: accumulation can intensify in some sectors, whereas local erosion may persist where wave action, sediment deficit, river-mouth instability, engineering structures, or vertical land motion modify the general regression trend. The paper proposes an integrated monitoring framework combining Landsat/Sentinel-2 shoreline extraction, DSAS statistics, Sentinel-1 InSAR, digital elevation data, hydrometeorological observations, and field verification. This framework can support future quantitative assessment and coastal management in the Lankaran-Astara region.
Keywords: *Caspian Sea; Lankaran; Astara; shoreline change; sea-level decline; coastal geomorphology; remote sensing; erosion; accumulation; InSAR.*

Introduction. The Caspian Sea is the world's largest enclosed inland water body and one of the most dynamic terminal basins in terms of historical water-level variability. Because it has no natural outlet to the global ocean, changes in river inflow, precipitation, evaporation, atmospheric circulation, and human water use are directly reflected in its water balance. The coastline therefore

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responds to basin-scale hydroclimatic variability much more rapidly than many open-ocean coasts. After the high-water phase that culminated in the mid-1990s, the Caspian entered a prolonged period of decline. Samant and Prange (2023) estimated an average fall of about 7 cm yr−1 for 1996–2015 and around 10 cm yr−1 for 2006–2021. Their CMIP6-based projections further indicate that continued warming may sustain a strongly negative water balance during the twenty-first century, although the magnitude of long-term decline remains scenario- and model-dependent [1].

The most recent basin-scale evidence has strengthened the view that current shrinkage reflects interacting climatic and anthropogenic pressures rather than a single mechanism. Duku et al. (2026), integrating satellite observations, in situ hydrological records, and reanalysis data, reported a decline of roughly 2 m since 1996 and a substantial reduction in the surface area of the Caspian Sea. Their analysis points to declining total river inflow, particularly from the Volga, together with modestly increasing evaporation, as major contemporary drivers. Safarov et al. (2025) likewise showed that changes in the regional wind regime are relevant because wind conditions influence evaporation and the transport of moisture away from the sea surface. Thus, the modern falling-level phase is embedded in a broader hydroclimatic shift[2-4].

For coastal geomorphology, a vertical water-level change is converted into horizontal shoreline displacement according to the gradient and morphology of the nearshore surface. A small vertical fall can generate a large horizontal retreat of the waterline across very shallow coastal plains, while steeper segments may exhibit limited positional change. The resulting transformation includes the emergence of former seabed, reorganization of beach profiles, changes in wave breaking, redistribution of sediments, and modification of river-mouth and lagoon environments. Therefore, sea-level decline should not be interpreted simply as a uniform seaward shift of the coast; it is a driver that interacts with local geological, hydrodynamic, and anthropogenic conditions.

The Lankaran-Astara sector is of particular interest because it occupies the humid southern part of Azerbaijan's Caspian coast and includes low-lying coastal surfaces,

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beaches, river mouths, settlement areas, transport corridors, and ecologically sensitive zones. Current monitoring by the Institute of Geography of Azerbaijan has already documented visible effects of sea retreat in this region: during a 2026 monitoring expedition, previously submerged tree stumps became exposed as the waterline moved seaward; after heavy rainfall, these surfaces were temporarily inundated again. This observation is important because it demonstrates the coexistence of a long-term regression trend with short-term hydrometeorological fluctuations (Institute of Geography, 2026).The aim of this paper is to analyse the principal directions of contemporary shoreline transformation in the Lankaran-Astara coastal zone under Caspian Sea-level decline and to propose a methodological framework for future quantitative monitoring. The paper focuses on four questions: (1) how the basin-wide decline is expected to affect the southern Azerbaijani shoreline; (2) why accumulation and erosion can coexist during a regression phase; (3) how vertical land motion may alter relative shoreline change; and (4) which remote-sensing and geodetic indicators should be combined in a robust monitoring programme[5].

2. Study Area, Methodology and Research Novelty. The Lankaran-Astara coast, located in the southwestern part of the South Caspian Basin, is characterized by low-gradient coastal plains, river-mouth systems, and diverse shoreline forms that respond differently to Caspian Sea-level changes. This study synthesizes recent literature, remote-sensing research, and local monitoring data to assess shoreline transformation without assigning unsupported site-specific displacement rates. Future quantitative analysis should combine Landsat and Sentinel-2 imagery, NDWI/MNDWI-based shoreline extraction, DSAS indicators such as NSM, EPR, and LRR, and InSAR or GNSS data on vertical land motion. The novelty of the study lies in interpreting shoreline change as the combined result of sea-level decline, sediment dynamics, erosion-accumulation processes, river activity, and local crustal deformation rather than as a uniform response to Caspian regression alone [6].

3.Results and Discussion. The available evidence consistently indicates that the Caspian Sea is in a

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significant declining phase, while also showing that the coastal response is highly spatially variable. Table 1 summarizes the principal studies used in the analysis and their relevance to the Lankaran-Astara problem.

Table 1

Selected evidence used to interpret modern shoreline dynamics in the Lankaran-Astara sector

Source	Period / data	Key finding	Relevance to Lankaran-Astara
Samant & Prange (2023)	1996-2021; CMIP6	Persistent decline; about 7 cm yr-1 (1996-2015) and ~10 cm yr-1 (2006-2021); strong future decline under warming scenarios.	Establishes the basin-scale forcing that drives regression of the southern Azerbaijani shoreline.
Gasimov (2021)	1976-2019; Landsat, NDWI, DSAS	Sea-level rise intensified abrasion; the 1996-2019 decline strengthened accumulation in many shallow Azerbaijani sectors.	Provides a regional remote-sensing analogue and a tested GIS methodology.
Court et al. (2025)	Caspian-wide geospatial assessment	A further 5-10 m decline would cause major ecosystem and infrastructure disruption around the basin.	Shows that shoreline change has ecological and planning consequences, not only geomorphological effects.
Duku et al. (2026)	Satellite + hydrological + reanalysis data	About 2 m level loss since 1996; reduced river inflow and increasing evaporation contribute to shrinkage.	Provides the newest peer-reviewed synthesis of contemporary water-balance drivers.

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Ahadov et al. (2026)	Sentinel-1 InSAR, 2014–2025	Preliminary results show localized uplift and subsidence along Neftchala–Lankaran, potentially comparable to sea-level decline rates.	Requires relative shoreline change to be interpreted together with vertical land motion.

The ongoing decline of the Caspian Sea level is causing a general seaward migration of the Lankaran–Astara shoreline and the exposure of former shallow-water surfaces, particularly in low-gradient coastal areas. However, shoreline regression does not imply uniform accumulation, as local erosion may continue under the influence of longshore sediment transport, river-mouth migration, storms, and coastal structures. Recent InSAR observations also indicate that localized uplift and subsidence can modify relative shoreline change, making it necessary to combine satellite shoreline mapping with vertical land-motion data. These geomorphological changes have important environmental and planning implications, since newly exposed areas may remain unstable, saline, periodically flooded, or vulnerable to future re-inundation. Therefore, coastal management should be based on continuous monitoring and the identification of zones with different levels of geomorphological stability

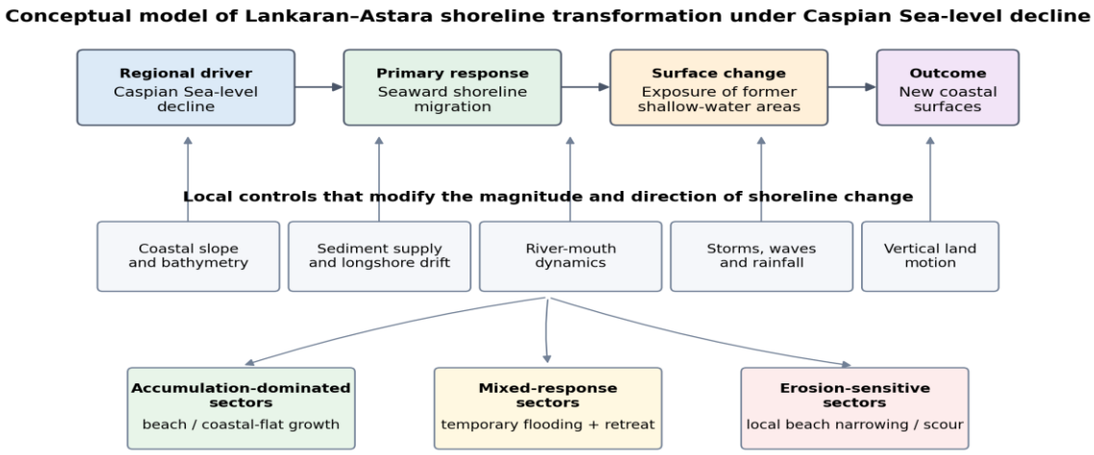

Figure 1. **Conceptual model of shoreline transformation in the Lankaran–Astara sector under Caspian Sea-level decline.**

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Proposed GIS and Geodetic Monitoring Framework. A practical GIS and geodetic monitoring framework for the Lankaran–Astara coast should combine multi-date Landsat and Sentinel-2 imagery, NDWI/MNDWI-based shoreline extraction, DSAS analysis, and Sentinel-1 InSAR data on vertical land motion. The analysis should also integrate sea-level records, rainfall, wind, river discharge, storm events, and field observations to explain the main drivers of shoreline change. For a master's thesis, comparing several cloud-free images from the last two decades using consistent methods would allow the coast to be classified into sectors of rapid seaward migration, relative stability, and local erosion[7].

Conclusion. The modern decline of the Caspian Sea is a major driver of contemporary shoreline transformation along the Lankaran–Astara coast. The first-order geomorphological response is seaward displacement of the waterline and exposure of former shallow-water surfaces, particularly in low-gradient sectors. Current local monitoring confirms that this process is already visible in the region. At the same time, the response is not spatially uniform. Accumulation may dominate in some segments, while local erosion persists where sediment supply, wave energy, river-mouth behaviour, coastal structures, or short-term hydrometeorological events modify the regional regression trend.

Recent space-geodetic evidence adds an important dimension: vertical land motion can alter relative shoreline change and should be considered together with absolute water-level decline. Therefore, the most reliable future assessment of the Lankaran–Astara coastline should integrate optical remote sensing, DSAS statistics, InSAR/GNSS deformation data, digital elevation models, hydrometeorological observations, and field verification. Such an approach would provide the quantitative basis needed to identify vulnerable coastal sectors, distinguish stable from transitional newly exposed land, and support adaptive coastal planning under continued Caspian Sea-level decline.

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INFORMATION AND WEB TECHNOLOGIES

Engineering Approaches to Improving Security and Reliability in Generative Artificial Intelligence Systems

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Abstract. The rapid integration of generative artificial intelligence into software platforms, decision-support systems, information retrieval environments and autonomous applications has created a new class of engineering challenges. In addition to conventional software vulnerabilities, generative AI systems may produce factually incorrect information, follow maliciously injected instructions, reveal sensitive data, generate unsafe content or initiate unintended actions when connected to external tools. These characteristics make security and reliability inseparable requirements rather than independent design objectives. This article examines contemporary engineering approaches for improving the security and reliability of generative AI systems, with particular emphasis on large language model-based applications. The study adopts an engineering-oriented analytical review of recent research published mainly between 2024 and 2026. Prompt injection, jailbreaking, hallucination, excessive refusal, information leakage, unsafe tool use and component-level vulnerabilities are considered as major risk categories. A multilayer protection architecture is proposed that combines input validation, contextual separation, prompt-injection detection, model-level safety mechanisms, retrieval-based grounding, output verification, runtime action control, logging and continuous adversarial testing. Particular attention is paid to the trade-off between security and usefulness, since excessively restrictive guardrails can reduce the functional value of an otherwise safe system. A practical evaluation framework based on attack success rate, factual consistency, false refusal rate, utility retention, latency and auditability is also presented. The article argues that dependable generative AI cannot be achieved through a single safety filter. Instead, security and reliability should be treated as lifecycle-wide engineering properties supported by layered controls, continuous measurement and adaptive risk management.
Keywords: *generative artificial intelligence, large language models, AI security, reliability, prompt injection, jailbreak attack, hallucination, guardrails, trustworthy AI, runtime safety.*

Introduction. Generative artificial intelligence has moved from experimental language generation toward integration with software applications, enterprise information systems, search environments, programming tools and autonomous agents. This transition changes the nature of

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the engineering problem. A stand-alone model that produces an inaccurate sentence may create an information-quality problem; the same model connected to databases, APIs, file systems or executable tools may transform an inaccurate interpretation into an operational security incident.

Traditional software engineering assumes that instructions and data can normally be separated by clearly defined syntax, interfaces and privilege boundaries. Large language models complicate this assumption because both instructions and external information are often represented in the same natural-language context. An apparently ordinary document, web page or retrieved database entry may therefore contain text that attempts to alter the behavior of the model. Recent work consequently treats prompt injection and jailbreaking not simply as undesirable model behavior, but as practical security problems affecting LLM-integrated systems [4].

Reliability presents a second challenge. Generative models can produce fluent and structurally convincing responses even when the underlying information is incomplete or incorrect. Hallucination is therefore particularly problematic in applications where users may interpret linguistic confidence as factual certainty. Production-oriented studies published in 2025 continue to identify hallucination detection and correction as essential requirements for dependable deployment [1].

Security mechanisms themselves can also introduce failure. A system designed to block every suspicious pattern may refuse legitimate requests, reducing usefulness and creating what is often described as over-defense. Recent prompt-injection research shows that protection must therefore be evaluated not only according to how many attacks are blocked, but also according to how accurately legitimate inputs are preserved [2-4]. These observations indicate that generative AI security cannot be reduced to a single moderation layer. The problem is better understood as an engineering assurance problem involving the model, application architecture, external data, tools, monitoring mechanisms and human oversight.The purpose of this article is therefore to examine recent approaches to generative AI security and reliability and to develop an integrated engineering framework for their practical application.

2. Research Approach. This study applies an engineering-oriented review of recent literature published mainly between 2024 and 2026. The analysis focuses on prompt injection,

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jailbreak defense, hallucination mitigation, safety mechanisms, model-level protection and runtime control. The NIST Generative AI Risk Management Framework was also considered, particularly its recommendations related to governance, testing, content provenance and incident management [5]. The reviewed approaches were grouped into six areas: input protection, model-level security, grounding and verification, runtime and tool-use control, monitoring and incident response, and continuous adversarial evaluation.

3. Major Security and Reliability Risks. Generative AI systems face several key security and reliability risks. **Prompt injection** can manipulate a model by inserting malicious instructions, especially in retrieval-based and agentic systems [6]. **Jailbreak attacks** attempt to bypass built-in safety mechanisms, demonstrating that guardrails alone cannot provide complete protection. **Hallucinations** may lead to unsupported or inaccurate outputs, requiring grounding and response verification [7-10]. **Data leakage and component risks** may arise from external models, APIs, databases and third-party software, making access control and secure integration essential. At the same time, overly restrictive safety mechanisms may reject legitimate requests. Therefore, effective AI security should balance **protection, reliability and system utility** [9].

4. Engineering Approaches to Security and Reliability. The security and reliability of generative AI systems can be improved through a combination of input validation, trust classification and clear separation between instructions and external data. Layered guardrails, including input filters, prompt-injection detection, model-level safety mechanisms and output verification, provide stronger protection than a single control. Reliability can also be increased by grounding responses in trusted sources and verifying generated content before release. For AI agents capable of performing external actions, runtime authorization is essential, since generated decisions should not automatically be executed without additional control.

5. Risk-Control Matrix. Generative AI risks require different safeguards; therefore, effective protection depends on combining specialized controls rather than relying on a single defense mechanism.

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Table 1.

Compact risk-control framework for generative AI systems

Risk	Typical failure	Main control	Metric
Prompt injection	Malicious instructions alter model behavior	Trust classification and prompt filtering	Attack Success Rate
Jailbreak	Safety restrictions are bypassed	Safety classifiers and model-level protection	Jailbreak Success Rate
Hallucination	Unsupported or incorrect output	RAG and evidence verification	Factual Consistency Rate
Data leakage	Sensitive information is exposed	Access control and output scanning	Leakage Rate
Unsafe / over-restricted behavior	Harmful actions or unnecessary refusals	Runtime authorization and balanced guardrails	Unsafe Action / False Refusal Rate

6. Evaluation of Security and Reliability. The security and reliability of generative AI systems can be assessed through several complementary indicators. Attack Success Rate (ASR) measures resistance to malicious attacks, False Refusal Rate (FRR) reflects unnecessary rejection of legitimate requests, Factual Consistency Rate (FCR) evaluates the accuracy of generated information, and Utility Retention (UR) shows whether safety mechanisms preserve normal system performance. Operational factors such as latency, cost, false detections, human intervention and auditability should also be considered. For integrated assessment, this study proposes the Generative AI Assurance Index (GAI-AI):

$$GAI\text{-}AI = w_1(1 - ASR) + w_2FCR + w_3UR + w_4AC$$

where AC represents audit coverage. The index combines security, reliability, usability and auditability in a single evaluation framework, while allowing the weights to be adjusted according to application requirements.

7. Discussion. Recent research shows a shift from model-centered safety toward system-level assurance in generative AI. Security depends not only on the model itself, but also on its interaction with external data, tools, users and application components. Since jailbreak and prompt-injection techniques continue to evolve, static protection is insufficient and should be supported by continuous testing, monitoring and control updates. The proposed L-GAISRA

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architecture addresses this challenge through layered protection that balances security with system usability.

Conclusion. Generative AI systems require security and reliability to be treated as core engineering requirements. Key risks such as prompt injection, jailbreak attacks, hallucination, data leakage and unsafe tool use cannot be addressed by a single defense mechanism. Therefore, a layered approach combining input validation, model-level safeguards, output verification, access control and continuous monitoring is necessary. The proposed L-GAISRA architecture supports this approach by integrating multiple protection layers while maintaining system usability.

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INFORMATION AND WEB TECHNOLOGIES

Intelligent Information Technologies in Crisis Management of Multimodal Transport and Logistics Projects: Adaptation to Uncertainty, Turbulence, and Systemic Risks (Under Warmi Conditions)

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Abstract. The article investigates the application of intelligent information technologies in crisis management of multimodal transport and logistics projects in the WARMI environment. The directions of IIT adaptation are determined: monitoring, forecasting, risk assessment, scenario modeling and optimization. Their role in increasing the stability and adaptability of logistics projects is substantiated.
Keywords: *intelligent information technologies; crisis management; transport and logistics projects; intelligent analysis & analytics; multimodal transportation; uncertainty; turbulence; systemic risks; WARMI environment; adaptive management; optimization.*

INTRODUCTION.

The modern world economy (including the entire service sector) currently operates in complex conditions of dynamically increasing uncertainty [1], turbulence and systemic risks of the external environment [2], which requires constant adaptation of organizational, technological and management mechanisms [3]. The high dependence of the service sector on highly competitive changes in demand [4], infrastructure, technologies, financial and global supply chains - increases their vulnerability to external shocks [5]. In these conditions, innovative management [6] acquires special importance, which involves the optimal implementation and use of intelligent information technologies: which provide environmental monitoring, forecasting of changes, risk assessment and adaptive decision-making [7]. This

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problem is especially relevant for the transport and logistics industry as the most important component of the modern service sector.

Given the above, the modern transport and logistics system also operates in conditions of qualitatively more complicated external environment [8], which is characterized by accelerating changes, high uncertainty, turbulence, multiplicity of interconnected threats and increased systemic risks. Multimodal transport and logistics projects [9] are especially vulnerable to such influences, since their implementation involves the coordination of different types of transport, infrastructure facilities, operators, information systems, cargo flows, financial resources and regulatory requirements (and the violation of one element of such a system can cause a chain reaction and significantly change the parameters of the entire project). In such conditions, traditional methods of modeling the management of transport and logistics projects, which are based mainly on deterministic planning, fixed regulations and reactive decision-making, become insufficiently effective [10]. After all, crisis situations in the transport and logistics sector require not only an operational response to already occurring violations, but also the ability to identify potential threats in advance, predict the development of events, form alternative scenarios and dynamically restructure management decisions [11].

A special role in solving this problem is played by intelligent information technologies (IIT), which combine methods of artificial intelligence, machine learning, intelligent data analytics, forecasting [12], optimization, expert systems, intelligent decision support, digital twins and automated monitoring. Their application allows us to move from a predominantly reactive model of crisis management to a proactive and adaptive model [13], focused on early detection of threats, assessment of options for the development of the situation and operational redistribution of resources.

The relevance of the study is further enhanced in the context of the WARMI concept, which is considered in this work as a generalized characteristic of the external environment, in which volatility and variability, ambiguity and uncertainty, risk, multiplicity of interconnected influences and instability of system parameters are simultaneously manifested. In such an environment,

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intelligent information technologies must adapt not only to changes in input data, but also to changes in the very logic of the functioning of the transport and logistics system.

That is why the purpose of this article is to systematize the features, specifics and directions of adaptation of intelligent information technologies for crisis management of transport and logistics multimodal projects in complex conditions of uncertainty, turbulence and systemic risks of the external environment, which correspond to the WARMI concept.

MAIN PART.

A). Multimodal transport and logistics projects as an object of intelligent crisis management.

A multimodal transport and logistics project is a complex organizational, economic and technological system in which the movement of material flow is carried out using several types of transport for the needs of coordinated management of routes, terms, resources, infrastructure and information flows. Unlike autonomous logistics operations, a multimodal project has a pronounced systemic interdependence: changing the parameters of one element can lead to changing the parameters of other elements and, ultimately, to deviation of the entire project from the target indicators.

In crisis conditions, this interdependence becomes a source of the risk multiplication effect. A delay in one transport arm can lead to a violation of the overload schedule, downtime of rolling stock, an increase in storage costs, route changes, additional financial costs and violation of delivery terms. Therefore, crisis management should take into account not individual risks, but mutual influence and the possibility of forming cascading chains.

An essential feature of multimodal projects is also the high dynamism of the information environment. Data on transport flows, weather conditions, infrastructure status, route capacity, tariffs, stocks, delivery times and availability of vehicles are constantly changing. Therefore, a management solution that is optimal at time t may become ineffective after a short period of time.

This necessitates the formation of an intelligent management system capable of performing a continuous cycle: monitoring → detection of deviations → intelligent diagnostics → forecasting → generation of alternatives → scenario evaluation → decision selection → adaptation → result

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control.

B). Specificity of intelligent information technologies in crisis management.

Intelligent information technologies fundamentally differ from traditional information systems in that they are focused not only on collecting, storing and transmitting information, but also on its intelligent interpretation and use for forming management decisions.

In transport and logistics crisis management, IITs should be considered as an integrated technological basis for several interrelated functions.

The first function is intelligent monitoring. IITs provide processing of operational information flows and detection of deviations from regulatory or forecast parameters. This allows you to detect signs of a crisis before the violation becomes critical.

The second function is intelligent diagnostics. The system must determine not only the fact of a deviation, but also its possible causes, relationships and potential consequences. For example, an increase in delivery time may be associated not with one factor, but with a combination of infrastructure, weather, organizational and resource constraints.

The third function is forecasting. Machine learning, intelligent data analysis and scenario modeling methods allow you to assess likely changes in transport flows, delivery times, infrastructure load, cost and risk level.

The fourth function is intelligent optimization. In the event of a crisis, it is necessary to quickly determine alternative routes, types of transport, sequence of operations, resource allocation and priorities. In such conditions, heuristic and metaheuristic optimization methods become especially important, allowing to find acceptable solutions in complex multi-criteria search spaces.

The fifth function is decision support. An intelligent system should not simply provide a forecast, but form a set of management alternatives with an assessment of their consequences, risks, cost and sustainability.

Thus, IITs in crisis management act not as a separate digital tool, but as an integrated mechanism for increasing the adaptability of the transport and logistics system.

C). WARMI conditions as an environment for the adaptation of intelligent technologies.

WARMI conditions require revision of the traditional

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logic of information technology application. If in a relatively stable environment the main task of a digital system is to ensure the accuracy, speed and efficiency of pre-defined processes, then in a crisis environment the priority shifts to stability, adaptability, flexibility and the ability to function with incomplete and contradictory information.

For transport and logistics multimodal projects, it is advisable to characterize the WARMI environment through several interrelated features: dynamism of external and internal environment parameters; uncertainty of initial data and future states of the system; turbulence of processes and high speed of changing conditions; multiplicity of simultaneously acting factors and scenarios; interdependence of risks and elements of the transport system; instability of causal relationships; incompleteness and heterogeneity of information support; the need for prompt review of decisions.

As a result, the IIT architecture itself must become adaptive. It cannot be assumed that the same model, algorithm or system of criteria will be equally effective under different environmental conditions. Therefore, it is promising to use dynamically reconfigurable intelligent systems capable of changing model parameters, criteria weights, the set of data used, and decision-making algorithms depending on the current level of uncertainty and risk.

D). Adaptation of IIT to the dynamics of uncertainty and systemic risks.

A key feature of IIT adaptation is the transition from processing static data sets to dealing with continuously changing information flows. For this, mechanisms for automatic updating of models, detection of changes in data and detection of situations in which previously formed dependencies cease to be relevant are necessary.

Adaptive forecasting is of particular importance. In times of crisis, historical data do not always allow us to adequately describe the future state of the system, as the operating conditions themselves may change significantly. Therefore, the predictive model should take into account both the statistical regularities of the past and the current signals of environmental change.

Adaptive risk assessment is becoming an important direction. The risk of a transport and logistics project should be considered as a dynamic characteristic that depends on the current state of routes, infrastructure, resources,

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counterparties and external factors. This involves regular recalculation of the risk profile and determination of critical combinations of factors.

The next direction is script adaptation. IITs should ensure the formation of several possible scenarios of the development of the crisis: basic, adverse, critical and alternative. In this, the management system should evaluate both the expected outcome of each scenario and its resistance to further environmental changes.

Therefore, the most effective is the search for a single "optimal" solution, and the formation of a robust solution capable of maintaining acceptable efficiency when the initial conditions change.

E). Intellectual support for anti-crisis restructuring of multimodal routes.

One of the most significant application areas of IIT is dynamic reconfiguration of multimodal routes. When a crisis event occurs, the system must promptly evaluate available alternatives and determine the possibility of changing the transport arm, mode of transport, loading point, time parameters or sequence of operations.

In this case, the routing task becomes multi-criteria. Cost, time, reliability, throughput, probability of delay, resource constraints, environmental parameters and level of risk must be considered simultaneously.

In these conditions, it is advisable to integrate intelligent data analysis with heuristic and metaheuristic optimization methods. Intelligent analysis provides the formation of an up-to-date picture of the state of the system, and optimization algorithms allow you to quickly search for alternative solutions in the space of constraints that have changed.

An architecture in which IIT forms not a single route but a portfolio of alternative solutions ranked by sustainability, cost, time and risk is promising. This increases the quality of management choices and reduces the system's dependence on one forecast scenario.

F). Integration of IIT, digital twins and intelligent analytics.

An important direction in the development of crisis management is the integration of intelligent information technologies with digital twins of transport and logistics projects. A digital twin allows you to form a dynamic virtual representation of a real project and model the consequences

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of various management influences.

In crisis conditions, a digital twin can be used as an experimental environment for testing alternative solutions without direct intervention in the real transport system. For example, you can assess the consequences of changing the route, redistributing vehicles, changing consolidation points or switching to another mode of transport.

Integration of a digital twin with IIT forms a fundamentally new management mechanism: real system → data flow → digital twin → intelligent analysis → scenario modeling → management recommendation → impact on the real system → new data.

Such an architecture creates a closed adaptive control loop and provides the possibility of continuous system learning based on the results of decisions made.

G). Problems and limitations of the application of intelligent information technologies.

Despite the significant potential of IIT, their use in crisis management is associated with a number of limitations. First of all, this is the problem of the quality of the source data. Incomplete, untimely, contradictory or erroneous data can lead to erroneous forecasts and ineffective decisions.

The second problem is the dependence of intelligent models on the data structure and the conditions of their training. With a sharp change in the environment, the effect of reducing the accuracy of the model may occur, since the new conditions are significantly different from those under which it was formed.

The third problem is related to the clarity of decisions. In critical transport and logistics situations, the manager needs to understand not only the solution proposed by the system, but also the reasons for its formation. Therefore, a promising direction is the use of understandable artificial intelligence and hybrid models that combine machine learning, expert knowledge and formalized restrictions.

The fourth problem is cybersecurity and reliability of information infrastructure. The higher the level of digital integration of the transport and logistics system, the greater the potential surface of technological and information risks.

Finally, there is an organizational risk: an intelligent system should not completely replace human decision-making in crisis management. The optimal model is the human-in-the-loop, in which IITs collect, process, forecast and rank alternatives, and the final decision on critical issues is made by an authorized specialist.

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CONCLUSIONS.

The analysis conducted allows us to conclude that crisis management of transport and logistics multimodal projects in the WARMI environment requires a qualitative change in approaches to the use of information technologies. The main problem is not only the need to increase the speed of information processing, but also to ensure the ability of the system to function under constantly changing initial conditions, incomplete data, high interdependence of risks and the occurrence of unexpected crisis events.

Intelligent information technologies form the technological basis of such a transition, ensuring the integration of monitoring, diagnostics, forecasting, scenario modeling, optimization and intelligent decision-making support. Their key advantage is the ability to transform large and dynamic information flows into management decisions focused not only on current efficiency, but also on the sustainability of the project.

The specificity of the application of IIT in multimodal projects is determined by the high interconnectedness of transport shoulders, infrastructure, resources and information flows. Therefore, intelligent management must take into account the cascading nature of risks and assess not individual violations, but systemic consequences.

Adaptation of IIT to WARMI conditions involves dynamic model updating, adaptive forecasting, constant risk reassessment, scenario modeling, use of robust solutions, and intelligent restructuring of routes and resources. Integration of IIT with digital twins, heuristic and metaheuristic optimization, intelligent analytics, and decision support technologies is particularly promising.

Thus, a promising model of crisis management of transport and logistics multimodal projects should be based on the principle of "anticipate - model - adapt - optimize - control - learn". This means a transition from reactive management of crisis consequences to proactive management of risk dynamics and stability of the entire transport and logistics system.

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INFORMATION AND WEB TECHNOLOGIES

Штучний Інтелект у Задачах Виявлення Мережевих Атак

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Мережеві системи виявлення вторгнень (NIDS) виконують функцію безперервного аналізу мережевих подій з метою виявлення ознак несанкціонованої або аномальної активності. Класичні підходи ґрунтуються на сигнатурному аналізі, аналізі стану протоколів і виявленні аномалій. Сигнатурний механізм забезпечує високу точність для відомих атак, але залежить від актуальності бази правил. Аномальний підхід формує модель нормальної або шкідливої поведінки та оцінює відхилення нових спостережень від цієї моделі. Саме ця постановка створила основу для використання статистичних методів, машинного навчання та глибоких нейронних мереж у мережевому моніторингу [2, 10, 11].

Машинне навчання в NIDS використовується для двох основних задач: класифікації мережевого трафіку та виявлення аномалій. У контрольованому навчанні модель будується на розмічених прикладах і встановлює відповідність між сукупністю ознак трафіку та відомими класами. Бінарна постановка розділяє нормальний і шкідливий трафік, багатокласова – визначає категорію атаки. Неконтрольовані методи працюють без повного набору міток і шукають статистично нетипові спостереження. Глибоке навчання дозволяє формувати багаторівневі представлення мережевих даних без ручного конструювання всіх ознак, але підвищує вимоги до обсягу вибірки, часу навчання та обчислювальних ресурсів [1, 7, 8, 9]. Узагальнену схему використання моделі машинного навчання у системі аналізу мережевого трафіку наведено на рисунку 1.

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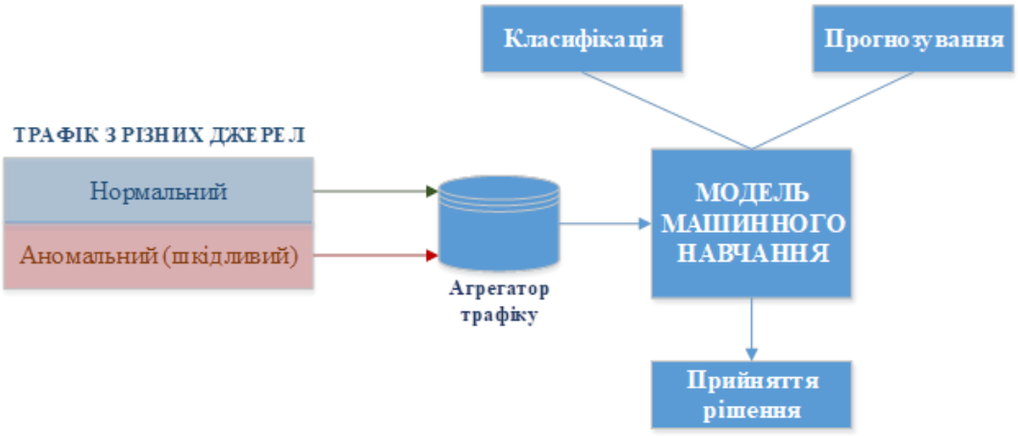

Рисунок 1. **Узагальнена схема застосування машинного навчання для аналізу мережевого трафіку**

На вхід NIDS надходять пакети або мережеві потоки, сформовані різними вузлами та сервісами. Сирий трафік не подається безпосередньо до більшості класичних моделей. Спочатку виконується агрегація та формування ознак: тривалість потоку, кількість пакетів, обсяг переданих даних, міжпакетні інтервали, інтенсивність передачі, тип протоколу, напрямок обміну, TCP-прапорці та статистичні характеристики розподілу пакетів. Після перетворення мережевої події у вектор ознак модель виконує класифікацію або обчислює аномальний бал. Вихід моделі використовується механізмом прийняття рішення для створення сповіщення, передачі події на додатковий аналіз або запуску захисної реакції. Помилки на етапі агрегації чи формування ознак безпосередньо змінюють простір, у якому працює алгоритм, тому якість NIDS визначається не лише вибором класифікатора [1, 2].

Репрезентативність навчальних даних є центральним обмеженням інтелектуальних NIDS. Sommer і Paxson описали проблему «закритого світу»: експериментальна вибірка має фіксований склад сервісів, користувачів, атак і часових характеристик, тоді як продуктивна мережа постійно змінюється [3]. Модель може демонструвати високі метрики на тестовій частині того самого набору даних і втрачати точність після перенесення в іншу інфраструктуру. Огляд мережевих датасетів підтверджує значні відмінності між ними за способом збору, набором протоколів, сценаріями атак, балансом класів і правилами маркування [4]. Результат експерименту тому характеризує не алгоритм у відриві від середовища, а пару «алгоритм – дані – процедура оцінювання».

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IoT-мережі посилюють проблему неоднорідності трафіку. Сенсори, камери, шлюзи, контролери та побутові пристрої мають різні профілі активності, використовують різні протоколи та часто працюють з обмеженими ресурсами. Дослідження NIDS для IoT розглядають машинне навчання як засіб розпізнавання DDoS, DoS, reconnaissance, spoofing, brute-force, Mirai та інших типів шкідливої активності [5]. Набір CICIoT2023 був створений для відтворення масштабних атак у середовищі зі 105 IoT-пристроїв і дозволяє досліджувати як відокремлення атак від нормального трафіку, так і класифікацію конкретних категорій мережевої активності [6].

Проблема дисбалансу класів безпосередньо впливає на оцінювання NIDS. У мережевих вибірках окремі атаки можуть становити незначну частку спостережень, тоді як інші класи домінують. За такого розподілу Accuracy здатна залишатися високою навіть при систематичних помилках на рідкісних класах. Оцінювання потребує Precision, Recall, F1-score, Balanced Accuracy, аналізу хибнопозитивних і хибнонегативних спрацювань та матриці помилок. Для захисної системи помилки мають різну вартість: надмірна кількість false positive перевантажує аналітиків, а false negative означає пропущену шкідливу активність [2, 9].

Експлуатаційні характеристики моделі мають таке саме значення, як і її точність. NIDS працює з потоком подій, тому затримка прогнозування, пропускна здатність, використання оперативної пам’яті та процесорного часу визначають можливість розгортання моделі в реальному середовищі. Складні ансамблеві та нейронні моделі можуть забезпечувати високу якість класифікації, але створювати неприйнятну затримку на периферійних вузлах. Легші алгоритми придатні для попередньої фільтрації, тоді як ресурсоємні моделі можуть виконувати поглиблений аналіз лише відібраних подій. Така багаторівнева архітектура відповідає практиці розподілу навантаження між мережевими сенсорами, центральними колекторами та аналітичними сервісами.

Відбір ознак визначає складність моделі та її здатність відокремлювати нормальну поведінку від атак. Мережеві набори часто містять корельовані або слабкоінформативні параметри. Їх безконтрольне використання збільшує розмірність простору ознак, час навчання та ризик перенавчання. Кореляційний аналіз, статистичні критерії, mutual information, важливість ознак у деревах і методи з регуляризацією застосовуються для формування компактнішого представлення трафіку. При цьому процедура відбору повинна виконуватися лише на навчальній

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частині даних; використання інформації з тестової вибірки створює витік даних і завищує оцінку якості моделі.

Мережевий трафік змінюється в часі навіть без дій зловмисника. Оновлення програмного забезпечення, поява нових сервісів, зміна робочих процесів або підключення нових пристроїв змінюють статистичний розподіл ознак. Для моделі це проявляється як drift між навчальним і поточним трафіком. Статична NIDS поступово накопичує помилки, якщо профіль середовища відрізняється від початкової вибірки. Реальне застосування машинного навчання потребує контролю якості після розгортання, накопичення нових перевірених прикладів та періодичного перенавчання.

Ще одна група ризиків пов'язана з тим, що модель машинного навчання сама стає об'єктом впливу. Зловмисник може змінювати характеристики мережевої активності так, щоб шкідливий потік залишався функціонально придатним, але переходив у область ознак, яку модель класифікує як нормальну. Для систем, що автоматично поповнюють навчальні дані, додатковою загрозою є внесення некоректно маркованих або спеціально сформованих прикладів. Стійкість до таких впливів потребує незалежної валідації даних, контролю джерел навчальної вибірки та перевірки моделі на модифікованих сценаріях атак.

Інтерпретованість рішення має практичне значення для роботи центру моніторингу безпеки. Сам факт мітки «attack» не пояснює причину спрацювання і ускладнює перевірку інциденту. Для дерев рішень і частини ансамблевих моделей можна оцінити внесок окремих характеристик, тоді як складні нейронні архітектури потребують окремих методів пояснення. Інтерпретація ознак допомагає відрізнити реальну закономірність від артефакту набору даних, виявити залежність від технічних параметрів конкретного стенда та підвищити довіру до автоматизованого рішення.

Практична архітектура NIDS на основі штучного інтелекту рідко обмежується однією моделлю. Сигнатурні правила забезпечують надійне розпізнавання відомих шаблонів, поведінкові механізми фіксують відхилення, а моделі машинного навчання виконують багатофакторну оцінку трафіку. Поєднання цих механізмів з кореляцією подій, журналами автентифікації, телеметрією вузлів і контекстом активів зменшує залежність рішення від одного джерела даних. Штучний інтелект у такій системі виконує роль аналітичного компонента, а не автономного замінника IDS/IPS.

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PHYSICAL EDUCATION AND SPORTS

Сучасні Підходи до Планування та Цифрового Контролю Тренувального Процесу Спортсменів-Спринтерів

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Сучасний тренувальний процес спортсменів-спринтерів є складною системою, яка поєднує планування, реалізацію тренувальних впливів, контроль реакції спортсмена, оцінювання спортивних результатів та коригування подальшої підготовки. Особливістю спринтерських дисциплін є необхідність одночасного розвитку швидкісних, силових, швидкісно-силових і технічних здібностей, що зумовлює необхідність чіткого дозування тренувального навантаження та раціонального поєднання окремих засобів підготовки.

Одним із найбільш ґрунтовних сучасних оглядів підготовки спортсменів високої кваліфікації у спринті є праця T. Haugen, S. Seiler, Ø. Sandbakk та E. Tønnessen, у якій узагальнено наукові та практичні підходи до розвитку елітної спринтерської результативності [1].

Автори зазначають, що результат у спринті визначається комплексом взаємопов'язаних чинників, серед яких особливе значення мають потужність, техніка бігу та спеціальна швидкісна витривалість. Водночас тренувальний процес повинен враховувати специфіку окремих компонентів спринтерської результативності та забезпечувати їх цілеспрямований розвиток.

Для спортсменів, які спеціалізуються на дистанціях 60, 100 і 200 м, співвідношення тренувальних засобів не може бути однаковим. Біг на 60 м значною мірою пов'язаний зі стартовою реакцією, прискоренням і досягненням максимальної швидкості; для дистанції 100 м особливого значення набуває здатність ефективно реалізувати максимальну швидкість упродовж бігу; на дистанції 200 м додатково зростає роль здатності підтримувати

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високу швидкість протягом більш тривалого часу [1]. Отже, вже на етапі планування необхідно враховувати спеціалізацію спортсмена та характер змагальної діяльності.

Сучасне розуміння тренувального процесу передбачає відмову від виключно стандартного підходу до підготовки. Навіть спортсмени одного віку, статі та спортивної кваліфікації можуть по-різному реагувати на однакове тренувальне навантаження. Відмінності можуть бути пов'язані з тренувальним стажем, рівнем фізичної підготовленості, технікою бігу, силовими можливостями, швидкісними характеристиками, станом відновлення та індивідуальною реакцією на навантаження. Тому сучасне планування має передбачати можливість адаптації тренувальної програми до фактичного стану конкретного спортсмена [1].

Важливим напрямом сучасних досліджень є моніторинг тренувального навантаження. S. L. Halson розглядає моніторинг навантаження як важливий компонент управління тренувальним процесом, який дозволяє оцінювати адаптацію спортсмена до тренувальної програми та своєчасно виявляти ознаки надмірної втоми, нефункціонального перенапруження або підвищеного ризику несприятливих наслідків для здоров'я [2]. При цьому контроль повинен здійснюватися систематично, а отримані показники мають розглядатися у динаміці, а не як окремі значення.

Питання моніторингу тренувальних навантажень детально розглянуті також у консенсусній заяві P. C. Bourdon та співавторів [3]. Автори наголошують, що оцінювання навантаження може здійснюватися із застосуванням різних показників та методів, а ефективний моніторинг повинен враховувати як зовнішнє навантаження, тобто фактично виконану спортсменом роботу, так і внутрішню реакцію організму. Такий підхід є особливо важливим для цифрової системи, оскільки дозволяє не обмежуватися лише фіксацією запланованого тренування, а порівнювати заплановані та фактичні параметри його виконання.

У контексті розроблення мобільного застосунку це означає необхідність передбачити можливість реєстрації таких показників, як тип тренувального заняття, його тривалість, обсяг, інтенсивність, кількість повторень, фактичне виконання запланованих завдань та суб'єктивна оцінка навантаження. Додатково можуть фіксуватися спортивні результати та суб'єктивні показники стану спортсмена. Накопичення таких даних створює основу для подальшого аналізу тренувального процесу.

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Класичні підходи до побудови тренувального процесу, представлені у працях Т. Бомпи [3], В. Іссуріна [4] та В. Платонова [5], визначають структуру макро-, мезо- та мікроциклів, закономірності розподілу навантажень і принципи досягнення спортивної форми.

У дослідженнях, присвячених легкій атлетиці, підкреслюється важливість раціонального поєднання швидкісних, силових та технічних компонентів підготовки, а також необхідність індивідуалізації тренувального процесу залежно від рівня підготовленості спортсменів [6]. Окремі аспекти трансферу фізичних якостей у спортивний результат розглядаються у роботах W. Young [7], де акцентується увага на взаємозв'язку силової та швидкісної підготовки у спринті.

Водночас значна кількість сучасних досліджень спрямована на вдосконалення систем моніторингу тренувального навантаження та відновлення спортсменів. Зокрема, у роботах C. Foster та співавт. [8] запропоновано підхід до оцінки навантаження на основі суб'єктивних показників, тоді як S. L. Halson [2] обґрунтовує необхідність комплексного контролю стану втоми для запобігання перетренованості. Розвиток технологій дозволив суттєво розширити можливості збору даних, що відображено у дослідженнях J. Peake та співавт. [9], де аналізується використання носимих пристроїв для оцінки фізіологічних параметрів спортсменів.

Окремий напрям досліджень пов'язаний із впровадженням цифрових технологій та систем підтримки прийняття рішень у спорті. У роботі A. Baca та P. Kornfeind [10] розглядаються системи швидкого зворотного зв'язку, які дозволяють оперативно коригувати тренувальний процес, а B. Ofoghi та співавт. [11] підкреслюють перспективи використання методів аналізу даних для підвищення ефективності спортивної діяльності. Сучасні технології трекінгу, за даними M. Buchheit та B. Simpson [12], створюють передумови для переходу від описового до аналітичного рівня управління тренуванням.

Обґрунтування концепції та розроблення моделі цифрової системи планування тренувального процесу в циклічних видах спорту (спринт) із визначенням її функціональних можливостей та засад технічної реалізації розглянуті в дослідженнях В. Мазіна [13].

Окреме значення має контроль відновлення. Ефективність тренувального процесу визначається не тільки величиною навантаження, а й здатністю спортсмена відновлюватися після виконаної роботи. У зв'язку з цим у сучасній практиці використовуються показники тривалості та якості сну,

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суб'єктивної втоми, загального самопочуття, м'язового болю та інші доступні характеристики [14; 15]. Для мобільної системи такі показники можуть бути представлені у вигляді короткої щоденної анкети, яку спортсмен заповнює перед або після тренувального заняття.

Сучасний підхід до управління тренувальним процесом передбачає формування замкненого циклу: планування → виконання → реєстрація результатів → контроль стану спортсмена → аналіз → коригування плану.

Саме такий принцип доцільно покласти в основу інформаційної моделі мобільного застосунку.

Ще одним важливим напрямом сучасних досліджень є використання інформаційних та цифрових технологій для забезпечення оперативного зворотного зв'язку. A. Васа та P. Kornfeind [15] досліджували системи швидкого зворотного зв'язку для тренування спортсменів, у яких інформація про виконання рухових дій може оперативно передаватися та використовуватися тренером для оцінювання й коригування тренувального процесу [3; 4; 5]. Це демонструє можливість переходу від традиційної схеми «тренування — запис результату — подальший аналіз» до більш оперативної системи, у якій дані можуть бути доступні для аналізу практично одразу після виконання вправи.

Подальший розвиток мобільних і сенсорних технологій розширює можливості такого підходу. Мобільний пристрій може виконувати функції інструмента збору, збереження та передачі інформації, тоді як серверна або хмарна частина системи може забезпечувати централізоване зберігання та аналітичну обробку даних. Для тренера це створює можливість отримувати узагальнену інформацію про спортсменів без необхідності працювати з великою кількістю паперових документів або окремих електронних таблиць.

Водночас використання цифрових технологій потребує критичного ставлення до достовірності отриманої інформації. J. M. Peake, G. Kerr та J. P. Sullivan у критичному огляді споживчих носимих пристроїв, мобільних застосунків та іншого обладнання для спортивного моніторингу звертають увагу на необхідність оцінювання точності та валідності даних, які генеруються цифровими пристроями [16]. Отже, сама наявність великої кількості цифрових показників не гарантує підвищення якості управління тренувальним процесом.

У систематичному огляді J. G. Claudino та співавторів розглянуто застосування методів штучного інтелекту для прогнозування спортивної результативності та оцінювання

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ризику травмування [17]. Автори зазначають перспективність використання алгоритмів машинного навчання у спортивній аналітиці, але водночас підкреслюють необхідність належної якості вихідних даних та коректної інтерпретації результатів.

Паралельно з цим у науковому та освітньому середовищі актуалізується проблема формування цифрових компетентностей фахівців, що відображено у європейських рамках DigComp 2.1 [18] та DigCompEdu [19].

Для системи планування спринтерської підготовки використання складних методів штучного інтелекту на першому етапі не є обов'язковим. Доцільніше спочатку реалізувати прозорі алгоритми оцінювання, засновані на порівнянні планових і фактичних показників. Такий підхід має перевагу з точки зору пояснюваності: тренер може чітко бачити, чому система сформувала певну рекомендацію. Надалі накопичена база даних може бути використана для розвитку більш складних моделей прогнозування.

Суттєве значення для цифрового планування має також проблема організації даних. Інформація про спортсмена повинна зберігатися не окремими фрагментами, а як взаємопов'язана система. Доцільно передбачити зберігання даних про профіль спортсмена, тренувальні плани, окремі тренувальні заняття, вправи, спортивні результати, навантаження, відновлення та сформовані рекомендації. Така структура забезпечує можливість аналізувати не тільки поточний стан, а й довгострокову динаміку.

Застосування цифрової системи також дозволяє підвищити оперативність взаємодії між спортсменом і тренером. Спортсмен може отримувати доступ до актуального тренувального плану, переглядати завдання конкретного заняття та після його завершення фіксувати фактичне виконання. Тренер, зі свого боку, отримує можливість переглядати результати та за необхідності вносити зміни до подальшого плану.

На основі аналізу сучасних наукових підходів можна визначити основні вимоги до системи цифрового планування тренувального процесу спортсменів-спринтерів:

1) індивідуалізація — можливість формування плану з урахуванням спеціалізації, рівня підготовленості та поточного стану спортсмена;

2) ієрархічність планування — взаємозв'язок між довгостроковими цілями, етапами підготовки, мікроциклами та окремими заняттями;

3) оперативний контроль — фіксація фактичного виконання тренувальних завдань;

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4) моніторинг навантаження — накопичення та аналіз показників обсягу й інтенсивності тренувальної роботи;

5) контроль відновлення — реєстрація доступних показників самопочуття та втоми;

6) облік спортивних результатів — збереження результатів бігу на 60, 100 і 200 м та інших контрольних вправ;

7) аналітичність — формування статистичних показників, графіків та оцінок динаміки;

8) адаптивність — можливість коригування подальшого тренувального плану залежно від отриманих даних;

9) зворотний зв'язок — забезпечення інформаційної взаємодії між спортсменом і тренером;

10) зрозумілість результатів — представлення рекомендацій у формі, придатній для практичного використання тренером.

Незважаючи на значну кількість досліджень у сфері теорії спортивного тренування, моніторингу навантажень та цифровізації спорту, аналіз наукових публікацій свідчить про відсутність інтегрованих рішень, які поєднують класичні принципи періодизації з сучасними інформаційними технологіями у вигляді єдиної системи планування, контролю та аналізу тренувального процесу. Існуючі програмні продукти здебільшого орієнтовані на окремі аспекти підготовки (облік навантаження, трекінг активності, аналіз фізіологічних показників) і не забезпечують комплексної візуалізації структури тренувального процесу.

Отже, аналіз сучасних наукових досліджень свідчить, що підготовка спортсменів-спринтерів розвивається у напрямі поєднання спеціалізованого тренувального впливу, систематичного моніторингу навантаження, оцінювання відновлення, аналізу спортивних результатів та використання цифрових технологій. Для спринтерських дисциплін особливо важливими є індивідуальний підхід, контроль динаміки швидкісних і силових характеристик, а також можливість оперативного коригування тренувальної програми.

Таким чином, наявна наукова база створює передумови для розроблення нових цифрових інструментів, які інтегрують методичні засади спортивного тренування з можливостями сучасних інформаційних технологій, що й обумовлює актуальність даного дослідження

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