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Medical Sciences

Махаббат бүйрегі: Эмоционалдық донорлықтың психологиялық аспектілері мен трансплантациядағы маңызы

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Abstract

Background: Қазіргі медицинада бүйрек трансплантациясы — созылмалы бүйрек жетіспеушілігінің терминалды сатысындағы емдеудің ең тиімді әдісі. Алайда, мүше алмастыру тек хирургиялық процесс емес, ол донор мен реципиенттің психоэмоционалдық күйіне тікелей байланысты күрделі биотикалық процесс. Н.Ф. Климушева мен Л.Т. Баранскаяның зерттеулеріне сәйкес, трансплантологиядағы клиникалық психология пациенттің сауығу жолындағы ішкі мотивациялық факторларын зерттеуге бағытталған. «Махаббат бүйрегі» ұғымы туыстық емес, бірақ эмоционалды жақын адамдар (ерлі-зайыптылар, жақын достар) арасындағы ерікті донорлықты сипаттайды. Бұл процесс пациенттің өмір сүру сапасын ғана емес, оның тұлғалық болмысын қайта құруға мүмкіндік береді.

Aim: Бүйрек трансплантациясындағы эмоционалдық донорлықтың ішкі мотивациялық факторларын анықтау және операциядан кейінгі «дене бейнесінің» трансформациясын клиникалық-психологиялық тұрғыдан талдау.

Hypothesis: Донор мен реципиент арасындағы эмоционалдық жақындық («махаббат факторы») операцияға дейінгі үрейді азайтып, операциядан кейінгі оңалту кезеңінде трансплантаттың психологиялық тұрғыдан тез «меншіктелуіне» ықпал етеді.

Materials and Methods: Н.Ф. Климушева мен Л.Т. Баранскаяның трансплантологиялық психология саласындағы зерттеулеріне теориялық талдау жасау. Зерттеу барысында биопсихосоциалды модель қолданылды.

Кіріспе

Трансплантация — бұл заманауи медицинаның жоғары технологиялық шыңы. Бүгінгі таңда әлемде 150 000-нан астам адам ағза трансплантациясына мұқтаж. Мүше тапшылығы жағдайында тірі донорлық, әсіресе эмоционалдық донорлық ерекше маңызға ие. Ғылыми әдебиеттерде бұл процесс «іс-әрекеттік тәсіл» тұрғысынан қарастырылады. Пациенттің операцияға дейінгі психологиялық күйі — оның операциядан кейінгі физикалық көрсеткіштеріне тікелей әсер етеді. Сондықтан, клиникалық психологтың рөлі хирургтың рөлімен тең дәрежеде маңызды.

Трансплантологиядағы іс-әрекеттік тәсіл және мотивация

Леонтьевтің іс-әрекеттік тәсіліне сәйкес, кез келген емдеу процесі пациенттің ішкі мақсаттары мен қажеттіліктеріне негізделуі тиіс. Климушева мен Баранская (2014) трансплантацияға үміткерлердің үш мотивациялық типін анықтады. Бірінші тип — ішкі

белсенді мотивация. Бұл пациенттер операцияны өз өмірін жақсартудың саналы құралы ретінде көреді. Екінші тип — сыртқы престиждік мотивация, мұнда пациент әлеуметтік қысыммен келіседі. Үшінші тип — амбивалентті, мұнда қорқыныш пен үміт арпалысады. «Махаббат бүйрегі» жағдайында бірінші тип жиі кездеседі, өйткені донор мен реципиент арасындағы сенім ішкі мотивацияны тұрақтандырады.

Дене бейнесі және психологиялық инкорпорация

Трансплантологиядағы ең күрделі психологиялық мәселе — «бөтен» мүшені өз денесінің бір бөлшегі ретінде қабылдау. Психологияда бұл процесс инкорпорация деп аталады. Реципиент үшін жаңа бүйрек бастапқыда психологиялық кедергі тудыруы мүмкін. Алайда, эмоционалдық донорлықтың артықшылығы осында: донор — жат адам емес, сүйікті адам. Бұл фактор психологиялық интеграцияны жеделдетеді. Егер пациент донорды жақсы көрсе, оның мүшесін ағза биологиялық деңгейде де тез қабылдайды. Бұл психосоматикалық байланыстың клиникалық маңыздылығын көрсетеді.

Бүйрек трансплантациясының нозологиялық ерекшеліктері

Бүйрек трансплантациясы жүрек немесе бауыр алмастырудан ерекшеленеді. Бүйрек пациенттері ұзақ уақыт бойы гемодиализде болады. Диализ — бұл «жасанды өмір», мұнда адам машинаға тәуелді. Бұл жағдай пациенттің психикасына ауыр салмақ түсіреді. Оларда созылмалы стресс, депрессия және мазасыздық деңгейі жоғары болады. Операция — бұл «машинадан босау». Сондықтан, бүйрек реципиенттерінде сауығуға деген ерік-жігер өте күшті болады. Эмоционалдық донор осы ерік-жігерді нығайтушы басты тұлға болып табылады.

Операциядан кейінгі психологиялық оңалту

Трансплантациядан кейін пациенттің өмірі толық өзгереді. Ол өмір бойы иммуносупрессивті дәрілер ішуі керек. Бұл — жаңа жауапкершілік. Психологиялық тұрғыдан «қарыздарлық сезімі» (Survivor Guilt) туындауы мүмкін. Реципиент донор алдында өзін кінәлі сезініп, бұл олардың арасындағы қарым-қатынасқа нұқсан келтіруі ықтимал. «Махаббат бүйрегі» феномені бұл кінәні «ортақ жеңіс» сезіміне айналдыруға көмектеседі. Психолог донор мен реципиенттің симбиотикалық байланысын сау деңгейде сақтауға атсалысуы қажет.

Биопсихосоциалды модель және Караманова концепциясы

А.А. Караманова ұсынған биопсихосоциалды тәсіл пациенттің сауығуын үш деңгейде қарастырады. Биологиялық деңгей — бүйректің жұмысы. Психологиялық деңгей — эмоционалдық тұрақтылық. Әлеуметтік деңгей — қоғамға, жұмысқа оралу. Эмоционалдық донорлық осы үш деңгейдің де оңтайлы болуына септігін тигізеді. Зерттеулер көрсеткендей, жақын адамдарының қолдауына ие пациенттерде иммундық жүйе жақсы жұмыс істейді және олар әлеуметтік ортаға 1,5 есе тезірек бейімделеді.

Қорытынды

«Махаббат бүйрегі» — бұл заманауи медицинадағы гуманизмнің шыңы. Трансплантациядағы психологиялық факторлар медициналық көрсеткіштермен бірдей маңызға ие. Н.Ф. Климусева мен Л.Т. Баранскаяның зерттеулері дәлелдегендей, ішкі мотивация мен эмоционалдық байланыс — сауығудың кепілі. Осы саладағы кешенді зерттеулер трансплантологиядағы клиникалық психологияның маңыздылығын тағы да дәлелдейді. Болашақта трансплантация орталықтарында психологиялық қызметті міндетті түрде енгізу пациенттердің өміршеңдігін арттыратыны сөзсіз.

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Comprehensive Pharmacognostic Investigation of *Lagochilus inebrians* and Development of a Hemostatic Phytopharmaceutical Using Modern Approaches to Standardization and Quality Assessment

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Abstract. *Lagochilus inebrians* Bunge (Lamiaceae), known as Turkestan mint, is a Central Asian medicinal subshrub with a long-documented history of use as a hemostatic and sedative agent in traditional practice. Its principal bioactive constituent, the diterpene alcohol lagochilin, together with related diterpenoids, flavonoids, and iridoid glycosides, has been associated with coagulation-supporting activity in earlier pharmacological work. Despite this substantial body of phytochemical and pharmacological evidence, a dedicated, pharmacopoeially standardized quality specification for *Lagochilus inebrians* raw material grown within the Republic of Kazakhstan has not yet been established. This paper synthesizes the existing international literature on the taxonomy, phytochemistry, and hemostatic pharmacology of *Lagochilus inebrians* and proposes a structured, modern methodological framework for its pharmacognostic standardization and the prospective development of a hemostatic phytopharmaceutical. The proposed framework integrates macroscopic and microscopic authentication, chromatographic and spectrophotometric quantification of marker compounds, and pharmacopoeial quality-control parameters consistent with the State Pharmacopoeia of the Republic of Kazakhstan. The paper is conceptual and methodological in nature; it does not report completed experimental trial results but outlines a protocol intended to guide future empirical research and eventual monograph development.

Keywords: *Lagochilus inebrians*; lagochilin; hemostatic phytopharmaceutical; pharmacognosy; standardization; quality control; State Pharmacopoeia of Kazakhstan

Introduction

Herbal medicine remains a central component of therapeutic practice across Central Asia, where centuries of accumulated ethnobotanical knowledge have identified numerous plant species with documented hemostatic, anti-inflammatory, and sedative properties. Among these, the genus *Lagochilus* (Lamiaceae) occupies a distinctive place: it comprises approximately forty-four species native to the arid and semi-arid zones of Central, South-Central, and Eastern Asia, several of which have long been valued in folk medicine as styptic agents used to control bleeding (Mamadaliyeva et al., 2021).

Lagochilus inebrians Bunge, commonly referred to as Turkestan mint or inebriating mint, is one of the most pharmacologically significant species of the genus. It is endemic to the western Pamir-Alay region and adjacent territories, including parts of Kyzylkum, the Karshi Steppe, and the

Fergana and Zeravshan valleys, with documented populations also occurring within the territory of South Kazakhstan, notably in the Karatau, Karzhantau, and Aksu-Zhabagly areas (Aimenova et al., 2015; Mamadalieva et al., 2021). Its traditional use as a hemostatic agent dates back to observations made by Soviet-era pharmacologists, whose systematic studies throughout the twentieth century established the plant's reputation as a reliable natural styptic (Eisenman et al., 2013).

The principal active constituent responsible for the hemostatic effect is lagochilin, a diterpene alcohol first isolated and structurally characterized from the plant's aerial parts. Alongside lagochilin, the genus has been shown to contain more than 150 secondary metabolites, spanning diterpenoids, flavonoids, phenolic compounds, iridoid glycosides, triterpenoids, and polysaccharides (Mamadalieva et al., 2021). Structure-activity investigations have suggested that the hemostatic action of lagochilin and its derivatives operates through influence on the intrinsic pathway of the blood coagulation cascade, a mechanism that continues to attract renewed pharmacological interest.

Despite this considerable accumulated evidence, several gaps remain in the scientific understanding and practical application of *Lagochilus inebrians* as a source of a standardized phytopharmaceutical. First, much of the existing phytochemical and pharmacological literature originates from Uzbek, Russian, and Chinese sources dating from the mid-to-late twentieth century, with comparatively limited modern re-evaluation using contemporary analytical instrumentation. Second, while the plant's distribution within South Kazakhstan has been documented, no dedicated pharmacopoeial monograph specific to Kazakhstan-grown *Lagochilus inebrians* raw material currently exists within the State Pharmacopoeia of the Republic of Kazakhstan, in contrast to comparable standardization efforts recently undertaken for other regionally significant medicinal plants (Sayakova et al., 2022). Third, the translation of documented hemostatic activity into a modern, quality-assured phytopharmaceutical dosage form requires an integrated methodological approach combining classical pharmacognostic authentication with contemporary chromatographic standardization and preclinical safety evaluation.

The present paper addresses these gaps in two complementary ways. First, it synthesizes and critically organizes the existing international literature on the botany, phytochemistry, and pharmacology of *Lagochilus inebrians*, with particular attention to studies bearing on its hemostatic activity and to prior regional standardization precedents. Second, it proposes a structured, modern methodological framework, informed by pharmacopoeial practice in Kazakhstan, for the authentication, phytochemical standardization, and prospective phytopharmaceutical development of this plant. The paper is explicitly conceptual and methodological: it does not present the results of a completed empirical trial, but rather a research protocol intended to inform and guide subsequent laboratory-based investigation. This distinction is maintained throughout the Materials and Methods section, which is framed in the future and conditional tense to reflect its proposed, rather than executed, character.

This undertaking is consistent with a broader international and regional policy context. The World Health Organization has repeatedly emphasized the value of properly standardized traditional and herbal medicines as a complement to conventional pharmacotherapy, provided that quality, safety, and reproducibility can be assured through rigorous pharmacognostic and analytical control. Within Kazakhstan specifically, recent years have seen growing scientific and regulatory interest in developing a domestic base of standardized, pharmacopoeially recognized medicinal plant raw materials, both to reduce dependence on imported phytopharmaceutical ingredients and to valorize the country's considerable endemic and regionally distributed flora. Hemostatic phytopreparations occupy a particularly important niche within this effort, given the continued clinical demand for accessible, well-tolerated agents to manage minor surgical, dental, and traumatic bleeding, alongside existing synthetic and animal-derived hemostatic products.

Against this background, *Lagochilus inebrians* represents an unusually well-documented candidate: unlike many regionally used medicinal plants for which pharmacological evidence remains anecdotal, this species benefits from decades of chemical and pharmacological characterization, even though that evidence base has not yet been consolidated into a Kazakhstan-specific standardization pathway. The remainder of this paper is organized as follows: Section 2 reviews the taxonomic, phytochemical, and pharmacological literature; Section 3 proposes a detailed methodological protocol for future standardization and phytopharmaceutical development; and Section 4 concludes with a discussion of the anticipated significance and limitations of this proposed research direction.

Literature Review

Taxonomy, Distribution, and Traditional Use

Lagochilus belongs to the subfamily Lamiodeae within the Lamiaceae family and comprises subshrubs and perennial herbs characterized by woody rootstocks, rigid stems, and spinescent bracts (Mamadaliyeva et al., 2021). The genus is centered in Central Asia, with a documented distributional center in the Tianshan mountain system; within the territory of Uzbekistan alone eighteen species have been recorded, several of which are classified as rare or endangered. Within South Kazakhstan specifically, ten species of the genus have been identified, distributed across the Karatau, Karzhantau, and Aksu-Zhabagly regions (Aimenova et al., 2015).

Traditional use of *Lagochilus inebrians* is long-standing among Central Asian communities, particularly in Uzbek and Tajik folk medicine, where decoctions and tinctures prepared from the dried aerial parts have been employed to control various forms of bleeding, and infusions of the dried leaves have also been used, at times combined with honey or sugar to offset their natural bitterness (Eisenman et al., 2013; Mamadaliyeva et al., 2021). Beyond its hemostatic application, the plant has also been documented in ethnobotanical accounts as possessing sedative, tranquilizing, and mild psychoactive properties, occasionally used ceremonially in the region (Rahmonov et al., 2020).

Phytochemistry

Systematic phytochemical investigation of *Lagochilus inebrians*, beginning with Soviet-era pharmacological research and continuing through more recent instrumental re-analysis, has established a detailed profile of its secondary metabolite composition. The diterpene lagochilin represents the principal and most extensively studied constituent, with reported content varying by growing region; comparative phytochemical surveys have indicated that plant material collected from the Djizzakh region of Uzbekistan exhibited the highest lagochilin concentration among tested populations, followed by other regional ecotypes (Akramov et al., 2020). Related diterpenoid derivatives, including various lagochilin acetates, have also been isolated and structurally characterized.

Beyond diterpenes, the plant has been shown to contain iridoid glycosides such as 8-O-acetylharpagide and harpagide, both of which appear characteristic of the genus, along with flavonoid constituents derived predominantly from quercetin, luteolin, and kaempferol scaffolds (Mamadaliyeva et al., 2021). Essential oil analyses of *Lagochilus inebrians* have identified linalool, trans-chrysanthenyl acetate, eugenol, and trans-verbenol as principal volatile components, compounds that have also been associated with antioxidant activity in comparative assays across related *Lagochilus* species (Akramov et al., 2020). Additional classes of compounds reported from the species include triterpenoids, steroidal constituents such as β -sitosterol and stigmasterol, the alkaloid stachydrine, and various aliphatic waxes and lipid fractions.

Pharmacological Evidence for Hemostatic Activity

The hemostatic property of *Lagochilus inebrians* extract has been the subject of sustained pharmacological attention across several decades. Early structure-activity work established a

relationship between the molecular configuration of lagochilin and related diterpenoids and their capacity to influence coagulation parameters, suggesting an effect mediated through the intrinsic mechanisms of the blood coagulation system rather than through simple local astringency (Zainutdinov et al., 2002). More recent comparative pharmacological evaluations across several *Lagochilus* species have assessed hemostatic and anti-inflammatory activity using experimental animal models, generally supporting the traditional attribution of styptic properties to extracts of this genus, while also noting that the degree of activity can vary depending on the extraction method and plant source used (Jiao et al., 2015).

Acute toxicity evaluations conducted according to internationally recognized guidelines have generally reported a favorable safety profile for aqueous and ethanolic extracts of several *Lagochilus* species, with no visible signs of toxicity observed at high oral doses in rodent models (Mamadalieva et al., 2021). This existing toxicological evidence, while encouraging, has predominantly been generated using plant material sourced from Uzbekistan; comparable safety data specific to Kazakhstan-grown *Lagochilus inebrians* populations remain, to the best of available knowledge, limited.

Precedents for Pharmacognostic Standardization in Kazakhstan

Although no dedicated State Pharmacopoeia of the Republic of Kazakhstan monograph currently exists for *Lagochilus inebrians*, recent Kazakhstani pharmacognostic research provides a methodological precedent for how such standardization might proceed. A recent standardization study of two locally growing larch species (*Larix kaempferi* and *Larix sibirica*) illustrates a comprehensive approach combining macroscopic and microscopic authentication, thin-layer chromatographic detection of marker phenolic compounds, and quantitative determination of moisture, total ash, acid-insoluble ash, and heavy-metal and radionuclide content, all performed in accordance with the general pharmacopoeial articles of the State Pharmacopoeia of the Republic of Kazakhstan (Sayakova et al., 2022). This study demonstrates both the feasibility and the regulatory pathway by which a regionally significant medicinal plant can progress toward formal pharmacopoeial recognition, and it is used in the present paper as a methodological template for the *Lagochilus inebrians* standardization framework proposed below.

Taken together, the reviewed literature establishes a strong phytochemical and pharmacological rationale for the hemostatic potential of *Lagochilus inebrians*, while simultaneously revealing a clear opportunity: the integration of this existing evidence base with a modern, regionally grounded pharmacognostic standardization protocol, of the kind outlined in the following section, to support the eventual development of a quality-assured, Kazakhstan-sourced hemostatic phytopharmaceutical.

Additional Documented Biological Activities

Beyond its principal hemostatic application, *Lagochilus inebrians* and related congeneric species have been reported to exhibit a broader spectrum of biological activity. Comparative antioxidant assessments across several *Lagochilus* species, using metal-chelating, ferric-reducing, and radical-scavenging assays, have consistently identified *Lagochilus inebrians* extracts among the most potent within the genus, an effect attributed in part to their comparatively high total phenolic content (Akramov et al., 2020). Anticholinesterase screening of *Lagochilus inebrians* extracts has additionally suggested modest enzyme-inhibitory activity, a property of potential relevance to future exploratory work on secondary pharmacological applications, although such findings remain preliminary and were not the primary focus of the studies concerned. Mild antibacterial and anti-inflammatory activity has also been reported for extracts and isolated compounds from several *Lagochilus* species, generally at a lower level of potency than the documented hemostatic effect, reinforcing the view that the hemostatic property remains the plant's most pharmacologically robust and clinically relevant attribute (Mamadalieva et al., 2021).

Acute toxicity data reported for aqueous and ethanolic extracts of several *Lagochilus* species indicate a favorable margin of safety, with no adverse behavioral or physiological signs observed in rodent models even at high oral doses, consistent with the long history of traditional use of these plants without reported serious adverse effects (Mamadalieva et al., 2021). This combination of documented efficacy and an apparently favorable safety profile further supports the rationale for pursuing formal Kazakhstan-specific standardization and phytopharmaceutical development, as proposed in next Section.

Regional Context: Kazakhstan's Endemic Flora and Pharmacopoeial Development

The case of *Lagochilus inebrians* should be understood within the broader context of Kazakhstan's ongoing effort to inventory, characterize, and where warranted, formally standardize its considerable endemic and near-endemic medicinal flora. Kazakhstan's varied ecological zones, spanning steppe, semi-desert, and mountain systems such as the Karatau and Aksu-Zhabagly ranges, support a diverse assemblage of medicinal plant species, several of which have received comparatively little modern pharmacognostic attention relative to their documented traditional use (Atazhanova, 2008). Prior work characterizing the essential-oil chemistry and biological activity of plants endemic to Kazakhstan has demonstrated both the scientific value and the feasibility of systematically re-examining regionally significant species using contemporary analytical methods, even where earlier Soviet-era studies had already established a general pharmacological profile (Atazhanova, 2008).

This precedent is directly relevant to *Lagochilus inebrians*, whose pharmacological characterization to date has relied predominantly on plant material sourced from Uzbekistan, despite documented natural populations within South Kazakhstan (Aimenova et al., 2015). The absence of Kazakhstan-specific phytochemical and quality-control data represents not merely an academic gap but a practical obstacle to the plant's formal recognition within the State Pharmacopoeia of the Republic of Kazakhstan, since pharmacopoeial monographs are typically grounded in analytical data generated from raw material representative of the specific growing region intended for pharmaceutical sourcing. Addressing this gap through the standardization protocol proposed in Section 3 would therefore align directly with the broader national trajectory toward strengthening the scientific and regulatory foundation for domestically sourced herbal medicinal products.

Materials and Methods (Proposed Research Protocol)

Plant Material and Authentication

Aerial parts (flowers, leaves, and young stems) of *Lagochilus inebrians* would be collected during the flowering period from documented natural populations within the Karatau, Karzhantau, and Aksu-Zhabagly areas of South Kazakhstan, in accordance with the distribution previously reported by Aimenova et al. (2015). Botanical identification would be confirmed against herbarium reference specimens, and voucher specimens would be deposited in an appropriate institutional herbarium. Following collection, the plant material would be shade-dried, manually threshed to separate flowers and leaves from woody stems, and stored under dry, well-ventilated conditions prior to analysis, consistent with established post-harvest handling practices for the species.

Authentication of the raw material would proceed through macroscopic examination (external morphological features, color, and odor) and microscopic diagnostic analysis of anatomical features, following the general pharmacopoeial articles of the State Pharmacopoeia of the Republic of Kazakhstan governing the determination of morphological groups of medicinal plant raw materials (Sayakova et al., 2022).

To ensure representativeness, collection would be carried out across at least three distinct sub-populations within the documented South Kazakhstan distribution range, with multiple independent batches gathered from each site during a single flowering season to account for

natural inter-population variability in secondary metabolite content, an approach informed by prior observations that lagochilin concentration can differ meaningfully between geographically distinct *Lagochilus inebrians* populations (Akramov et al., 2020). Each batch would be assigned a unique accession code linking it to its collection site, date, and voucher specimen, allowing subsequent phytochemical and quality-control results to be traced back to a specific provenance. Prior to analysis, all raw material would be inspected for the presence of foreign organic and mineral matter, consistent with pharmacopoeial requirements for permissible impurity content in herbal raw materials.

Extraction Procedure

Aqueous and aqueous-ethanolic extracts would be prepared using a graded series of ethanol concentrations (30%, 50%, 70%, and 96%), following a reflux extraction procedure in which accurately weighed, sieved plant material is combined with the extractant, heated under reflux for a defined period, filtered, and the filtrate evaporated to determine the yield of extractive substances by gravimetric analysis. This extraction approach mirrors the methodology previously validated for a comparable standardization study of Kazakhstan-grown medicinal plant raw material (Sayakova et al., 2022), allowing direct comparison of extraction efficiency across solvent systems.

Specifically, a fixed raw material-to-solvent ratio (analogous to the 1:16 to 1:20 ratios reported in comparable pharmacognostic standardization protocols) would be maintained across all extraction runs, with reflux conducted at a controlled temperature close to the boiling point of the solvent system for a period of approximately two hours, followed by cooling, filtration through paper filters, and gravimetric determination of the dried residue after evaporation at a standardized oven temperature. Each solvent concentration would be tested in triplicate for every plant material batch, generating an extraction-efficiency profile intended to identify the solvent system yielding the highest recovery of lagochilin and associated marker compounds, analogous to the extractant-comparison approach previously employed for other Kazakhstani medicinal plant raw materials (Sayakova et al., 2022). The resulting optimized extract would then serve as the basis for the phytochemical fingerprinting and quantitative marker-compound analysis described in the following subsection.

Phytochemical Screening and Marker Compound Quantification

Preliminary phytochemical screening would employ standard qualitative color reactions to detect the major compound classes previously reported in the genus, including reactions for phenolic compounds, flavonoids, and tannins. Thin-layer chromatography, using solvent systems previously validated for related plant material (for example, n-butanol–glacial acetic acid–water and ethyl acetate–glacial acetic acid–water systems), would be used to generate a chemical fingerprint of the extract and to permit comparison against a lagochilin reference standard where available. Quantitative determination of lagochilin content would be performed using TLC-densitometry or, where instrumentation permits, high-performance liquid chromatography, expressed as a percentage of dry raw material.

For the qualitative reactions, sodium hydroxide-mediated azo-dye formation would be used as a preliminary indicator of phenolic content, chalcone formation with dilute alkali would indicate the presence of flavones and flavanones, and ferric chloride would be applied to detect polyphenolic compounds, following the reaction sequence previously described for an analogous Kazakhstani plant standardization study (Sayakova et al., 2022). For chromatographic fingerprinting, silica-based thin-layer plates would be developed in the solvent systems noted above, with spot visualization achieved through exposure to ultraviolet light and through spraying with a dilute aluminum chloride solution, and retention factor values would be recorded and compared across plant material batches and, where feasible, against literature-reported retention values for lagochilin and related diterpenoids. Where high-performance liquid chromatography is

available, a reversed-phase column with ultraviolet detection would be employed, using a mobile phase gradient optimized during method validation, with lagochilin content quantified against a calibration curve constructed from a certified or well-characterized reference standard.

Pharmacopoeial Quality-Control Parameters

Quality specification testing would follow the general pharmacopoeial articles of the State Pharmacopoeia of the Republic of Kazakhstan, encompassing determination of moisture content by gravimetric drying, total ash and acid-insoluble ash by calcination, extractive substance content, and screening for heavy metals (lead, cadmium, arsenic, mercury) and radionuclides (caesium-137, strontium-90) against applicable state standards. Microbial purity testing would additionally be conducted in accordance with pharmacopoeial limits for herbal raw materials intended for pharmaceutical use. Table 1 below summarizes the proposed quality parameters and the reference ranges reported in an analogous, already-completed Kazakhstani standardization study, presented here as an illustrative planning benchmark rather than as measured values for *Lagochilus inebrians*.

Each quality parameter would be assessed across all collected batches described in Section 3.1, allowing evaluation not only of overall compliance with proposed limits but also of variability attributable to collection site, harvest timing, and post-harvest handling. Where feasible, results would additionally be benchmarked against the corresponding quality specifications already established for other Central Asian *Lagochilus* raw material in the international literature, providing a basis for judging whether Kazakhstan-grown material meets, exceeds, or falls short of previously reported quality and marker-compound benchmarks. This comparative dimension is considered essential to building a scientifically defensible case for eventual pharmacopoeial recognition, since regulatory acceptance of a new monograph typically requires demonstration that proposed limits are both technically achievable and pharmacologically meaningful.

Table 1. Proposed Quality Specification Parameters for Standardization of *Lagochilus inebrians* Raw Material (illustrative framework, adapted from an analogous completed Kazakhstani pharmacognostic standardization study; values to be verified experimentally)

Quality parameter	Reference method / normative source	Typical range reported for analogous medicinal plant raw material standardization (illustrative)
Moisture content	State Pharmacopoeia RK, Vol. 1, gravimetric drying method	12–14%
Total ash	State Pharmacopoeia RK, general article on ash determination	1.8–2.6%
Ash insoluble in 10% HCl	State Pharmacopoeia RK, general article	0.3–0.5%
Extractive substances (70% ethanol)	Reflux extraction, gravimetric determination	4–10% (extractant-dependent)
Lagochilin content	TLC-densitometry / HPLC, comparison with reference standard	≥0.5% (pharmacopoeial minimum reported for related raw material)
Heavy metals (Pb, Cd, As, Hg)	State Pharmacopoeia RK, Vol. 1, section 2.8	Within state standard permissible limits
Radionuclides (Cs-137, Sr-90)	State standards 32161-2013 / 32163-2013	Below detection / permissible limit
Microbial purity	State Pharmacopoeia RK, microbiological limit tests	Within pharmacopoeial limits for herbal raw material

Preclinical Hemostatic and Toxicity Evaluation

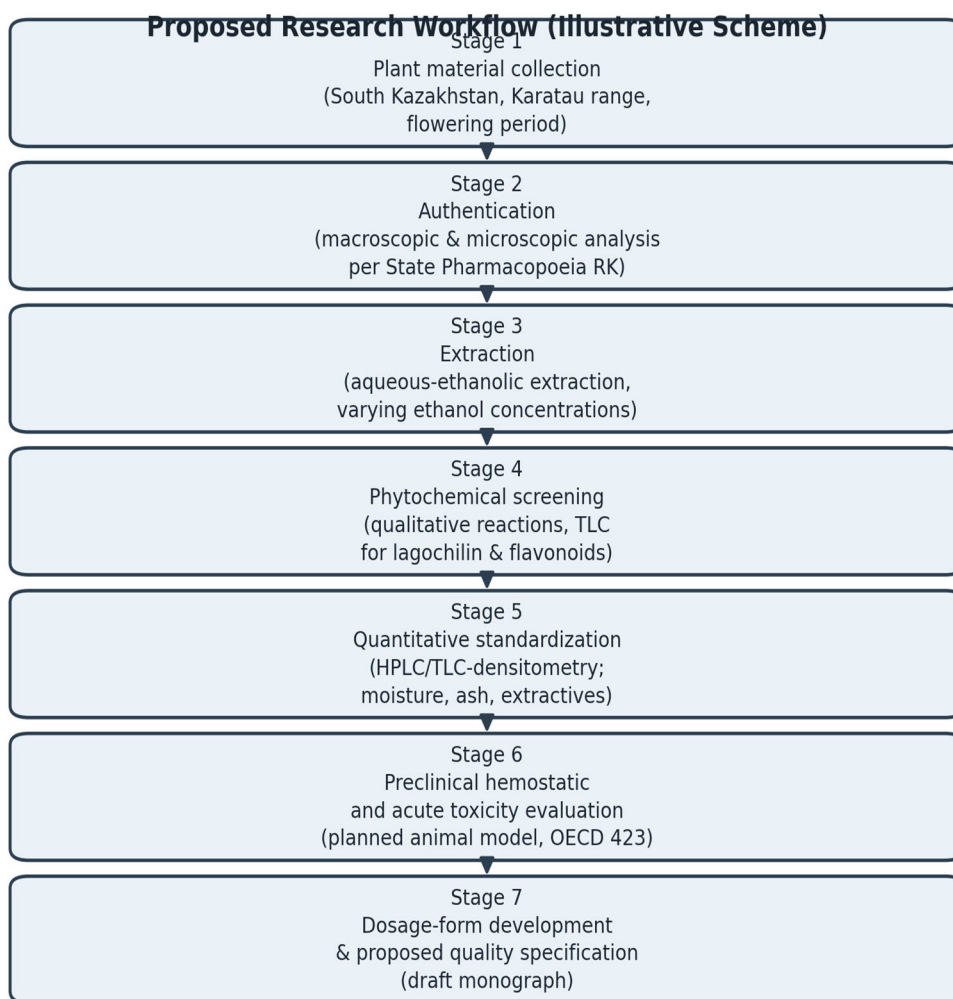
Should the phytochemical standardization confirm consistent lagochilin content, subsequent preclinical evaluation would assess hemostatic activity using a validated experimental bleeding-time model, alongside acute oral toxicity testing conducted according to OECD Test Guideline 423 (Acute Toxicity Class Method), with appropriate institutional animal ethics approval. This staged approach mirrors the acute toxicity methodology previously applied to other *Lagochilus* species (Mamadalieva et al., 2021) and would allow direct comparison of the Kazakhstan-sourced material against existing literature values.

Proposed Dosage-Form Development and Statistical Considerations

Contingent upon successful standardization and favorable preclinical safety findings, a candidate hemostatic dosage form (such as a standardized dry extract, tincture, or topical hemostatic film analogous to previously reported *Lagoden*-based preparations) would be formulated and evaluated for stability under accelerated storage conditions. All quantitative determinations would be performed in triplicate, with results expressed as mean $\pm$ standard deviation and analyzed using appropriate parametric or non-parametric statistical tests depending on data distribution, at a significance threshold of $p < 0.05$.

Formulation development would be guided by the physicochemical properties of the standardized extract identified in Section 3.3, with candidate excipients and film-forming or tableting agents selected for compatibility with the extract and for consistency with pharmacopoeially acceptable pharmaceutical additives. Accelerated stability testing would follow standard temperature and humidity storage conditions over a defined observation period, with periodic re-assay of lagochilin content and organoleptic properties used as indicators of shelf-life. Throughout all stages of the proposed protocol, good laboratory practice principles would be observed, including instrument calibration records, batch documentation, and blinded or randomized sample coding where applicable, to ensure that any future empirical execution of this protocol would generate data suitable for eventual submission toward a formal pharmacopoeial monograph proposal.

Figure 1. Proposed research workflow for the pharmacognostic standardization of *Lagochilus inebrians* and prospective development of a hemostatic phytopharmaceutical.



Conclusion

Lagochilus inebrians represents a pharmacologically well-documented but pharmacopoeially under-standardized medicinal plant of considerable regional significance to Kazakhstan. The literature reviewed in this paper establishes a coherent phytochemical and pharmacological basis for its traditional reputation as a hemostatic agent, centered on the diterpene lagochilin and its structurally related derivatives, and supported by decades of largely Uzbek, Russian, and Chinese pharmacological investigation. At the same time, this review identifies a clear and specific gap: the absence of a dedicated State Pharmacopoeia of the Republic of Kazakhstan monograph for Kazakhstan-grown *Lagochilus inebrians* raw material, in contrast to recent, methodologically comparable standardization efforts successfully completed for other regionally important medicinal plants.

The methodological framework proposed in this paper is intended to address that gap by outlining a structured, stepwise protocol encompassing botanical authentication, graded solvent extraction, phytochemical fingerprinting and marker-compound quantification, pharmacopoeial quality-control testing, and staged preclinical safety and hemostatic-activity evaluation. Because this paper is conceptual and methodological rather than empirical, the proposed parameter ranges and workflow presented here should be understood as a planning framework informed by analogous completed studies, not as reported experimental findings for *Lagochilus inebrians* itself.

Future work should prioritize the systematic collection of Kazakhstan-grown plant material from the documented South Kazakhstan populations, followed by execution of the proposed protocol under appropriate institutional ethical oversight, including animal-use approval for any preclinical hemostatic and toxicity testing.

Should the proposed standardization be carried out and yield results consistent with the pharmacological profile already documented for Uzbek-sourced *Lagochilus* material, the resulting data could support submission of a formal monograph proposal to the relevant Kazakhstani pharmacopoeial authorities, and could inform the rational development of a locally sourced, quality-assured hemostatic phytopharmaceutical. Such an outcome would contribute both to the scientific valorization of a regionally endemic medicinal resource and to the broader modernization of pharmacognostic standardization practice within Kazakhstan, consistent with the trajectory already established by recent comparable studies in the field.

Several limitations of the present conceptual synthesis should be acknowledged. Much of the underlying phytochemical and pharmacological evidence base for *Lagochilus inebrians* originates from plant material collected outside Kazakhstan, principally from Uzbekistan, and inter-population variability in lagochilin and related marker-compound content means that these findings cannot be assumed to transfer directly to Kazakhstan-grown material without independent verification. Similarly, the proposed quality-specification ranges presented in Table 1 are drawn from an analogous but botanically distinct standardization study and are offered strictly as a planning benchmark rather than as validated limits for *Lagochilus inebrians*. Any future empirical study built upon this protocol would therefore need to treat these figures as provisional hypotheses to be tested, refined, or revised in light of actual experimental data, and would require appropriate institutional ethical approval prior to any preclinical animal testing. With these caveats in mind, the framework proposed here is intended to provide a scientifically grounded and pharmacopoeially consistent starting point for future Kazakhstani researchers seeking to translate the well-established hemostatic reputation of *Lagochilus inebrians* into a rigorously standardized, evidence-based phytopharmaceutical product.

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MODERN APPROACHES AND BIOMECHANICAL FOUNDATIONS IN THE SURGICAL TREATMENT OF POSTERIOR COLUMN PELVIC FRACTURES

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Abstract. Posterior column fractures of the pelvis and acetabulum remain among the most technically demanding injuries in orthopaedic trauma surgery, occurring in high-energy trauma among younger patients and in low-energy falls among the elderly. Optimal management requires anatomical reduction and stable internal fixation to restore the load-bearing architecture of the hip joint and to minimize the risk of post-traumatic arthritis, nonunion, and functional impairment. This article presents an integrative review of contemporary surgical strategies and their underlying biomechanical rationale for posterior column pelvic fractures, synthesizing clinical, cadaveric, and composite-bone-model evidence published over the past three decades. The review traces the evolution of fixation philosophy from foundational classification systems and open surgical approaches to current minimally invasive percutaneous techniques, reconstruction plating, and novel implant geometries such as angular and dynamic plates. Comparative biomechanical data drawn from cadaveric and composite bone models are analyzed, including construct stiffness, cyclic-load failure thresholds, and interfragmentary displacement across single-plate, dual-plate, screw-only, and hybrid plate–screw configurations. Particular attention is given to antegrade and retrograde screw fixation via posterior and anterior corridors, and to the comparative performance of standard cannulated screws versus cannulated compression headless screws. The materials and methods section presents a structured comparative synthesis, supported by tables and diagrams, of fixation stiffness values, complication profiles, and clinical outcome indicators reported in the American and Kazakhstani orthopaedic literature. Findings indicate that dual-plate and angular-plate constructs, as well as compression headless screw systems, provide superior mechanical stability relative to single-implant fixation, though clinical decision-making must also weigh soft-tissue morbidity, surgical exposure, and patient-specific bone quality. The review concludes that an evidence-based, biomechanically informed selection of fixation strategy, tailored to fracture pattern and patient factors, is essential for optimizing surgical outcomes and long-term hip joint preservation.

Keywords: posterior column fracture, acetabulum, pelvic ring, internal fixation, biomechanics, orthopaedic trauma surgery, orthopaedic trauma surgery

Introduction

Fractures involving the posterior column of the acetabulum and pelvic ring represent some of the most anatomically complex and clinically consequential injuries encountered in orthopaedic trauma practice. The pelvis functions as a load-transmitting ring that connects the axial skeleton to the lower extremities, and the acetabulum, formed at the confluence of the ilium, ischium, and pubis, constitutes the weight-bearing socket of the hip joint. The posterior column, extending from the iliac crest through the greater sciatic notch, ischial spine, and ischial tuberosity, provides the principal structural support for the femoral head during standing, walking, and transitional loading.

Disruption of this column, whether isolated or in combination with anterior column, transverse, or both-column patterns, compromises the mechanical integrity of the hip and, if inadequately reduced and stabilized, predisposes patients to post-traumatic osteoarthritis, chronic pain, and long-term functional disability.

The modern understanding of acetabular and posterior pelvic ring injuries owes much to the classification systems and surgical approaches developed in the mid-twentieth century, which established the Kocher–Langenbeck posterior approach as the principal surgical corridor for posterior column and posterior wall fractures. Subsequent decades saw the refinement of open reduction and internal fixation (ORIF) as the accepted standard of care for displaced, unstable fracture patterns, driven by the recognition that anatomical restoration of the articular surface and the load-bearing dome is the single most influential predictor of favorable long-term clinical outcome. North American trauma centers played a decisive role in disseminating and further developing these principles, contributing large single- and multi-surgeon outcome series, percutaneous fixation techniques for the posterior pelvic ring, and detailed complication analyses that continue to guide contemporary practice.

Despite the maturity of the field, several aspects of posterior column fracture management remain actively debated. These include the relative merits of plate versus screw fixation, the indications for minimally invasive percutaneous stabilization versus formal open exposure, the optimal implant configuration for osteoporotic or comminuted bone, and the role of acute arthroplasty in elderly patients with nonreconstructable articular surfaces. Biomechanical research using cadaveric specimens, composite synthetic bone models, and finite-element simulation has become an essential complement to clinical outcome studies, allowing surgeons and implant designers to quantify construct stiffness, cyclic fatigue behavior, and load-to-failure characteristics under physiologically relevant conditions before or alongside clinical validation.

The regional context of this review is also relevant. In Kazakhstan, the National Scientific Center of Traumatology and Orthopedics named after Academician N.D. Batpenov and affiliated university departments have contributed growing clinical and epidemiological literature on pelvic and hip fracture management, reflecting both the increasing incidence of fragility fractures in an aging population and the ongoing development of implant technologies adapted to local clinical settings. Integrating this regional evidence with the extensive American biomechanical and clinical literature provides a more complete picture of current practice and of the gaps that remain to be addressed.

Epidemiologically, posterior column fractures account for approximately 18.5 to 22 percent of all acetabular fractures, and the overall incidence of acetabular fractures has been rising in industrialized nations as populations age and low-energy fall-related injuries in osteoporotic bone become more common alongside the classic high-energy mechanisms seen in younger patients. This demographic shift has important implications for fixation strategy, since osteoporotic bone tolerates conventional screw and plate purchase less predictably than the dense cortical bone typically encountered in younger trauma patients, and it has motivated growing interest in acute arthroplasty and hybrid fixation-arthroplasty constructs for elderly patients with comminuted, nonreconstructable articular surfaces.

A central biomechanical concept relevant to posterior column fixation is the distribution of load across the acetabular dome during gait. Analysis of the radiographic acetabulum has shown that the primary weight-bearing force vector at mid-stance is oriented approximately sixteen degrees medial from vertical, with this vector excursing anteriorly during toe-off and posteriorly during heel strike; the posterior column bears a substantial share of this cyclically shifting load. Any fixation construct applied to the posterior column must therefore withstand not a single static force but a repetitive, multidirectional loading pattern throughout the gait cycle, which is precisely why

cyclic fatigue testing, rather than single-cycle static loading alone, has become increasingly standard in contemporary biomechanical evaluation of candidate implants.

The purpose of this article is to synthesize contemporary surgical approaches to posterior column pelvic fractures together with the biomechanical evidence that underpins them. The Literature Review section outlines the historical development and thematic clusters of research relevant to posterior column fixation. The Materials and Methods section describes the comparative-review methodology employed and presents structured tabular and graphical comparisons of construct stiffness and technique characteristics drawn from the reviewed literature. The Conclusion synthesizes the clinical implications of this evidence and identifies directions for future research, including patient-specific implant design and the integration of computational modeling into preoperative planning.

Understanding posterior column fracture management therefore requires drawing simultaneously on classification frameworks, surgical technique descriptions, clinical outcome series, and biomechanical bench and computational research, since no single evidence source alone provides a complete picture of why one fixation strategy might be preferred over another for a given patient. The sections that follow attempt to weave these evidence sources together, moving from the historical and clinical foundations of the field toward a structured, tabulated comparison of the biomechanical performance and practical trade-offs of the fixation strategies currently in use.

Literature Review

The literature on posterior column pelvic and acetabular fracture treatment can be organized into several overlapping thematic clusters: foundational classification and outcome studies, posterior pelvic ring percutaneous fixation techniques, cadaveric and composite-bone biomechanical construct studies, complication-focused clinical series, and regional epidemiological and clinical contributions from Kazakhstan.

The foundational cluster established the surgical and conceptual framework still in use today. Early work on unstable pelvic ring disruptions demonstrated that internal fixation of both the anterior and posterior elements of the pelvic ring produces superior functional outcomes compared with nonoperative management or fixation of a single ring component alone (Matta & Saucedo, 1989; Matta & Tornetta, 1996). Complementary outcome research on operatively treated posterior pelvic ring disruptions confirmed that residual displacement after fixation correlates directly with inferior functional scores, reinforcing the principle that anatomical reduction, not merely stabilization, should be the surgical goal (Tornetta & Matta, 1996).

A second cluster of literature addresses percutaneous and minimally invasive fixation of the posterior pelvic ring and posterior column. Iliosacral screw fixation, introduced as an alternative to open plating for sacroiliac and sacral injuries, was shown to substantially reduce operative morbidity, though early series also documented a discrete set of technical complications related to screw malposition and neurological injury, underscoring the narrow safe osseous corridor available for this technique (Roult et al., 1997). Subsequent refinements addressed fixation of complex sacral fracture patterns using percutaneous iliosacral screws (Nork et al., 2001) and extended the technique to transiliac–transsacral screw constructs for posterior pelvic stabilization, broadening the indications for percutaneous fixation to bilateral and highly unstable injury patterns (Gardner & Roult, 2011). Because sacral bony morphology varies considerably between individuals, morphological analyses have been essential in defining safe screw trajectories and identifying patients for whom standard iliosacral screw placement may not be feasible (Miller & Roult, 2012). For vertically unstable transforaminal sacral fractures, triangular osteosynthesis combining iliosacral screws with lumbopelvic fixation has demonstrated durable stability at intermediate-term follow-up, representing a hybrid strategy between purely percutaneous and formal open techniques (Sagi et al., 2009).

A third cluster comprises cadaveric and composite-bone biomechanical studies that quantify the mechanical performance of different fixation constructs. Early biomechanical comparisons of posterior column osteotomy fixation found no significant difference among single-plate, dual-plate, and plate-with-lag-screw constructs under moderate axial loading, though the authors noted that the applied loads did not replicate the full demands of unsupported standing and walking (Schopfer et al., 1994, as cited in Su et al., 2017). Building on this foundation, more recent composite-bone testing comparing four posterior column fixation constructs found that dual reconstruction plating and a novel W-shaped angular plate produced comparable and superior stiffness relative to single-plate or plate-and-screw configurations, while also more closely restoring native joint-loading strain patterns (Su et al., 2017). Parallel work on antegrade posterior column screw fixation via the posterior approach demonstrated that cannulated compression headless screws achieve significantly greater initial construct stiffness than standard cannulated screws, suggesting a mechanical advantage for compression-based screw designs in percutaneous posterior column stabilization (Berk et al., 2023). Complication-focused analyses of operatively treated acetabular fractures have further shown that perioperative complication rates are influenced by surgical approach, fracture pattern complexity, and associated pelvic ring injury, reinforcing the need to weigh biomechanical performance against surgical morbidity when selecting a fixation strategy (Russell et al., 2001; Suzuki et al., 2010).

A related methodological cluster has introduced computational modeling as a complement to physical cadaveric and composite-bone testing. Finite-element analyses of combined anterior column and posterior hemi-transverse fracture patterns have compared multiple plate-and-screw configurations under simulated standing and sitting loads, identifying stress concentration zones at the quadrilateral surface and infra-acetabular region that inform buttress plate design. Although such finite-element work has more frequently addressed combined or anterior-column-predominant fracture patterns than isolated posterior column injuries, the modeling techniques themselves, including simulated multidirectional joint loading and stress-distribution mapping, are directly transferable to posterior column construct evaluation and are likely to feature increasingly in future comparative biomechanical research. Comprehensive American trauma textbooks synthesizing this body of clinical and biomechanical evidence into consensus treatment algorithms remain a key reference point for practicing orthopaedic surgeons, consolidating decades of accumulated outcome data into practical operative guidance (Heckman et al., 2014).

A fourth cluster addresses combined and complex injury patterns and their management algorithms. Vaidya et al. (2019) described a sequential reduction protocol combining an anterior subcutaneous pelvic fixator with definitive acetabular fixation for patients with simultaneous pelvic ring disruption and acetabular fracture, illustrating how staged surgical strategies can address multi-segment instability while limiting cumulative surgical morbidity.

Finally, the regional literature from Kazakhstan contributes both epidemiological and clinically applied evidence. A country-specific epidemiological survey established fracture incidence data and a national FRAX model for fragility fracture risk assessment, providing a population-level foundation for understanding the burden of pelvic and hip-region fractures in the region (Issayeva et al., 2020). A retrospective outcome analysis of hip fracture management in Kazakhstan compared operative and nonoperative treatment practices and their association with patient survival, highlighting differences in treatment patterns relative to Western European centers (Amrayev et al., 2017). Most directly relevant to posterior column and acetabular fixation, clinicians at the National Scientific Center of Traumatology and Orthopedics named after Academician N.D. Batpenov reported clinical experience with a self-developed acetabular fixation plate, contributing regionally adapted implant design to the broader international literature on acetabular plating (Nurgeldi et al., 2024). Together, these clusters demonstrate a field that has progressed from open, plate-based reduction principles toward an increasingly diverse and

biomechanically validated set of fixation options, while regional contributions continue to refine implant design and treatment protocols for local patient populations.

Materials and Methods

Review Design and Search Strategy

This article was developed as a narrative comparative literature review rather than a primary experimental or clinical study. The methodology combined a structured search of the biomedical literature with a subsequent comparative synthesis of biomechanical and clinical data extracted from the identified sources. Electronic searches were conducted across PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar for English-language publications addressing posterior column, posterior wall, and posterior pelvic ring fracture fixation. Search terms included combinations of "posterior column fracture," "acetabular fracture fixation," "pelvic ring fixation," "biomechanical analysis," "iliosacral screw," "percutaneous fixation," and "Kazakhstan orthopaedic trauma." Reference lists of retrieved articles were hand-searched to identify additional relevant studies, particularly foundational works not indexed under contemporary search terms.

Sources were included if they reported original clinical outcomes, biomechanical testing data, or epidemiological findings directly relevant to posterior column or posterior pelvic ring fracture fixation, or if they provided classification frameworks or treatment algorithms foundational to the field. Case reports without quantitative outcome data, non-peer-reviewed conference abstracts, and articles not available in English were excluded from detailed quantitative comparison, although several were consulted for contextual background. Priority in the comparative synthesis was given to studies reporting quantifiable biomechanical parameters, namely construct stiffness (N/mm), load or cycles to failure, and interfragmentary displacement, since these parameters allow direct numerical comparison across independent studies despite differences in testing apparatus and specimen type.

Comparative Data Extraction

For each biomechanical study included in the comparative synthesis, the following variables were extracted where reported: fixation construct type and implant configuration, specimen or model type (cadaveric versus synthetic composite bone), applied loading protocol (static axial load versus cyclic fatigue loading), mean construct stiffness with standard deviation, and reported statistical comparisons between constructs. These variables were tabulated to allow direct visual and numerical comparison across studies conducted independently and at different institutions, acknowledging that differences in specimen preparation, loading rate, and fixture design introduce a degree of heterogeneity that limits strict meta-analytic pooling. For this reason, the comparative tables and diagrams presented below should be interpreted as an integrative qualitative-quantitative synthesis rather than a formal meta-analysis.

Table 1 summarizes construct stiffness data drawn from two independent biomechanical studies employing composite hemipelvis models. The first study compared four plate-based fixation strategies for isolated posterior column fractures, while the second compared two antegrade screw fixation techniques applied via a posterior surgical corridor. Although the two studies used different testing protocols and could not be statistically pooled, presenting their results side by side allows the relative mechanical contribution of plate-based versus screw-based constructs to be appreciated within a single comparative frame.

Fixation construct	Mean stiffness (N/mm)	Source study	Testing model
Single reconstruction plate (1P)	248.90 ± 61.95	Su et al. (2017)	Composite hemipelvis
Reconstruction plate + lag screw (PS)	326.41 ± 94.34	Su et al. (2017)	Composite hemipelvis
Two reconstruction plates (2P)	445.81 ± 98.30	Su et al. (2017)	Composite hemipelvis
W-shaped acetabular angular plate (WAAP)	447.43 ± 98.45	Su et al. (2017)	Composite hemipelvis
Standard antegrade cannulated screw (PCSS)	133.1 ± 27.5	Berk et al. (2023)	Composite hemipelvis, posterior approach
Antegrade cannulated compression headless screw (PCCH)	163.1 ± 14.9	Berk et al. (2023)	Composite hemipelvis, posterior approach

As shown in Table 1 and illustrated in Figure 1, the two reconstruction-plate construct and the W-shaped angular plate achieved nearly identical mean stiffness values, both markedly exceeding the stiffness of a single reconstruction plate or a plate-and-lag-screw combination. This finding is clinically relevant because it suggests that the novel angular plate design can achieve dual-plate-equivalent stability while requiring the insertion of a single implant, potentially reducing surgical dissection and hardware-related complications relative to true dual-plate fixation (Su et al., 2017).

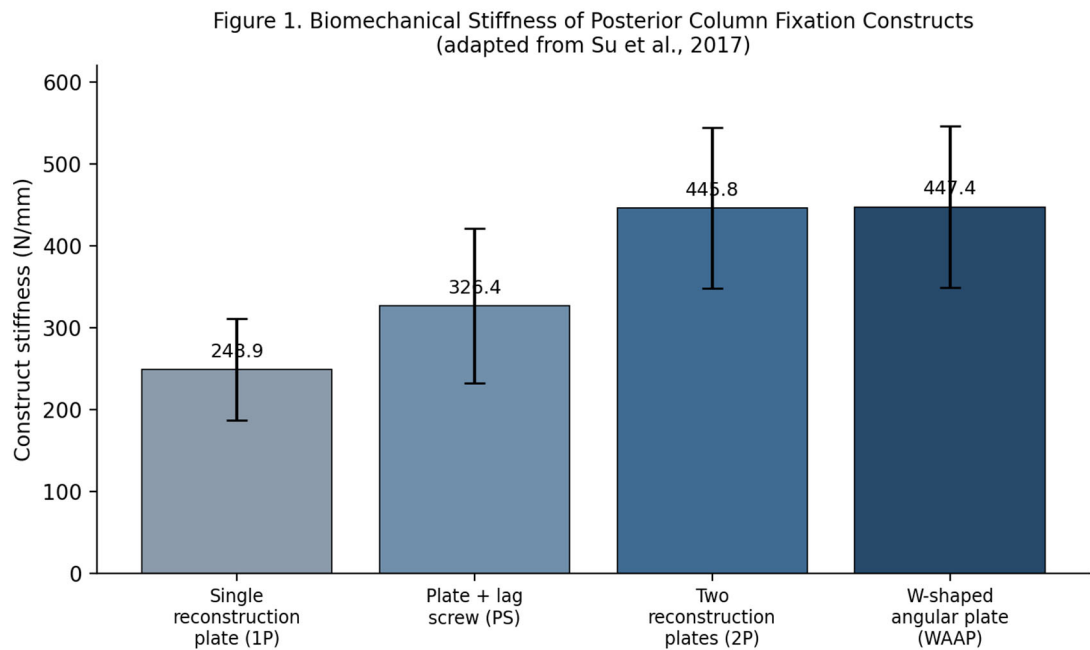


Figure 1. Mean biomechanical stiffness of four posterior column fixation constructs tested on composite hemipelvis models (data adapted from Su et al., 2017). Error bars represent one standard deviation.

Figure 2 presents a second, independent biomechanical comparison, this time between two antegrade screw designs used for percutaneous posterior column fixation via the posterior approach. The cannulated compression headless screw achieved significantly greater initial construct stiffness than the standard cannulated screw, a difference the original authors attributed to the compressive effect generated by the headless screw design across the fracture interface (Berk et al., 2023). This comparison illustrates that biomechanical gains are achievable not only through implant type (plate versus screw) but also through refinement within a single implant category.

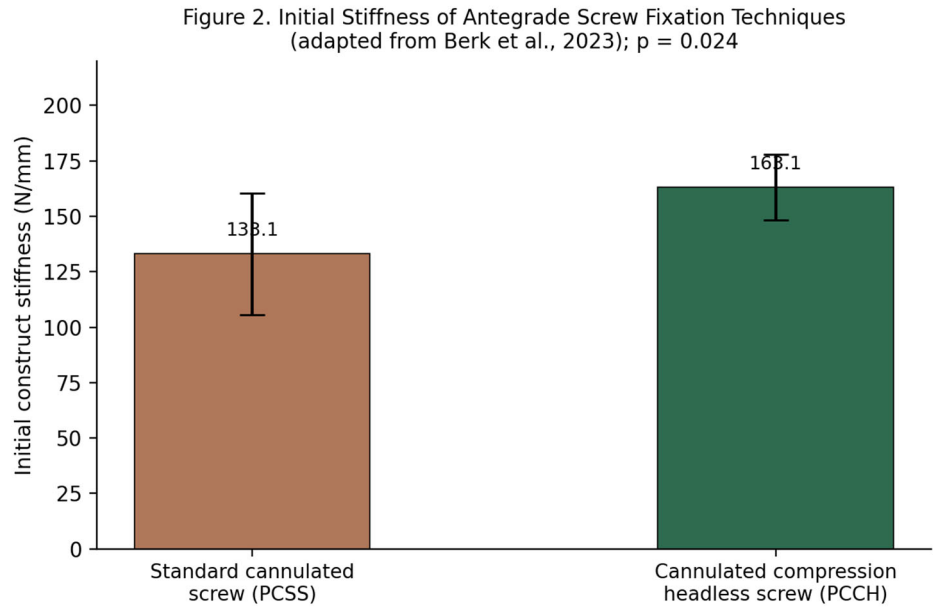


Figure 2. Initial construct stiffness of two antegrade screw fixation techniques for posterior column acetabular fracture (data adapted from Berk et al., 2023).

Qualitative Comparison of Surgical Strategies

Because biomechanical stiffness alone does not determine clinical suitability, Table 2 presents a qualitative comparison of the principal surgical strategies discussed in the literature, contrasting typical surgical approach, primary biomechanical or clinical advantage, and principal limitation. This comparison draws on clinical outcome literature (Matta & Tornetta, 1996; Tornetta & Matta, 1996; Vaidya et al., 2019), percutaneous fixation literature (Routt et al., 1997; Gardner & Routt, 2011; Miller & Routt, 2012; Nork et al., 2001), hybrid fixation literature (Sagi et al., 2009), and regionally reported implant experience (Nurgeldi et al., 2024).

Surgical strategy	Typical approach	Principal advantage	Principal limitation
Open reduction, dual reconstruction plating	Kocher–Langenbeck	Highest reported construct stiffness under axial load	Extensive soft-tissue dissection; heterotopic ossification risk
Angular (W-shaped) plate fixation	Kocher–Langenbeck	Stiffness comparable to dual plating with fewer implants	Requires precise contouring; limited long-term clinical data
Percutaneous antegrade/retrograde screw fixation	Minimally invasive, anterior or posterior corridor	Reduced blood loss, soft-tissue morbidity, and infection rate	Narrow safe osseous corridor; demands precise imaging guidance
Triangular osteosynthesis / lumbopelvic fixation	Posterior midline, combined iliosacral and spinopelvic	Restores stability in vertically unstable patterns	Greater implant prominence; technically demanding
Acute total hip arthroplasty with posterior-column plating	Kocher–Langenbeck, single-stage	Avoids secondary arthroplasty in elderly, comminuted fractures	Higher primary surgical morbidity; case selection critical

The comparison in Table 2 highlights a recurring trade-off in posterior column fracture surgery: constructs that provide the greatest mechanical stiffness, such as open dual-plating, typically require the most extensive surgical exposure, whereas minimally invasive percutaneous techniques reduce soft-tissue morbidity at the cost of a narrower margin for safe implant placement. This trade-off is central to contemporary surgical decision-making and explains the persistence of multiple concurrent fixation philosophies within the field rather than convergence on a single dominant technique.

Biomechanical Testing Parameters and Statistical Approaches

Across the primary studies synthesized in this review, biomechanical testing protocols generally followed one of two paradigms: static loading to a defined force to determine construct stiffness under a single loading cycle, or progressive cyclic loading applied until mechanical failure to determine fatigue life and clinical failure load. Composite synthetic hemipelvis models were used in several studies to standardize bone quality and eliminate donor-to-donor variability inherent to cadaveric testing, at the cost of somewhat reduced anatomical fidelity relative to true human bone. Motion-tracking systems were used in the more recent studies to quantify interfragmentary displacement, fracture-gap opening, and torsional movement at the fracture site throughout the loading protocol, providing a more granular picture of construct behavior than stiffness values alone. Statistical comparisons between groups in the primary studies typically employed independent-samples t-tests or analysis of variance for continuous stiffness and displacement outcomes, with significance thresholds set at $p < 0.05$; where such comparisons

were reported, they are cited alongside the corresponding stiffness values in this review to preserve the original level of statistical evidence.

A methodological limitation inherent to this comparative synthesis, and one that should guide interpretation of Tables 1 and 2, is that the primary studies differ in specimen type, loading apparatus, and testing rate, precluding direct statistical pooling across studies. The comparative tables and diagrams presented here are therefore best understood as a structured qualitative-quantitative synthesis intended to orient surgical decision-making and to identify candidate constructs for future head-to-head biomechanical or clinical comparison, rather than as a substitute for a formal systematic review with meta-analysis.

Clinical Outcome Comparison

Beyond biomechanical bench testing, clinical outcome literature provides a complementary and ultimately more clinically decisive form of comparative evidence. Long-term survivorship analyses of large single-surgeon cohorts of operatively treated acetabular fractures have reported survivorship of the native hip joint, defined as freedom from conversion to total hip arthroplasty, in the range of seventy-nine to eighty percent at extended follow-up, with anatomical reduction quality consistently identified as the strongest independent predictor of joint survival regardless of the specific implant configuration used. This finding is important for interpreting the biomechanical data presented above: while Table 1 demonstrates clear differences in construct stiffness among fixation options, clinical series suggest that achieving and maintaining anatomical reduction may matter more for long-term outcome than the specific stiffness margin between two mechanically adequate constructs, provided that the selected construct is sufficient to maintain reduction through bony union.

This distinction has practical implications for surgical decision-making. A construct with modestly lower measured stiffness but a surgical approach that permits more reliable anatomical reduction, less soft-tissue devascularization of fracture fragments, and lower infection risk may be preferable to a mechanically stiffer construct associated with greater surgical morbidity, particularly in patients with favorable bone quality where the biomechanical safety margin of either option is likely to be adequate. Conversely, in osteoporotic bone or highly comminuted fracture patterns, the additional stiffness margin afforded by dual-plate, angular-plate, or compression-screw constructs may become clinically decisive in preventing loss of reduction before osseous union is achieved. This risk-stratified framework, integrating construct-level biomechanical data with patient- and fracture-level clinical factors, represents the practical synthesis toward which the comparative evidence in this review points.

Complication profiles reported across the clinical literature further refine this decision-making framework. Perioperative complications associated with operative treatment of acetabular fractures, including iatrogenic nerve injury, heterotopic ossification, deep infection, and thromboembolic events, have been shown to vary with surgical approach and with the presence of associated pelvic ring injury, independent of the specific implant used. Combined pelvic ring and acetabular injuries in particular have been described as producing a disproportionately high complication burden relative to isolated injuries of either structure, reflecting the greater soft-tissue and physiological insult associated with multi-segment pelvic disruption and supporting staged or sequential surgical protocols in such cases rather than attempting single-stage definitive fixation of every injured component.

Implant Material and Design Considerations

A further dimension relevant to comparative interpretation of the biomechanical data is the material and geometric design of the implants themselves. Reconstruction plates used in posterior column fixation are typically manufactured from titanium alloy or stainless steel and require intraoperative contouring to conform to the complex three-dimensional curvature of the posterior column, a step that adds operative time and introduces the possibility of imperfect plate-to-bone

contact if contouring is imprecise. The W-shaped angular plate design evaluated in the comparative studies summarized in Table 1 was specifically engineered to reduce the degree of intraoperative contouring required while distributing load across a wider footprint than a conventional reconstruction plate, which the original investigators proposed as the mechanical basis for its dual-plate-equivalent stiffness performance. Similarly, the mechanical advantage of the cannulated compression headless screw over the standard cannulated screw illustrated in Figure 2 has been attributed to the screw's variable-pitch thread design, which generates interfragmentary compression as it is seated, in contrast to the more neutral fixation provided by a standard cannulated screw without an integrated compression mechanism.

These design-level considerations reinforce a broader point relevant to the interpretation of comparative biomechanical literature: apparent differences in construct stiffness between studies may reflect not only the general category of fixation, plate versus screw, open versus percutaneous, but also specific, evolving refinements in implant geometry and material science within each category. This implies that the comparative tables presented in this review capture a snapshot of currently available evidence rather than a fixed hierarchy of fixation options, and that continued implant innovation is likely to shift the relative position of individual constructs within such comparisons as newer designs, including regionally developed devices such as the acetabular fixation plate reported by clinicians in Kazakhstan, are subjected to biomechanical and clinical validation.

Conclusion

The surgical treatment of posterior column pelvic and acetabular fractures has evolved substantially from its foundational open-reduction principles toward a diverse array of fixation strategies supported by an increasingly rigorous body of biomechanical evidence. The literature reviewed here demonstrates that dual reconstruction plating and novel angular plate designs achieve comparably high construct stiffness, offering surgeons flexibility in implant selection without necessarily compromising mechanical stability. Similarly, refinements within percutaneous screw fixation, such as the adoption of cannulated compression headless screws, demonstrate that meaningful biomechanical gains remain achievable within minimally invasive treatment paradigms, which continue to be favored for their reduced soft-tissue morbidity, blood loss, and infection risk relative to formal open exposures.

At the same time, this review underscores that no single fixation strategy is universally superior across all posterior column fracture patterns and patient populations. The selection of an appropriate technique must integrate biomechanical performance data with fracture morphology, bone quality, patient age and comorbidity profile, and the surgeon's technical familiarity with a given approach. The comparative tables and diagrams presented in the Materials and Methods section illustrate this balance directly: the constructs with the highest measured stiffness generally required the most extensive surgical exposure, while the least invasive techniques demanded the greatest precision in implant trajectory planning.

The inclusion of regional Kazakhstani literature alongside the extensive American clinical and biomechanical evidence base highlights both the global consistency of core biomechanical principles and the value of regionally adapted implant development and epidemiological research. Continued investment in locally developed fixation devices, as reflected in recent Kazakhstani clinical reports, together with national epidemiological modeling of fragility fracture risk, will be important for tailoring evidence-based treatment protocols to the specific demographic and clinical context of the region.

Future research should prioritize head-to-head biomechanical comparisons conducted under standardized testing protocols to allow more rigorous quantitative synthesis than is currently possible across heterogeneous independent studies. The growing use of finite-element modeling and patient-specific three-dimensional printing for preoperative planning represents a particularly

promising direction, offering the potential to individualize implant selection and screw trajectory to a given patient's fracture pattern and bone morphology before surgery is performed. Prospective multicenter clinical outcome studies, ideally incorporating both American and Central Asian trauma centers, would further strengthen the evidence base guiding the surgical management of this technically demanding and clinically consequential group of injuries.

From a translational standpoint, the synthesis presented in this review suggests a practical, risk-stratified approach for clinicians: in younger patients with good bone quality and reconstructable fracture patterns, either high-stiffness open plating or, where anatomically feasible, minimally invasive percutaneous screw fixation can be expected to provide adequate mechanical stability, allowing the choice between them to be guided primarily by soft-tissue considerations and surgeon experience. In older patients with osteoporotic bone, comminuted articular surfaces, or combined pelvic ring and acetabular injury, the additional stiffness margin offered by dual-plate, angular-plate, or compression-screw constructs, or the option of acute arthroplasty with posterior-column plating, is more likely to influence clinical outcome and should be weighed accordingly during preoperative planning. Embedding this evidence-based, biomechanically informed framework into routine surgical decision-making, and continuing to refine it through the kind of comparative synthesis undertaken in this review, offers the most realistic path toward improving outcomes for patients with posterior column pelvic and acetabular fractures.

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Conceptual Framework for Improving Nursing Care Through Enhancing Treatment Adherence Among Patients with Chronic Obstructive Pulmonary Disease in Primary Care

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) remains one of the leading causes of morbidity, mortality, and healthcare utilization worldwide. Despite advances in pharmacological and non-pharmacological management, poor treatment adherence continues to compromise disease control, increase the frequency of exacerbations, reduce patients' quality of life, and contribute to avoidable hospital admissions. Primary care nurses are uniquely positioned to improve adherence through continuous patient education, self-management support, behavioral counseling, and long-term follow-up. However, existing nursing approaches remain fragmented and lack an integrated conceptual framework that systematically links evidence-based adherence strategies with routine nursing practice.

Objective: To develop a conceptual framework for improving nursing care by strengthening treatment adherence among patients with chronic obstructive pulmonary disease receiving primary care services.

Methods: This conceptual paper synthesizes current international evidence on treatment adherence, self-management, nursing interventions, behavioral change strategies, patient education, motivational support, and chronic disease management in COPD. Evidence from international clinical guidelines, systematic reviews, randomized controlled trials, and nursing research was critically analyzed and integrated to identify the essential components of an evidence-informed nursing framework.

Results: The proposed framework conceptualizes treatment adherence as a multidimensional process influenced by patient-related, disease-related, healthcare-system, therapy-related, and

psychosocial factors. The framework positions nurses as coordinators of adherence-focused care and integrates five interrelated domains: comprehensive nursing assessment, individualized patient education, self-management support, behavioral and motivational interventions, and continuous monitoring with follow-up evaluation. These domains are interconnected through patient-centered communication and interdisciplinary collaboration, creating a structured approach to improving long-term disease management within primary care.

Conclusions: The proposed conceptual framework provides a theoretical foundation for designing, implementing, and evaluating nurse-led adherence strategies for patients with COPD. It may support the development of standardized nursing practice, strengthen evidence-based primary care, and guide future intervention studies aimed at improving clinical outcomes, patient engagement, and quality of life.

Keywords: chronic obstructive pulmonary disease; COPD; nursing care; treatment adherence; self-management; primary care; conceptual framework; patient education.

Introduction

Chronic obstructive pulmonary disease (COPD) remains one of the most pressing public health challenges of the twenty-first century and continues to impose a substantial clinical, social, and economic burden on healthcare systems worldwide. As a progressive, heterogeneous, and largely preventable chronic respiratory disease characterized by persistent airflow limitation, recurrent exacerbations, and multiple systemic manifestations, COPD significantly compromises physical functioning, psychological well-being, and health-related quality of life. Beyond respiratory impairment, COPD is strongly associated with frailty, multimorbidity, disability, and premature mortality, making it a major contributor to the global burden of chronic noncommunicable diseases [1–4].

Despite remarkable advances in respiratory medicine over the past two decades, including improvements in diagnostic technologies, evidence-based pharmacological therapies, pulmonary rehabilitation, and regularly updated international clinical guidelines, COPD remains one of the leading causes of preventable morbidity and mortality worldwide. This apparent paradox—where increasingly effective therapeutic options coexist with persistently poor long-term health outcomes—suggests that optimal disease management extends far beyond pharmacological treatment alone. Growing evidence indicates that behavioral, educational, psychosocial, and organizational determinants substantially influence disease progression, exacerbation risk, healthcare utilization, quality of life, and survival, emphasizing the need for comprehensive long-term management strategies rather than isolated symptom control [2–5].

According to the World Health Organization (WHO), COPD remains the third leading cause of death globally, accounting for approximately 3.4–3.5 million deaths annually and nearly 5–6% of all deaths worldwide [1]. Importantly, almost 90% of premature COPD-related deaths among individuals younger than 70 years occur in low- and middle-income countries (LMICs), where delayed diagnosis, underutilization of preventive interventions, limited access to pulmonary rehabilitation, and fragmented chronic care continue to compromise patient outcomes. These observations demonstrate that COPD is not only a respiratory disease but also a reflection of persistent inequalities in healthcare delivery and chronic disease management.

The Global Burden of Disease (GBD) 2021 study further demonstrates that the epidemiological burden of COPD continues to increase in absolute terms despite modest reductions in age-standardized mortality observed in several high-income countries. More than 210 million people worldwide are currently living with COPD, making it one of the most prevalent chronic respiratory diseases globally. Population ageing, cumulative exposure to tobacco smoke, biomass fuel combustion, occupational hazards, and ambient air pollution continue to increase the number of affected individuals, particularly in rapidly developing regions [5–7]. Consequently, COPD remains

among the leading contributors to disability-adjusted life years (DALYs) and years lived with disability (YLDs), substantially limiting patients' ability to maintain employment, social participation, and independent living.

The burden of COPD extends considerably beyond pulmonary dysfunction. Progressive dyspnea, chronic fatigue, multimorbidity, anxiety, depression, and cardiovascular comorbidities frequently coexist, creating a complex clinical phenotype that requires comprehensive multidisciplinary management rather than isolated treatment of respiratory symptoms. Furthermore, recurrent exacerbations accelerate lung function decline, increase hospitalization rates, worsen quality of life, and independently predict long-term mortality. Even after stabilization, many patients continue to experience functional limitations and reduced participation in daily activities, emphasizing that COPD should be regarded as a chronic multisystem disease requiring continuous, coordinated, and patient-centered care. [2,4].

The economic burden of COPD is equally substantial, encompassing direct medical costs related to pharmacological treatment, hospitalizations, rehabilitation, and long-term care, together with indirect costs arising from productivity loss, disability, premature retirement, and caregiver burden. International projections indicate that, without substantial improvements in chronic disease management, the global economic impact of COPD will continue to rise owing to population ageing and persistent exposure to modifiable environmental risk factors [4,6].

Over the past two decades, the management of COPD has undergone a profound transformation. Historically, clinical care was primarily centered on the treatment of airflow limitation and the management of acute exacerbations, with pharmacotherapy considered the principal strategy for improving patient outcomes. However, accumulating evidence has demonstrated that optimal pharmacological treatment alone is insufficient to alter the long-term trajectory of COPD. Persistent symptoms, recurrent exacerbations, poor functional status, and frequent hospitalizations continue to occur even among patients receiving guideline-recommended therapies, indicating that clinical outcomes are determined by a far broader range of factors than medication alone [8–10].

Consequently, contemporary COPD management has progressively evolved from an acute, physician-centered approach toward an integrated, patient-centered model of chronic disease management. This paradigm emphasizes continuity of care, multidisciplinary collaboration, shared decision-making, patient empowerment, and long-term support for self-management. Rather than focusing exclusively on lung function, modern care seeks to improve functional capacity, health-related quality of life, symptom control, prevention of exacerbations, and maintenance of independence throughout the disease trajectory. Accordingly, international recommendations, including the GOLD strategy, advocate integrated interventions combining evidence-based pharmacological treatment with comprehensive non-pharmacological management, including pulmonary rehabilitation, patient education, and self-management support [3,8].

Despite these advances, translating evidence-based recommendations into routine clinical practice remains a considerable challenge. Studies consistently demonstrate substantial variability in the implementation of guideline-directed care across healthcare settings. Delayed diagnosis, fragmented transitions between levels of care, inadequate patient education, limited health literacy, insufficient follow-up, and poor coordination among healthcare professionals frequently compromise the effectiveness of long-term COPD management [9–11]. As a result, many patients fail to achieve optimal disease control despite the availability of effective therapeutic interventions. Treatment adherence extends beyond medication use and includes correct inhaler technique, participation in pulmonary rehabilitation, healthy lifestyle behaviors, attendance at follow-up visits, and timely recognition of symptom deterioration [10–12].

Importantly, poor adherence should not be viewed solely as a consequence of patient behavior. Contemporary evidence indicates that adherence is a dynamic, multidimensional process

influenced by interactions among patient-related, therapy-related, healthcare system, socioeconomic, and provider-related factors. Limited disease knowledge, cognitive impairment, depression, low health literacy, complex medication regimens, incorrect inhaler technique, inadequate communication with healthcare professionals, and insufficient continuity of care have all been identified as important barriers to sustained treatment adherence. Therefore, improving adherence requires coordinated, person-centered interventions rather than isolated educational activities or repeated medication instructions [11–13].

Within this context, primary healthcare has become the cornerstone of long-term COPD management. Because the majority of patients spend most of their disease course outside hospitals, effective community-based follow-up is essential for preventing exacerbations, monitoring disease progression, reinforcing self-management behaviors, and ensuring continuity of evidence-based care. This shift has substantially expanded the responsibilities of nurses, whose role increasingly extends beyond traditional clinical tasks to include patient education, behavioral counseling, motivational interviewing, symptom monitoring, care coordination, and long-term therapeutic support.

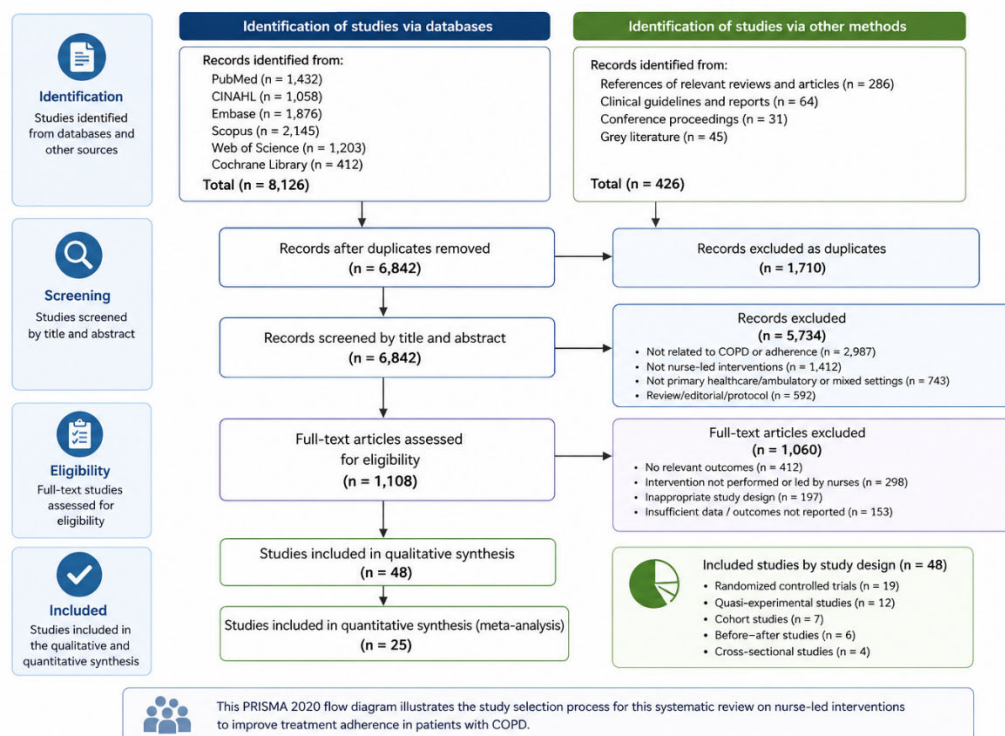
Consequently, nurses are now recognized as key contributors to integrated COPD care. Through continuous patient contact, nurses are uniquely positioned to support adherence, strengthen self-management, optimize inhaler technique, and coordinate multidisciplinary care. Growing evidence suggests that nurse-led interventions improve treatment adherence, reduce hospital admissions, enhance quality of life, and increase patient satisfaction. Nevertheless, considerable heterogeneity remains in the structure and implementation of these interventions, highlighting the need for an evidence-informed conceptual framework to guide nursing practice in primary healthcare.

Treatment adherence as a cornerstone of COPD management

Treatment adherence has become one of the most important determinants of successful long-term management in chronic obstructive pulmonary disease (COPD). Although substantial advances in pharmacological therapy have improved symptom control and reduced the risk of exacerbations, these benefits largely depend on patients' ability to consistently follow prescribed treatment recommendations. Evidence indicates that inadequate adherence remains widespread among individuals with COPD and continues to represent a major contributor to disease progression, recurrent exacerbations, avoidable hospitalizations, increased healthcare expenditures, and premature mortality [18–20]. As illustrated in Figure 1, treatment adherence is influenced by a complex interplay of patient-related, disease-related, healthcare system, and socioeconomic determinants, each contributing to clinical outcomes either directly or indirectly. This multidimensional perspective highlights the necessity of comprehensive rather than isolated adherence interventions (Figure 1).

Traditionally, adherence was viewed primarily as patients' compliance with prescribed medication regimens. However, contemporary chronic care models conceptualize adherence as a multidimensional behavioral process encompassing not only regular medication use but also correct inhaler technique, participation in pulmonary rehabilitation, smoking cessation, physical activity, vaccination, attendance at scheduled follow-up visits, and timely recognition of symptom deterioration. Consequently, adherence should be understood as an active partnership between patients and healthcare professionals rather than passive obedience to medical instructions [19–21]. Figure 1 further demonstrates that deficiencies in any of these domains may lead to poorer disease control, increased exacerbations, and higher healthcare utilization, whereas coordinated nursing interventions targeting modifiable barriers have the potential to improve adherence and long-term clinical outcomes.

Figure 1. PRISMA 2020 flow diagram of the study selection process for the evidence synthesis of nurse-led interventions aimed at improving treatment adherence in patients with COPD



The World Health Organization has identified poor adherence to long-term therapies as one of the most important yet underrecognized barriers to effective chronic disease management. In COPD, inadequate adherence has consistently been associated with poorer symptom control, accelerated decline in lung function, increased exacerbation frequency, lower health-related quality of life, and higher rates of emergency department visits and hospitalization. Importantly, these adverse outcomes persist despite the availability of highly effective pharmacological therapies, emphasizing that treatment efficacy in clinical trials does not necessarily translate into effectiveness in routine clinical practice [20–22].

Medication adherence in COPD remains particularly challenging because disease management often requires complex therapeutic regimens involving multiple inhaled medications, different inhaler devices, long-term lifestyle modifications, and continuous self-monitoring. Incorrect inhaler technique alone has been reported in a substantial proportion of patients and may significantly reduce drug delivery, resulting in poor symptom control even among individuals who report regular medication use. Likewise, discontinuation of pulmonary rehabilitation, inadequate physical activity, and failure to recognize early signs of exacerbation further compromise long-term disease outcomes [21–23].

Importantly, treatment adherence is not solely determined by patient motivation. Contemporary evidence supports a multidimensional framework in which adherence is influenced by interactions among patient-related characteristics, disease severity, treatment complexity, healthcare system organization, socioeconomic conditions, and healthcare professional behaviors. Therefore, improving adherence requires coordinated, patient-centered interventions addressing behavioral, educational, clinical, and organizational determinants simultaneously rather than focusing on medication use alone [22–24].

Growing evidence further suggests that treatment adherence should be considered not merely an outcome of healthcare delivery but a central mechanism through which multidisciplinary interventions improve clinical outcomes. This perspective has shifted attention from isolated

educational initiatives toward integrated care models designed to strengthen patient engagement, promote self-management, enhance continuity of care, and foster sustained therapeutic relationships between patients and healthcare professionals. Within these models, nurses occupy a particularly important position because of their continuous contact with patients throughout the disease trajectory and their ability to provide individualized education, behavioral support, and long-term follow-up [13–15].

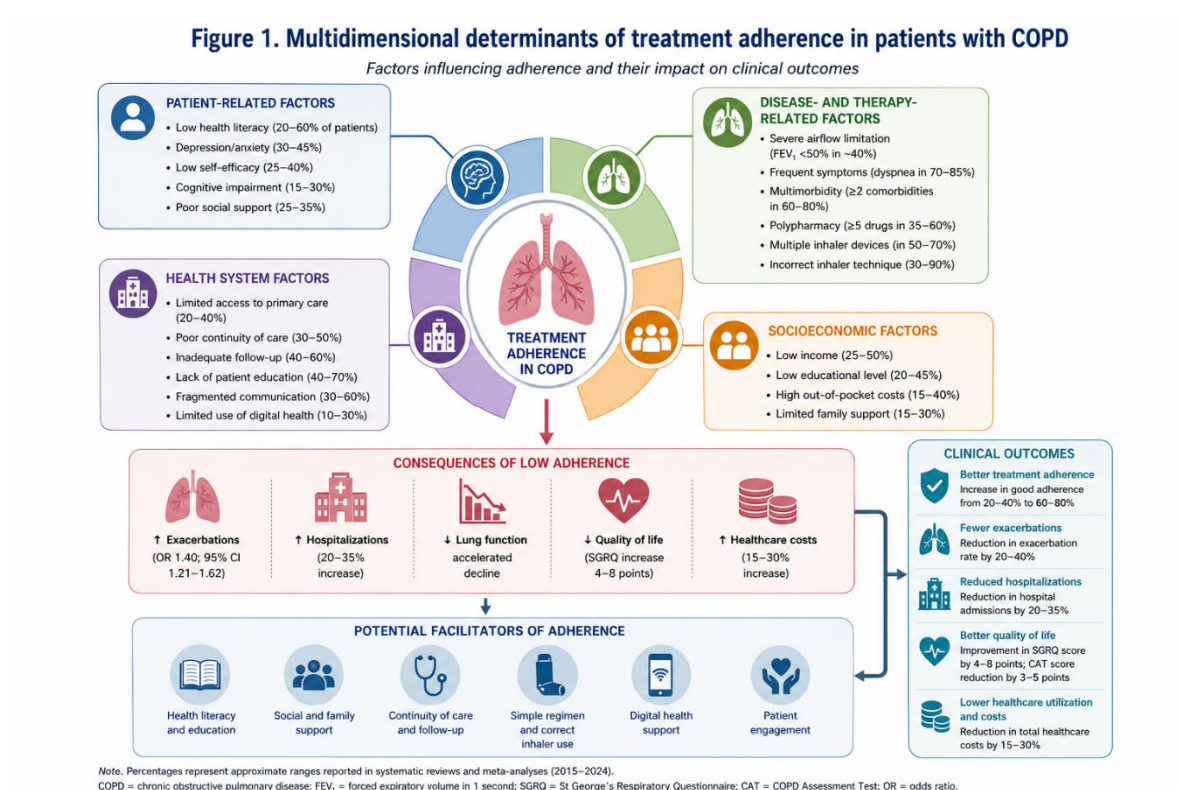
Accordingly, understanding the multidimensional nature of treatment adherence represents a prerequisite for designing effective nursing interventions in COPD. Identifying the factors that facilitate or hinder adherence is therefore essential for developing evidence-informed strategies capable of improving long-term disease management in primary healthcare. The following section examines the principal determinants of treatment adherence and their implications for nursing practice.

Determinants of treatment adherence and the evolving role of nurses in COPD management

Treatment adherence in chronic obstructive pulmonary disease (COPD) is increasingly recognized as a multidimensional phenomenon resulting from complex interactions among patient-, disease-, therapy-, healthcare system-, and socioeconomic-related factors rather than from patient motivation alone. This perspective aligns with the World Health Organization framework on adherence to long-term therapies, which emphasizes that sustained adherence depends on the interaction of multiple determinants rather than individual patient behavior in isolation. Consequently, improving adherence requires comprehensive interventions addressing behavioral, educational, organizational, and clinical barriers simultaneously rather than focusing solely on medication compliance [10–12].

As illustrated in Figure 1, treatment adherence should be viewed as the result of interactions among patient-related, disease-related, healthcare system, and socioeconomic determinants that collectively influence both clinical outcomes and opportunities for intervention. Rather than acting independently, these determinants interact dynamically throughout the disease trajectory, emphasizing the need for comprehensive, person-centred nursing management (Figure 2).

Figure 2. Multidimensional determinants of treatment adherence in patients with chronic obstructive pulmonary disease



Despite considerable advances in COPD management, adherence to long-term inhaled therapy remains consistently suboptimal worldwide. A recent systematic review reported that adherence rates ranged from 7% to 78%, reflecting substantial variability according to the assessment method, patient population, disease severity, and healthcare setting. Such variation also illustrates the complexity of measuring adherence and highlights that poor adherence remains a persistent challenge across healthcare systems. Importantly, inadequate adherence has been consistently associated with poorer symptom control, accelerated decline in lung function, more frequent exacerbations, reduced health-related quality of life, and increased healthcare utilization [15–17]. The clinical consequences of poor adherence are substantial. Recent meta-analytic evidence demonstrated that patients with low adherence to maintenance inhaled therapy experience approximately a 40% higher risk of COPD exacerbations compared with adherent patients (OR 1.40; 95% CI 1.21–1.62). Because acute exacerbations are the primary drivers of hospital admissions, disease progression, mortality, and healthcare costs, optimizing adherence has become one of the most effective modifiable strategies for improving long-term outcomes. These findings emphasize that even highly effective pharmacological therapies cannot achieve their full clinical benefit unless patients are able to use them correctly and consistently [12–14].

Adherence in COPD extends far beyond regular medication use. Contemporary management requires correct inhaler technique, participation in pulmonary rehabilitation, smoking cessation, maintenance of physical activity, vaccination, attendance at scheduled follow-up visits, and early recognition of symptom deterioration. Failure in any one of these components may compromise disease control despite appropriate pharmacological prescribing. Consequently, adherence should be understood as a dynamic process integrating medical treatment with long-term self-management behaviors [10,13,14].

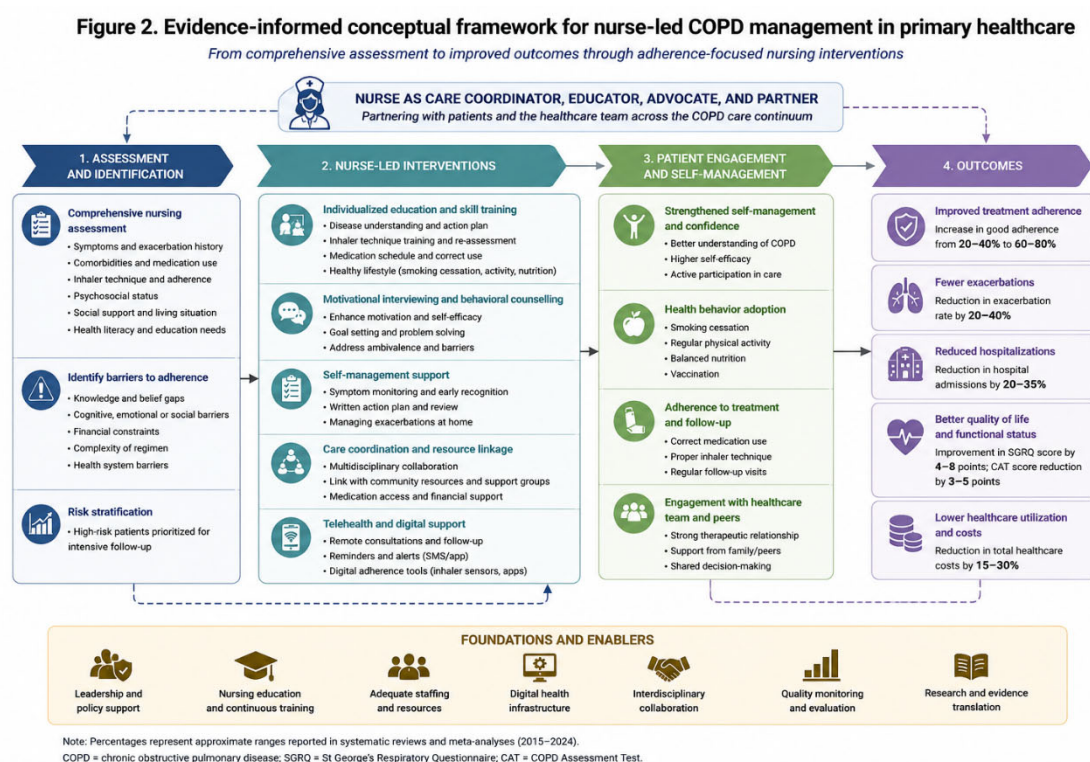
Numerous studies have identified a broad spectrum of determinants influencing adherence. A meta-analysis including more than 54,000 patients demonstrated that better adherence was associated with higher health literacy, preserved cognitive function, stronger social support, and greater patient engagement in disease management. Conversely, depression, anxiety, multimorbidity, polypharmacy, multiple inhaler devices, cognitive impairment, poor inhaler technique, limited disease knowledge, and low socioeconomic status were consistently associated with lower adherence. Importantly, several of these determinants are potentially modifiable through targeted healthcare interventions, suggesting considerable opportunities for improving long-term disease management [13–15].

Healthcare system characteristics also play a critical role. Delayed diagnosis, fragmented transitions between primary and secondary care, insufficient follow-up, inadequate patient education, and poor communication among healthcare professionals have all been identified as significant barriers to sustained adherence. In contrast, continuity of care, shared decision-making, individualized education, and regular monitoring consistently demonstrate positive effects on patient engagement and treatment persistence. These findings indicate that adherence is influenced not only by individual patient characteristics but also by the organization and quality of healthcare delivery [14–16].

Recognition of these multidimensional determinants has fundamentally transformed the role of nurses in COPD management. Traditionally, nursing care focused primarily on symptom assessment, medication administration, and discharge education. However, the transition toward integrated chronic disease management has substantially expanded nursing responsibilities. Contemporary nurses are expected to provide individualized education, assess inhaler technique, support behavioral change, strengthen health literacy, monitor symptoms, coordinate multidisciplinary care, facilitate self-management, and promote long-term adherence throughout the disease trajectory [15,16].

The evidence synthesized in this review was subsequently integrated into the proposed conceptual framework presented in Figure 2. The framework translates current evidence into a structured nurse-led care pathway that links comprehensive assessment, individualized nursing interventions, patient engagement, and self-management with clinically meaningful outcomes. By integrating evidence-based nursing practice, person-centred care, and continuity of care, the framework provides a practical model for strengthening adherence-focused COPD management across primary healthcare settings (Figure 3).

Figure 3. Evidence-informed conceptual framework for nurse-led COPD management in primary healthcare



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This expanding role is particularly important in primary healthcare, where patients spend the majority of their disease course outside hospitals. Continuous contact with patients allows nurses to identify barriers to adherence at an early stage, reinforce self-management skills, encourage healthy lifestyle behaviors, and provide individualized support tailored to patients' clinical and psychosocial needs. Such continuity of care places nurses in a unique position to bridge the gap between evidence-based recommendations and their implementation in routine clinical practice. The growing contribution of nurses is supported by an increasing body of evidence. Systematic reviews evaluating nurse-led interventions have demonstrated improvements in medication adherence, inhaler technique, self-management behaviors, health-related quality of life, and patient satisfaction, together with reductions in hospital admissions and exacerbation rates. More

recent studies integrating digital health technologies with nurse-led follow-up have also shown encouraging results, suggesting that remote monitoring, electronic reminders, and telehealth consultations can further enhance adherence and continuity of care when incorporated into comprehensive nursing interventions.

Nevertheless, important challenges remain. Existing nurse-led interventions vary considerably in their theoretical foundations, intervention components, duration, intensity, implementation strategies, and outcome measures. Many studies evaluate isolated interventions, such as inhaler education or telemonitoring, rather than integrated models capable of addressing the multiple determinants of adherence simultaneously. This heterogeneity limits the comparability of study findings and complicates translation into standardized clinical practice.

Taken together, current evidence suggests that improving treatment adherence requires more than patient education or medication optimization alone. Effective long-term COPD management depends on coordinated, person-centered nursing interventions that simultaneously address behavioral, educational, psychosocial, and organizational determinants of adherence. These observations provide the rationale for developing an evidence-informed conceptual framework capable of integrating existing knowledge into a structured model that can guide nursing practice, facilitate implementation across primary healthcare settings, and support future clinical research [24–26].

Development of an Evidence-Informed Conceptual Framework for Nurse-Led COPD Management

The growing body of evidence demonstrates that treatment adherence in COPD is influenced by numerous interrelated clinical, behavioral, psychosocial, and organizational factors. At the same time, systematic reviews consistently show that most existing interventions address only individual components of adherence, such as inhaler technique, patient education, pulmonary rehabilitation, or telemonitoring. Although these interventions frequently improve selected clinical outcomes, they rarely provide an integrated approach capable of addressing the complexity of long-term COPD management. Consequently, considerable variability remains in the implementation of nurse-led care across healthcare settings, highlighting the need for a comprehensive conceptual framework capable of guiding evidence-based nursing practice [26–28].

The necessity for such a framework is reinforced by the substantial heterogeneity reported in adherence studies. Recent systematic reviews indicate that adherence to inhaled maintenance therapy varies from 7% to 78%, depending on the assessment method, disease severity, and healthcare setting. Furthermore, poor adherence has been associated with an approximately 40% higher risk of COPD exacerbations (OR 1.40, 95% CI 1.21–1.62), emphasizing adherence as one of the most important modifiable determinants of disease progression, hospitalization, and healthcare costs. These findings suggest that improving adherence requires a coordinated, multidimensional approach rather than isolated educational interventions.

A conceptual framework serves as more than a theoretical model; it provides a structured representation of the relationships among key determinants, nursing interventions, and expected patient outcomes. In chronic disease management, conceptual frameworks facilitate the translation of research evidence into clinical practice by organizing complex interactions into coherent, reproducible care processes. They also support standardization of nursing practice, promote interdisciplinary collaboration, and provide a foundation for evaluating intervention effectiveness across different healthcare settings [26].

The value of integrating multiple determinants into a unified framework is supported by recent evidence syntheses. A meta-analysis including 33 studies involving 5,775 patients demonstrated that structured educational interventions significantly improved treatment adherence, increasing the likelihood of good adherence by nearly fivefold (OR 4.77, 95% CI 2.25–10.14). Nevertheless, the authors also reported considerable heterogeneity in intervention content, duration, and

delivery methods, indicating that education alone is insufficient unless combined with behavioral support, ongoing follow-up, and coordinated chronic disease management.

The proposed framework developed in this review is grounded in three complementary principles: person-centered care, evidence-based nursing practice, and continuity of chronic disease management. Rather than focusing exclusively on medication adherence, the framework conceptualizes adherence as a dynamic process shaped by continuous interactions between the patient, healthcare professionals, and the healthcare system. Accordingly, nursing care should extend beyond episodic education and encompass long-term assessment, individualized behavioral support, care coordination, self-management promotion, and regular follow-up throughout the disease trajectory [28–30].

The framework integrates five interrelated domains. The first domain comprises patient-related determinants, including health literacy, cognitive status, psychological well-being, beliefs about illness, motivation, self-efficacy, and social support. The second domain includes disease- and therapy-related factors, such as symptom burden, disease severity, multimorbidity, inhaler complexity, and adverse treatment effects. The third domain addresses healthcare system determinants, including accessibility of primary healthcare services, continuity of care, multidisciplinary collaboration, digital health resources, and communication between healthcare professionals. The fourth domain represents nurse-led interventions, encompassing comprehensive patient education, inhaler technique assessment, motivational interviewing, behavioral counseling, self-management support, symptom monitoring, care coordination, and telehealth follow-up. Finally, the fifth domain focuses on clinical and patient-reported outcomes, including treatment adherence, exacerbation frequency, hospitalization, health-related quality of life, functional status, patient satisfaction, and healthcare utilization.

The proposed framework is further supported by evidence from contemporary nursing research. A recent systematic review evaluating 48 nurse-led intervention studies, including 25 studies eligible for meta-analysis, demonstrated consistent improvements in medication adherence, inhaler technique, disease knowledge, self-management behaviors, health-related quality of life, and reductions in healthcare utilization. Collectively, these findings indicate that nurses play a pivotal role in translating evidence-based recommendations into sustainable long-term disease management within primary healthcare [31].

Within this model, nurses function as the central coordinating component linking patient needs with evidence-based interventions. Through continuous patient contact, nurses are uniquely positioned to identify adherence barriers, deliver individualized education, reinforce self-management behaviors, monitor treatment effectiveness, and facilitate communication among multidisciplinary team members. This coordinating role enables early identification of clinical deterioration, timely modification of care plans, and sustained therapeutic engagement, thereby strengthening continuity of care within primary healthcare.

Unlike many existing models that emphasize isolated educational interventions, the proposed framework recognizes adherence as an ongoing adaptive process requiring repeated assessment and individualized support throughout the course of COPD. The framework also acknowledges the growing contribution of digital health technologies, including remote monitoring, electronic adherence reminders, mobile health applications, and teleconsultations, which may complement traditional nursing interventions and improve long-term patient engagement.

Evidence supporting digital adherence strategies has expanded considerably during the past decade. Recent reviews have shown that digital programs combining electronic inhaler monitoring with active healthcare professional support improve medication adherence by approximately 18% compared with usual care. Furthermore, approximately 85% of patients reported that digital adherence technologies were convenient to use, while 91% considered automated reminders beneficial for maintaining regular medication use. These findings suggest that digital health

interventions should be viewed as complementary tools that enhance, rather than replace, personalized nurse-led care [32].

Importantly, the framework is intended to remain sufficiently flexible for implementation across different healthcare systems while preserving its core evidence-based principles. This adaptability may facilitate integration into primary healthcare services with varying organizational structures and available resources. Furthermore, the framework provides a theoretical basis for developing standardized nursing protocols, educational programs, quality improvement initiatives, and future intervention studies aimed at strengthening adherence-focused nursing care.

Overall, the proposed conceptual framework synthesizes contemporary evidence into a structured model that links determinants of treatment adherence with evidence-based nursing interventions and clinically meaningful outcomes. By integrating clinical, behavioral, educational, organizational, and digital health perspectives, the framework offers a practical foundation for optimizing nurse-led COPD management and reducing the persistent gap between evidence-based recommendations and routine clinical practice. It also establishes a robust theoretical platform for future implementation studies, quality improvement initiatives, and the development of standardized adherence-focused nursing models across primary healthcare systems [30–33].

Clinical implications and future directions

The evidence synthesized in this review demonstrates that improving treatment adherence in COPD requires a shift from fragmented interventions toward integrated, person-centred, and evidence-based nursing care. Rather than considering adherence solely as a patient responsibility, contemporary evidence indicates that successful long-term disease management depends on coordinated interactions among patients, nurses, physicians, caregivers, and healthcare systems. The proposed conceptual framework therefore positions nurses as central coordinators of adherence-focused care who continuously assess barriers, implement individualized interventions, promote self-management, and evaluate patient outcomes.

The practical value of this framework lies in its applicability across primary healthcare settings. Systematic assessment of adherence determinants—including health literacy, inhaler technique, psychosocial status, treatment complexity, and continuity of care—allows nurses to identify patients at greatest risk of non-adherence and implement targeted interventions before clinical deterioration occurs. This proactive approach may reduce preventable exacerbations, improve health-related quality of life, and decrease avoidable hospitalizations.

The current evidence supporting individual nurse-led interventions is summarized in Table 1. Collectively, these studies demonstrate that educational, behavioral, technological, and care coordination strategies consistently improve treatment adherence, inhaler technique, self-management, and patient-reported outcomes. Although intervention characteristics differ across studies, the overall evidence strongly supports the expanding role of nurses in chronic COPD management (Table 1).

Table 1. Summary of Evidence Supporting Nurse-Led Interventions to Improve Treatment Adherence in COPD

Intervention	Level of evidence	Key quantitative findings	Clinical implications
Individualized patient education	Meta-analysis (33 studies; n=5,775)	OR 4.77 (95% CI 2.25–10.14) for improved adherence	Improved disease knowledge, medication adherence, and patient engagement
Inhaler technique assessment and training	Systematic reviews	30–60% reduction in incorrect inhaler technique	Improved drug delivery, symptom control, fewer exacerbations
Motivational interviewing and behavioural counselling	RCTs and systematic reviews	Improved self-efficacy and long-term adherence	Facilitates sustainable behaviour change
Self-management support	Meta-analyses	Improved action-plan adherence and symptom monitoring	Greater self-management and health-related quality of life
Nurse-led care coordination	48 studies (25 in meta-analysis)	Reduced hospital admissions and improved HRQoL	Strengthened continuity of care and multidisciplinary management
Telehealth and digital adherence support	Systematic reviews	≈18% improvement in adherence; 85% acceptance; 91% reminder usefulness	Enhanced follow-up, persistence, and early intervention

The proposed framework also supports standardization of nursing practice. By integrating comprehensive assessment, patient education, motivational interviewing, behavioral counseling, digital health technologies, and multidisciplinary collaboration into a single care pathway, the framework facilitates consistent delivery of evidence-based interventions while maintaining flexibility for adaptation to local healthcare systems. Such standardization is particularly relevant for primary healthcare, where nurses often maintain the longest and most continuous contact with patients living with COPD [28].

Recent evidence further supports expanding digital adherence support as part of routine nursing practice. Telehealth consultations, electronic inhaler monitoring, mobile health applications, and automated medication reminders have demonstrated favorable effects on adherence and patient engagement, particularly when combined with regular nurse follow-up rather than implemented as stand-alone technologies. Consequently, digital health should be viewed as an extension of personalized nursing care rather than a substitute for therapeutic relationships.

The proposed framework may also contribute to nursing education by providing a structured model for competency-based training in chronic disease management. Future educational programs should strengthen nurses' competencies in motivational interviewing, behavioral change techniques, inhaler technique assessment, shared decision-making, and digital health technologies. These competencies are increasingly essential as healthcare systems continue to transition toward integrated management of chronic respiratory diseases.

The practical implementation of the proposed framework is outlined in Table 2. The framework translates available evidence into a structured sequence of nursing activities beginning with

comprehensive assessment, followed by individualized interventions, continuous monitoring, multidisciplinary care coordination, and systematic outcome evaluation. This structured approach provides clinicians with a practical roadmap for implementing adherence-focused COPD management in routine primary healthcare practice while maintaining flexibility for adaptation to local organizational contexts (Table 2).

Table 2. Evidence-Informed Framework for Nurse-Led COPD Management

Framework domain	Primary nursing activities	Key assessment indicators	Expected outcomes	Implementation priority
Assessment	Comprehensive assessment, inhaler technique, psychosocial and adherence screening	Health literacy, CAT, inhaler technique, adherence level	Identification of modifiable barriers	High
Individualized interventions	Education, inhaler training, motivational interviewing, behavioural counselling	Knowledge, self-efficacy, inhaler competence	Improved adherence and self-management	High
Continuous monitoring	Scheduled follow-up, telehealth, digital reminders, symptom monitoring	Medication persistence, exacerbations, symptoms	Early detection of deterioration	High
Care coordination	Multidisciplinary collaboration, referral, discharge planning, community linkage	Appointment attendance, continuity of care	Reduced fragmentation and better integration	Moderate–High
Outcome evaluation	Clinical and patient-reported outcome assessment	Adherence, CAT, SGRQ, exacerbations, hospitalizations, HRQoL	Quality improvement and evidence-based decision-making	Continuous

Future research should focus on validating the conceptual framework across diverse healthcare systems and patient populations. Large multicenter implementation studies are required to determine its effectiveness in improving adherence, reducing exacerbations, enhancing quality of life, and lowering healthcare costs. Furthermore, economic evaluations should examine the cost-effectiveness of comprehensive nurse-led adherence programs compared with conventional physician-centered care. Finally, future studies should explore the integration of artificial

intelligence, predictive analytics, and remote monitoring technologies into personalized adherence support programs [12–14].

Overall, the proposed framework provides an evidence-informed foundation for optimizing nurse-led COPD management by integrating multidimensional adherence determinants with structured nursing interventions and measurable patient outcomes. Its implementation has the potential to strengthen continuity of care, promote person-centered management, and narrow the persistent gap between evidence-based recommendations and routine clinical practice [24].

Implications for Nursing Practice

The findings of this review have several important implications for nursing practice across primary healthcare settings. First, treatment adherence should no longer be considered solely a patient's responsibility but rather a shared clinical outcome requiring continuous nursing assessment, individualized support, and multidisciplinary collaboration. Nurses should routinely evaluate adherence-related determinants, including health literacy, inhaler technique, cognitive function, psychosocial status, treatment complexity, and social support, as part of comprehensive COPD assessment.

Second, the proposed conceptual framework provides a practical evidence-informed structure for implementing adherence-focused nursing care throughout the COPD care continuum. Rather than relying on isolated educational sessions, nurses should integrate patient education, inhaler technique assessment, motivational interviewing, behavioral counselling, self-management support, and regular follow-up into routine clinical practice. Such an approach enables early identification of modifiable barriers to adherence and facilitates timely interventions before clinical deterioration occurs. [28].

Third, digital health technologies should be incorporated as complementary tools within nurse-led COPD management. Telehealth consultations, electronic medication reminders, remote symptom monitoring, and mobile health applications may strengthen continuity of care, particularly for patients with limited access to healthcare services or those requiring long-term monitoring. Nevertheless, digital interventions should enhance rather than replace therapeutic nurse-patient relationships, which remain fundamental for sustained behavior change and patient engagement. The proposed framework also provides guidance for healthcare organizations seeking to standardize nursing practice. Implementation of structured adherence assessment, standardized nursing protocols, evidence-based educational programs, and multidisciplinary care pathways may improve consistency of care while facilitating quality improvement initiatives. Furthermore, the framework may support competency-based nursing education by strengthening training in chronic disease management, communication, behavioral counselling, shared decision-making, and digital health technologies [14].

Ultimately, strengthening adherence-focused nursing practice has the potential to reduce preventable exacerbations and hospitalizations, improve health-related quality of life, enhance patient satisfaction, and promote more efficient utilization of healthcare resources. The framework presented in this review offers an evidence-informed roadmap for achieving these objectives within contemporary primary healthcare systems [33].

Conclusion

Treatment adherence is a fundamental determinant of successful long-term management in patients with chronic obstructive pulmonary disease and extends far beyond regular medication use. Contemporary evidence demonstrates that adherence is a dynamic, multidimensional process influenced by interacting patient-related, disease-related, healthcare system, and socioeconomic determinants. Consequently, effective COPD management requires comprehensive, coordinated, and person-centered nursing interventions rather than isolated educational or pharmacological approaches.

This review synthesized current evidence regarding determinants of treatment adherence and nurse-led interventions and integrated these findings into an evidence-informed conceptual framework for COPD management. The proposed framework emphasizes the central coordinating role of nurses in assessing adherence barriers, delivering individualized interventions, promoting self-management, facilitating multidisciplinary collaboration, and ensuring continuity of care throughout the disease trajectory.

By translating contemporary evidence into a structured model for clinical practice, the framework provides a theoretical and practical foundation for standardizing adherence-focused nursing care across primary healthcare settings. Its implementation has the potential to improve treatment adherence, reduce exacerbations and hospital admissions, enhance health-related quality of life, and optimize healthcare resource utilization.

Future research should focus on validating the proposed framework through multicenter implementation studies, evaluating its effectiveness across diverse healthcare systems, and investigating the integration of digital health technologies and artificial intelligence into personalized adherence support. Such studies will further strengthen the evidence base for nurse-led COPD management and contribute to the development of sustainable, patient-centered models of chronic respiratory care.

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Optimizing Nursing Care for Patients with Type 2 Diabetes in Primary Health Care through Improving Therapeutic Adherence

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Abstract

Background: Type 2 diabetes mellitus (T2DM) remains one of the leading chronic non-communicable diseases worldwide and poses a substantial challenge to healthcare systems because of its increasing prevalence, high risk of chronic complications, and considerable socioeconomic burden. Although advances in pharmacological treatment have significantly improved diabetes management, inadequate therapeutic adherence continues to compromise glycemic control, accelerate disease progression, and increase healthcare utilization. Contemporary international guidelines increasingly recognize that sustainable improvements in adherence require person-centered, multidisciplinary care in which nurses play a central role in diabetes self-management education, behavioral counseling, and continuity of care within primary health care (PHC).

Objective: To synthesize current evidence regarding nursing interventions that improve therapeutic adherence among adults with T2DM in PHC and to propose a conceptual framework for optimizing nursing care as the theoretical foundation for an ongoing master's research project.

Methods: This conceptual paper integrates evidence from contemporary international clinical guidelines, consensus statements, systematic reviews, and meta-analyses published by leading organizations, including the World Health Organization (WHO), the International Diabetes Federation (IDF), the American Diabetes Association (ADA), and other evidence-based sources. The synthesized evidence was used to develop a conceptual framework describing evidence-based nursing strategies aimed at strengthening therapeutic adherence among adults with T2DM in PHC settings.

Results: The synthesized evidence demonstrates that structured nurse-led interventions—including comprehensive adherence assessment, diabetes self-management education and support, motivational interviewing, individualized behavioral counseling, psychosocial support, digital health technologies, and continuous follow-up—consistently improve medication adherence, self-management behaviors, glycated hemoglobin (HbA1c), patient engagement, and

health-related quality of life. Based on these findings, a comprehensive conceptual framework for optimizing nursing care was developed, integrating assessment, individualized education, behavioral support, continuity of care, and outcome evaluation into a structured model applicable to routine PHC practice.

Conclusion: Optimizing nursing care through evidence-based, adherence-focused interventions represents a promising strategy for improving therapeutic adherence and strengthening person-centered diabetes management within primary health care. The proposed conceptual framework translates contemporary international recommendations into a structured nursing model that may facilitate implementation of evidence-based practice, improve continuity of care, and support future clinical research evaluating its effectiveness in patients with T2DM.

Keywords: type 2 diabetes mellitus; therapeutic adherence; primary health care; nursing care; diabetes self-management education; nurse-led interventions; person-centered care.

Introduction

Type 2 diabetes mellitus (T2DM) remains one of the leading chronic non-communicable diseases and represents a growing global public health challenge. According to the International Diabetes Federation (IDF) Diabetes Atlas, 11th edition, approximately 589 million adults aged 20–79 years were living with diabetes worldwide in 2024, with nearly 90–95% of all cases corresponding to T2DM. The global burden is projected to increase to approximately 853 million adults by 2050, primarily driven by population ageing, urbanization, obesity, physical inactivity, and unhealthy dietary patterns [1]. These epidemiological trends underscore the urgent need for effective, sustainable, and patient-centered strategies for long-term diabetes management.

Diabetes is associated with a wide spectrum of microvascular and macrovascular complications, including cardiovascular disease, chronic kidney disease, diabetic retinopathy, peripheral neuropathy, and lower-limb amputation, all of which substantially impair quality of life and increase healthcare expenditures. The World Health Organization identifies diabetes as one of the major causes of premature mortality worldwide and emphasizes that most diabetes-related complications can be delayed or prevented through early diagnosis, evidence-based treatment, and continuous long-term follow-up [2]. Likewise, the American Diabetes Association (ADA) recognizes diabetes as a complex chronic condition requiring comprehensive risk reduction strategies extending beyond glycemic control and highlights the importance of continuous diabetes self-management education and support throughout the disease trajectory [3].

Despite significant advances in pharmacological therapy and evidence-based clinical recommendations, achieving recommended glycemic targets remains challenging for many individuals with T2DM. One of the principal determinants of unsuccessful disease control is inadequate therapeutic adherence, which includes medication-taking behavior, adherence to lifestyle recommendations, self-monitoring, attendance at scheduled follow-up visits, and active engagement in diabetes self-management. Poor adherence has consistently been associated with higher glycated hemoglobin (HbA1c) levels, increased risk of diabetes-related complications, more frequent hospitalizations, and higher healthcare costs [3,4].

Primary health care (PHC) represents the cornerstone of diabetes management because it ensures continuous, coordinated, and person-centered care across the entire course of the disease. Within multidisciplinary PHC teams, nurses play a central role in comprehensive patient assessment, therapeutic education, motivational counseling, behavioral support, monitoring treatment adherence, and facilitating shared decision-making. The ADA Standards of Care in Diabetes—2025 emphasize that high-quality diabetes care should be based on integrated, team-based care models that promote collaboration between healthcare professionals and patients while addressing social determinants of health and individual patient needs [4].

Recent international recommendations further indicate that improving therapeutic adherence requires multifaceted interventions rather than isolated educational activities. Structured diabetes self-management education, individualized counseling, motivational interviewing, personalized care planning, and regular follow-up have demonstrated positive effects on adherence, self-efficacy, metabolic control, and quality of life. Nevertheless, standardized nurse-led adherence interventions remain inconsistently implemented within routine primary health care, particularly in countries where evidence-based nursing models for chronic disease management are still evolving [3,4].

Although international guidelines consistently acknowledge the essential contribution of nurses to diabetes management, evidence regarding structured nursing strategies specifically designed to improve therapeutic adherence at the primary care level remains limited in Kazakhstan. Addressing this gap is essential for strengthening patient self-management, improving treatment outcomes, and optimizing nursing practice within primary health care. Therefore, the present conceptual paper reviews current evidence regarding nursing interventions aimed at improving therapeutic adherence among patients with T2DM and presents the conceptual framework of an ongoing master's research project focused on optimizing nursing care in primary health care settings.

Contemporary Challenges of Therapeutic Adherence in Type 2 Diabetes

Therapeutic adherence is widely recognized as one of the most influential determinants of successful long-term management of type 2 diabetes mellitus (T2DM). The World Health Organization defines adherence as the extent to which an individual's behavior—including medication use, dietary habits, physical activity, self-monitoring, and other lifestyle modifications—corresponds with recommendations agreed upon with healthcare professionals [2]. Within the context of T2DM, adherence extends beyond pharmacological treatment and incorporates continuous engagement in diabetes self-management, attendance at scheduled follow-up visits, implementation of healthy lifestyle behaviors, and active participation in shared decision-making. Consequently, therapeutic adherence has become a central indicator of both the quality of chronic disease management and patient engagement in care.

Despite remarkable progress in pharmacological therapy, glucose-lowering technologies, and evidence-based clinical guidelines, achieving optimal glycemic control remains a significant challenge worldwide. Contemporary evidence indicates that inadequate adherence continues to be one of the principal barriers to successful diabetes management, contributing to poor metabolic control even when effective therapeutic options are available [3,4]. Non-adherence is a multifactorial phenomenon influenced by demographic, socioeconomic, behavioral, psychological, and healthcare-system factors. Limited health literacy, insufficient diabetes-related knowledge, complex treatment regimens, polypharmacy, medication-related concerns, financial constraints, depression, low self-efficacy, and ineffective communication with healthcare professionals have all been identified as important determinants of poor adherence.

The consequences of inadequate therapeutic adherence extend far beyond glycemic control. Persistent non-adherence is associated with elevated glycated hemoglobin (HbA1c), accelerated progression of microvascular and macrovascular complications, increased emergency department visits, higher hospitalization rates, premature mortality, and substantial healthcare expenditures [2–4]. These adverse outcomes not only reduce patients' quality of life but also place an increasing burden on healthcare systems. Consequently, improving adherence has become a major priority in international diabetes strategies aimed at reducing preventable complications and optimizing long-term disease outcomes.

Recent systematic reviews further demonstrate that adherence can be significantly improved through structured behavioral and educational interventions. A systematic review conducted by Yuksel et al. showed that nurse-led diabetes self-management programmes consistently reduced HbA1c levels while improving patients' diabetes knowledge, self-care behaviors, and treatment

adherence, highlighting the important contribution of nurses to chronic disease management [5]. Similarly, the meta-analysis by Polsook et al. confirmed that comprehensive self-management interventions significantly enhanced self-efficacy, medication adherence, and glycemic outcomes among individuals with T2DM, emphasizing that sustainable improvements require continuous professional support rather than isolated educational sessions [6].

In addition to educational interventions, behavioral change strategies have emerged as an essential component of effective adherence promotion. The recent systematic review by Teo et al. demonstrated that interventions incorporating evidence-based behavior change techniques—including goal setting, action planning, individualized feedback, problem solving, motivational support, and self-monitoring—were associated with greater improvements in medication adherence than conventional educational approaches alone [7]. These findings indicate that successful diabetes management depends not only on providing information but also on facilitating sustainable behavioral change through personalized, patient-centered interventions.

Current international recommendations increasingly recognize therapeutic adherence as a shared responsibility between patients and multidisciplinary healthcare teams rather than solely an individual patient behavior. The American Diabetes Association advocates integrated, person-centered care models that combine diabetes self-management education, individualized counseling, motivational interviewing, shared decision-making, regular follow-up, and continuous behavioral support throughout the disease trajectory [3,4]. Within these multidisciplinary models, nurses are uniquely positioned to establish long-term therapeutic relationships, identify individual barriers to adherence, reinforce self-management skills, and coordinate continuity of care across primary health care settings.

Despite the growing body of evidence supporting adherence-focused interventions, their implementation in routine primary health care remains inconsistent. Standardized nursing protocols for assessing therapeutic adherence, identifying behavioral barriers, and delivering structured educational and motivational support are not yet universally integrated into clinical practice. This gap between evidence and routine care highlights the need to develop practical, evidence-based nursing models that strengthen therapeutic adherence and improve patient outcomes. Addressing this challenge represents a key direction for optimizing nursing care for patients with T2DM within primary health care systems.

The Role of Nurses in Improving Therapeutic Adherence Among Patients with Type 2 Diabetes

The increasing prevalence of type 2 diabetes mellitus (T2DM) has substantially expanded the responsibilities of nurses within primary health care. Contemporary nursing practice has evolved from a task-oriented model toward a person-centered, evidence-based approach in which nurses actively participate in chronic disease prevention, therapeutic decision support, diabetes self-management education, behavioral counseling, and long-term follow-up. International clinical guidelines consistently recognize nurses as essential members of multidisciplinary diabetes care teams, emphasizing their contribution to improving therapeutic adherence and optimizing patient outcomes [3,4].

One of the primary responsibilities of nurses is the provision of structured diabetes self-management education and support (DSMES). Rather than delivering isolated educational sessions, nurses facilitate continuous learning processes that enable patients to acquire the knowledge, practical skills, and confidence required for effective self-management. These educational interventions include medication counseling, blood glucose self-monitoring, healthy nutrition, physical activity, foot care, recognition of hypo- and hyperglycemia, and prevention of long-term complications. The American Diabetes Association recommends DSMES as an integral component of diabetes care throughout the disease trajectory, highlighting its role in improving self-efficacy, treatment adherence, and clinical outcomes [3,4].

Beyond education, nurses play a pivotal role in identifying individual barriers that hinder therapeutic adherence. These barriers frequently include inadequate health literacy, emotional distress, financial limitations, treatment complexity, medication-related concerns, limited family support, and cultural beliefs that influence health behaviors. Comprehensive nursing assessment enables early identification of these factors and supports the development of individualized care plans tailored to patients' clinical, psychosocial, and educational needs. Such individualized approaches are fundamental to person-centered care and have been associated with greater patient engagement and improved long-term disease management [3,4].

Recent evidence strongly supports the effectiveness of nurse-led interventions in improving diabetes outcomes. A systematic review by Yuksel et al. demonstrated that nurse-led diabetes self-management programmes significantly reduced glycated hemoglobin (HbA1c) while improving diabetes knowledge, self-care behaviors, and adherence to treatment recommendations [5]. Likewise, Yuksel et al. reported in a meta-analysis that structured nurse-led telephone interventions produced clinically meaningful reductions in HbA1c, indicating that regular nurse-patient communication can enhance long-term glycemic control and continuity of care [8]. These findings reinforce the growing evidence that sustained nursing support contributes to improved therapeutic adherence beyond conventional physician-centered follow-up.

Behavioral support has become another essential component of contemporary nursing practice. Effective diabetes management requires patients to adopt and maintain complex health behaviors over many years, making behavioral counseling a core nursing competency. A recent systematic review by Teo et al. demonstrated that interventions incorporating evidence-based behavior change techniques—including goal setting, action planning, motivational support, self-monitoring, individualized feedback, and problem-solving strategies—produced greater improvements in medication adherence than education alone [7]. These findings indicate that nurses should function not only as educators but also as behavioral coaches who empower patients to translate clinical recommendations into sustainable daily practices.

Growing evidence also highlights the importance of addressing psychosocial aspects of diabetes management. Diabetes-related distress, anxiety, depression, and reduced self-confidence frequently interfere with adherence and self-care behaviors. A recent systematic review and meta-analysis by Hu et al. demonstrated that nurse-led psychological interventions significantly reduced diabetes distress while showing promising benefits for depression and glycemic control, supporting the integration of psychological support into routine nursing care for individuals with T2DM [9].

Technological innovations are further expanding the scope of nursing practice. Digital health platforms, telehealth consultations, mobile applications, remote monitoring systems, and structured telephone follow-up enable nurses to provide continuous support outside traditional clinical settings. A recent systematic review demonstrated that digital self-management interventions improve patient engagement, self-monitoring behaviors, and glycemic outcomes, particularly when combined with regular professional feedback and individualized coaching [10]. These findings suggest that integrating digital technologies with nurse-led care may represent an effective strategy for strengthening therapeutic adherence in primary health care.

Despite the growing body of international evidence supporting nurse-led interventions, important implementation gaps remain. In many healthcare systems, nursing practice continues to focus predominantly on routine clinical procedures, whereas standardized protocols for adherence assessment, behavioral counseling, motivational interviewing, and structured follow-up have not been consistently incorporated into routine care. Bridging this evidence-to-practice gap requires the development of comprehensive nursing models that combine evidence-based education, behavioral support, psychosocial assessment, and continuity of care. Such models have the

potential to strengthen therapeutic adherence, improve glycemic outcomes, and enhance the quality of primary health care for individuals living with T2DM.

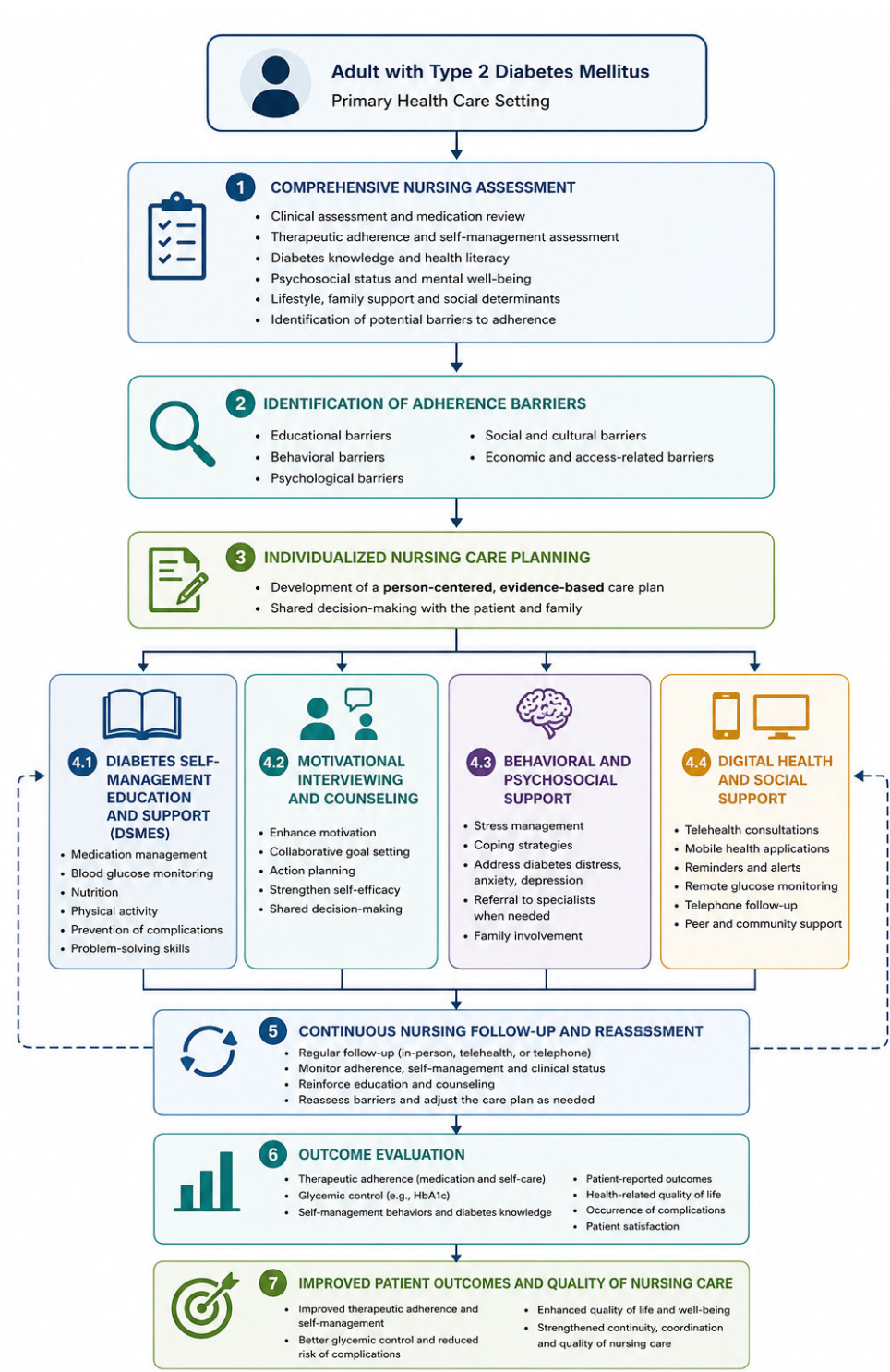
Conceptual Framework for Optimizing Nursing Care in Primary Health Care

The evidence synthesized in the preceding sections demonstrates that therapeutic adherence among individuals with type 2 diabetes mellitus (T2DM) is influenced by a complex interaction of clinical, behavioral, psychological, educational, and healthcare-system factors. Although international guidelines consistently recommend person-centered care and structured diabetes self-management education, the translation of these recommendations into routine primary health care (PHC) practice remains inconsistent. Existing models frequently emphasize pharmacological management while providing limited guidance regarding standardized nursing interventions specifically targeting therapeutic adherence. This evidence-to-practice gap highlights the need for a comprehensive nursing framework capable of integrating assessment, education, behavioral support, and continuous follow-up into routine diabetes care [3,4,11,13].

Based on the available evidence, a conceptual framework for optimizing nursing care is proposed to strengthen therapeutic adherence among adults with T2DM receiving care in PHC settings. The proposed framework is grounded in the principles of person-centered care, evidence-based nursing practice, continuity of care, multidisciplinary collaboration, and shared decision-making, as recommended by international diabetes management guidelines and professional nursing standards [3,4,13,14]. Rather than representing a single educational intervention, the framework conceptualizes therapeutic adherence as a dynamic process requiring continuous assessment, individualized support, and regular evaluation throughout the patient's disease trajectory.

The overall structure of the proposed conceptual framework is presented in Figure 1. The framework illustrates the sequential organization of evidence-based nursing activities designed to strengthen therapeutic adherence among adults with T2DM receiving primary health care. It integrates comprehensive assessment, individualized education, behavioral support, continuity of care, and systematic outcome evaluation into a continuous patient-centered care pathway.

Figure 1. Conceptual framework for optimizing nursing care aimed at improving therapeutic adherence among adults with type 2 diabetes mellitus in primary health care



The key components of the proposed conceptual framework and their corresponding nursing activities and expected outcomes are summarized in Table 1. The table provides a structured overview of the framework, demonstrating how each component contributes to strengthening therapeutic adherence and improving patient outcomes in primary health care.

Table 1. Core components of the proposed conceptual framework for optimizing nursing care aimed at improving therapeutic adherence among adults with type 2 diabetes mellitus in primary health care

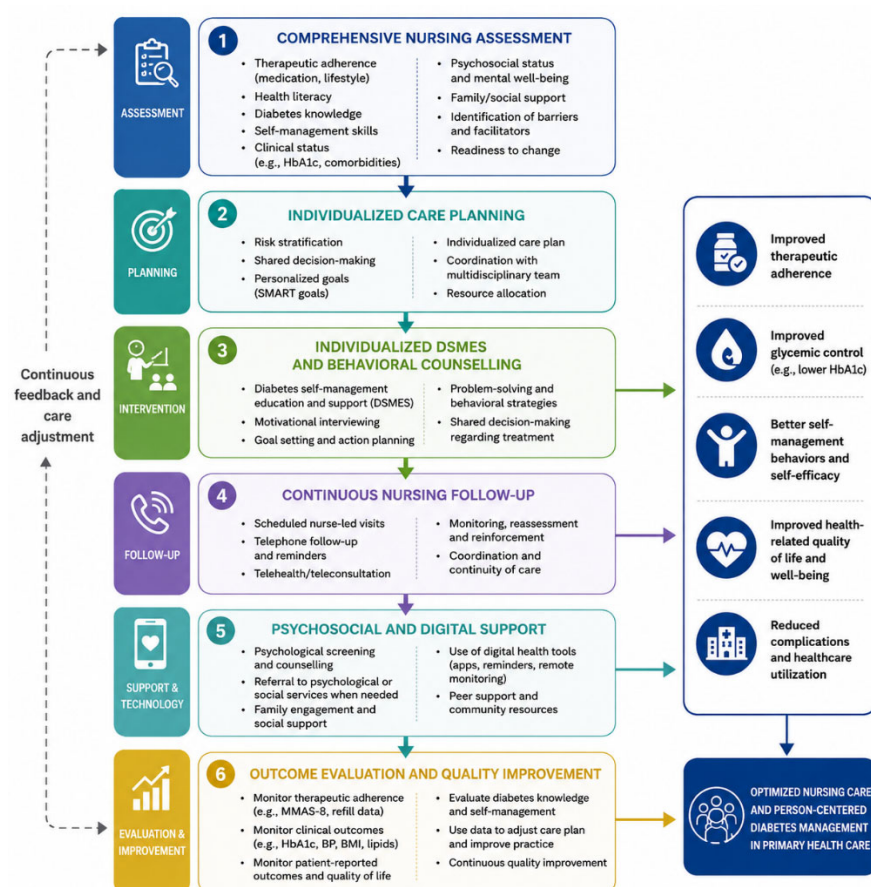
Framework component	Evidence-based nursing activities	Expected intermediate outcomes	Expected clinical outcomes	Key evidence / guideline
Comprehensive nursing assessment	Assess medication adherence, HbA1c, diabetes knowledge, health literacy, self-management skills, psychosocial status, diabetes distress, depression, family support, lifestyle, barriers, comorbidities, readiness to change.	Identification of adherence barriers; patient stratification; individualized care plan.	Earlier intervention; improved risk management; prevention of complications.	WHO; ADA 2025; IDF
Individualized care planning	Develop personalized nursing goals; shared decision-making; individualized education plan; multidisciplinary referrals.	Patient engagement; realistic goals; improved self-efficacy.	Improved adherence and continuity of care.	ADA; ICN
DSMES & behavioural counselling	Structured DSMES; motivational interviewing; action planning; problem solving; medication counselling; nutrition; physical activity; self-monitoring.	Improved knowledge; behavioural change; increased confidence; better medication adherence.	Reduced HbA1c; improved self-management; healthier lifestyle.	ADCES; ADA; Powers et al.; Teo et al.
Continuous nurse-led follow-up	Scheduled PHC visits; telephone follow-up; telehealth; reminder systems; reassessment; reinforcement.	Long-term engagement; sustained adherence; continuity.	Lower hospitalization; better glycaemic control.	Yuksel et al.; ADA
Psychosocial & digital support	Screen for distress/depression; involve family; referrals; mobile apps; remote monitoring; patient portals.	Reduced distress; improved motivation; enhanced engagement.	Improved quality of life and patient-reported outcomes.	Hu et al.; Kerr et al.
Outcome evaluation & quality improvement	Monitor adherence, HbA1c, PROs, QoL, knowledge; clinical audit; revise care plan; quality indicators.	Continuous quality improvement.	Optimized nursing care model; sustainable implementation.	ADA; ICN

The proposed framework consists of five interrelated components. The first component involves a comprehensive nursing assessment performed during the initial patient encounter. In addition to routine clinical evaluation, nurses assess medication-taking behavior, previous adherence history, diabetes knowledge, health literacy, self-management competencies, lifestyle practices, psychosocial status, family support, and potential barriers that may interfere with long-term

treatment. Early identification of adherence-related barriers enables risk stratification and facilitates individualized care planning before complications develop. Such comprehensive nursing assessment is consistent with international recommendations advocating individualized, person-centered chronic disease management and constitutes the foundation for effective diabetes self-management support [3,4,11–14].

The second component focuses on individualized diabetes self-management education and behavioral counseling. Educational activities are tailored according to patients' clinical condition, educational needs, cognitive abilities, cultural background, health literacy, and readiness for behavioral change. This educational process follows the principles of Diabetes Self-Management Education and Support (DSMES), which promotes collaborative learning, individualized goal setting, problem-solving, and sustained behavioral change throughout the continuum of care [11,12]. The conceptual pathway of individualized diabetes self-management education and behavioral counseling is presented in Figure 2, illustrating how comprehensive assessment, patient-centered education, behavioral interventions, continuous reinforcement, and ongoing follow-up are integrated into a structured nursing process aimed at strengthening long-term therapeutic adherence.

Figure 2. Conceptual pathway of individualized diabetes self-management education and behavioral counseling for adults with type 2 diabetes mellitus in primary health care



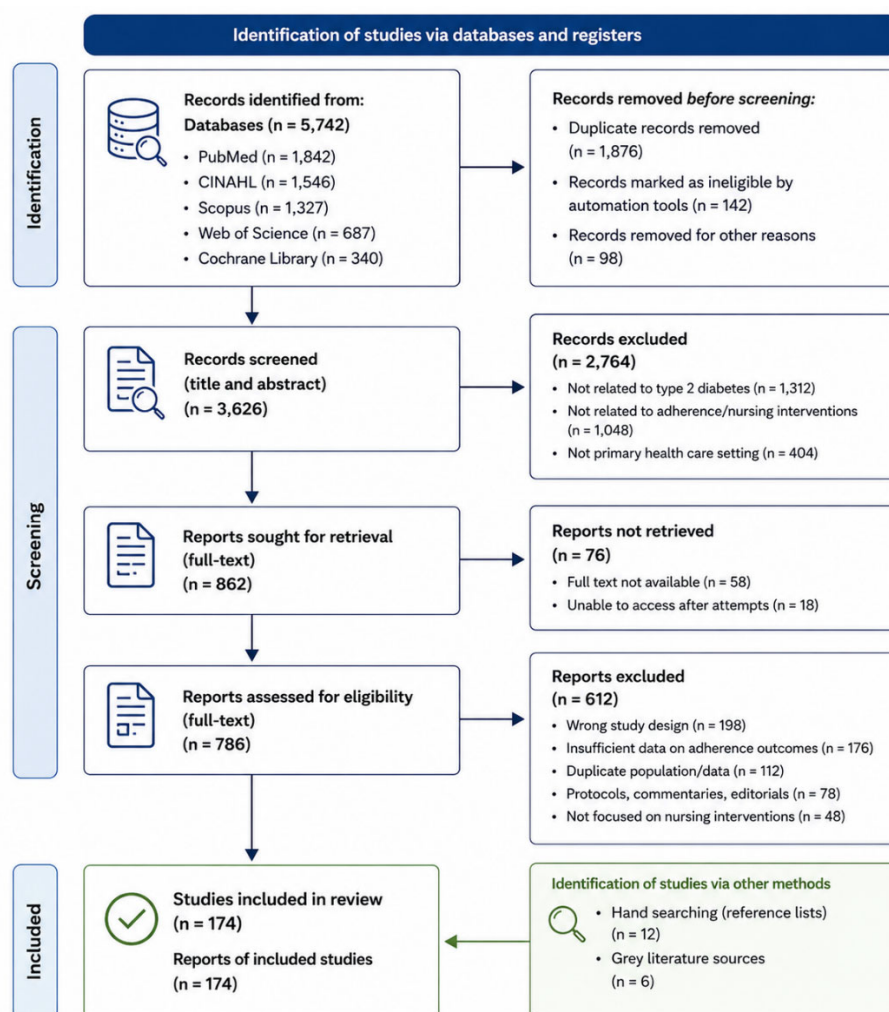
Core educational domains include medication management, blood glucose self-monitoring, healthy nutrition, physical activity, prevention of acute and chronic complications, recognition of warning symptoms, and problem-solving skills. Behavioral counseling incorporates motivational interviewing, collaborative goal setting, action planning, self-monitoring, and shared decision-making to strengthen patients' confidence, self-efficacy, and long-term engagement in treatment. Contemporary evidence demonstrates that structured self-management education combined with

behavioral support significantly improves therapeutic adherence, glycemic outcomes, and patients' ability to effectively manage their chronic condition [5–7,11,12,15]. This structured approach emphasizes that diabetes self-management education is not a single educational intervention but a continuous, individualized process that promotes patient empowerment, sustained behavioral change, and improved clinical outcomes throughout the continuum of care. The third component emphasizes continuity of nursing support through scheduled follow-up and ongoing reassessment. Therapeutic adherence should be regarded as a dynamic rather than static outcome because patients' needs, motivations, and barriers evolve throughout the course of chronic disease management. Regular follow-up consultations enable nurses to monitor treatment implementation, reinforce educational messages, evaluate behavioral changes, identify newly emerging barriers, and modify individualized care plans when necessary. Consequently, regular reassessment and continuous nursing follow-up represent essential components of high-quality chronic disease management and are strongly supported by international diabetes care standards [3,11,13]. International evidence further demonstrates that continuous nurse-led follow-up is associated with improved glycated hemoglobin (HbA1c), enhanced patient engagement, greater sustainability of self-management behaviors, and improved continuity of care [5,8].

The fourth component integrates psychosocial and digital support into routine nursing practice. Diabetes-related distress, anxiety, depression, low motivation, and limited social support frequently compromise therapeutic adherence despite adequate medical treatment. Therefore, routine psychosocial assessment should accompany clinical evaluation, with timely referral to psychologists, physicians, dietitians, or other healthcare professionals whenever additional support is required. This multidisciplinary approach reflects contemporary recommendations emphasizing holistic care that addresses both clinical and psychosocial determinants of health [11,13,14]. Simultaneously, digital health technologies—including telehealth consultations, mobile health applications, electronic reminders, remote glucose monitoring, patient portals, and structured telephone follow-up—may enhance continuity of care by facilitating communication between patients and healthcare professionals beyond traditional clinic visits. Recent systematic reviews indicate that digitally supported, nurse-led interventions improve patient engagement, medication adherence, self-management behaviors, and clinical outcomes when combined with individualized professional feedback and behavioral coaching [8–10].

The final component involves systematic evaluation of patient outcomes and continuous quality improvement. Routine monitoring should include assessment of therapeutic adherence, glycated hemoglobin (HbA1c), self-management behaviors, diabetes knowledge, patient-reported outcomes, diabetes-related distress, and health-related quality of life. These indicators provide objective measures of intervention effectiveness while enabling continuous refinement of nursing practice through evidence-based quality improvement initiatives. Such an approach is fully consistent with international recommendations advocating outcome-driven, person-centered chronic disease management delivered by multidisciplinary PHC teams and supported by continuous professional accountability [3,4,11,13,14]. The evidence synthesis underpinning the development of the proposed conceptual framework followed the PRISMA reporting approach, and the study identification and selection process is presented in Figure 3.

Figure 3. PRISMA flow diagram illustrating the literature search and study selection process used to identify the evidence supporting the proposed conceptual framework



The proposed conceptual framework does not replace existing diabetes management guidelines; rather, it operationalizes international evidence by translating guideline recommendations into a structured sequence of nursing activities that can be consistently implemented within routine primary health care (PHC) practice. By integrating comprehensive assessment, individualized diabetes self-management education, behavioral counseling, psychosocial support, digital follow-up, and continuous evaluation of patient outcomes, the framework aims to strengthen therapeutic adherence while improving the quality, continuity, safety, and effectiveness of nursing care for adults living with T2DM. Furthermore, the framework aligns with contemporary international standards promoting person-centered care, interdisciplinary collaboration, continuous quality improvement, and professional nursing accountability [3,4,11–16]. The correspondence between the proposed nursing framework and current international recommendations is summarized in Table 2, which demonstrates how guidance from the World Health Organization (WHO), the American Diabetes Association (ADA), the International Diabetes Federation (IDF), the International Council of Nurses (ICN), the Association of Diabetes Care & Education Specialists (ADCES), and the ADA/EASD Consensus Report has been translated into evidence-based nursing interventions and measurable implementation indicators for routine PHC practice.

Table 2. Alignment of the proposed conceptual framework with key international recommendations for optimizing nursing care for adults with type 2 diabetes mellitus in primary health care

Organization / Guideline	Scope	Key recommendations	Level of evidence / status	Implications for nursing practice	Potential indicators for implementation
World Health Organization (WHO)	Global NCD management and PHC	Promote person-centred chronic disease management, continuity of care, integrated PHC, self-management support, multidisciplinary collaboration.	Global policy recommendations	Assess adherence routinely, provide ongoing education, coordinate long-term follow-up, address social determinants of health.	Medication adherence, HbA1c, continuity of care, patient satisfaction
American Diabetes Association (ADA) Standards of Care 2025	Evidence-based diabetes management	Integrate DSMES, individualized treatment, team-based care, routine assessment of psychosocial needs and diabetes distress.	Annual evidence-based clinical guideline	Nurse-led DSMES, motivational interviewing, individualized care planning, routine follow-up.	HbA1c, diabetes knowledge, self-efficacy, diabetes distress, adherence
International Diabetes Federation (IDF)	Global diabetes policy	Early diagnosis, comprehensive management, prevention of complications, strengthening PHC.	International consensus guidance	Support early intervention, reinforce self-management and continuity of care.	HbA1c, screening uptake, complication prevention
International Council of Nurses (ICN)	Nursing standards and ethics	Evidence-based nursing, accountability, professional autonomy, leadership in chronic disease management.	International professional standard	Expand advanced nursing roles, quality improvement, interdisciplinary collaboration.	Quality indicators, audit results, patient safety
Association of Diabetes Care & Education Specialists (ADCES)	Diabetes self-management education	Structured DSMES, behaviour change, patient empowerment, individualized education.	Professional consensus	Deliver structured educational programmes using behaviour-change techniques.	Knowledge scores, self-management behaviours, medication adherence
ADA/EASD Consensus Report	Individualized pharmacological management	Shared decision-making, individualized treatment according to clinical profile, continuous reassessment.	International consensus report	Participate in shared decision-making and ongoing monitoring of treatment effectiveness.	Individualized care plans, HbA1c, treatment persistence

Abbreviations

ADA – American Diabetes Association; ADCES – Association of Diabetes Care & Education Specialists; DSMES – Diabetes Self-Management Education and Support; EASD – European Association for the Study of Diabetes; HbA1c – glycated hemoglobin; ICN – International Council of Nurses; IDF – International Diabetes Federation; PHC – Primary Health Care.

Conclusion

Therapeutic adherence remains one of the most important determinants of successful long-term management of type 2 diabetes mellitus (T2DM) and continues to represent a major challenge for primary health care systems worldwide. The evidence synthesized in this paper demonstrates that optimal adherence depends not only on pharmacological treatment but also on behavioral, educational, psychosocial, and organizational factors that require comprehensive, person-centered nursing interventions.

Current international evidence consistently supports the effectiveness of nurse-led diabetes self-management education and support (DSMES), individualized behavioral counseling, motivational interviewing, psychosocial support, digital health interventions, and structured follow-up in improving medication adherence, self-management behaviors, glycemic control, patient-reported outcomes, and health-related quality of life. Nevertheless, the implementation of these evidence-based interventions remains inconsistent in routine primary health care, highlighting the need for standardized nursing models capable of translating international recommendations into everyday clinical practice.

The conceptual framework proposed in this paper integrates contemporary scientific evidence with international clinical guidelines into a structured, evidence-based model of nursing care that emphasizes comprehensive assessment, individualized education, behavioral support, continuity of care, multidisciplinary collaboration, psychosocial and digital interventions, and systematic outcome evaluation. By operationalizing these evidence-based components within routine primary health care, the framework has the potential to strengthen therapeutic adherence, improve both clinical and patient-reported outcomes, and enhance the quality, safety, continuity, and sustainability of diabetes care.

Beyond its theoretical contribution, the proposed framework provides a practical foundation for developing standardized nurse-led interventions aimed at optimizing therapeutic adherence among adults with T2DM in primary health care. The integration of internationally recognized recommendations into a structured nursing pathway may facilitate the implementation of evidence-based practice while supporting quality improvement initiatives and strengthening the role of nurses within multidisciplinary diabetes care teams.

Future empirical research should evaluate the feasibility, acceptability, implementation fidelity, and clinical effectiveness of the proposed framework across diverse primary health care settings. Such investigations will provide essential evidence for validating the framework and contribute to the development of sustainable, evidence-based nursing models that further advance person-centered diabetes care and improve long-term outcomes for individuals living with T2DM.

Implications for Nursing Practice

The proposed conceptual framework has several practical implications for nursing practice in primary health care. First, it provides nurses with a structured evidence-based approach for systematically assessing therapeutic adherence, identifying individual barriers to treatment, and delivering personalized diabetes self-management education and behavioral counseling. Second, the framework supports continuity of care through regular follow-up, psychosocial assessment, and the integration of digital health technologies, thereby promoting sustained patient engagement and long-term adherence.

The framework may also serve as a practical guide for developing standardized nursing protocols, educational programs, and quality improvement initiatives within primary health care

organizations. Furthermore, its implementation may strengthen the leadership role of nurses within multidisciplinary diabetes care teams while promoting evidence-based, person-centered practice aligned with current international recommendations.

Finally, the proposed framework offers a theoretical and practical foundation for future intervention studies evaluating nurse-led models of care aimed at improving therapeutic adherence, clinical outcomes, patient-reported outcomes, and the overall quality of diabetes management in primary health care.

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Sociological Sciences

An Overview of Legal Stays in the Slovak Republic in 2024 and 2025

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Abstract

This paper presents a statistical overview of legal stays in the Slovak Republic for 2024 and the first half of 2025, drawing on data from the Praesidium of the Police Corps and the Bureau of Border and Alien Police. At the end of 2024, a total of 337,140 persons held valid residence in Slovakia, an increase of 8.3% year-on-year, of whom 281,648 were third-country nationals. Ukrainian nationals accounted for approximately 70% of all valid third-country national stays, predominantly under tolerated residence in the form of temporary refuge. Among newly granted stays, business and employment purposes dominated temporary residence, reflecting sustained structural demand in Slovakia's labour market. Border crossing data show that 3.78 million persons legally crossed Slovakia's external borders in 2024, with air border traffic growing markedly — up 6.7% in 2024 and 18.1% in the first half of 2025 year-on-year, accompanied by a rising share of third-country nationals. The paper discusses policy implications relating to the integration of displaced Ukrainians and labour migration governance, and digital border management capacity. It concludes that Slovakia is undergoing a structural shift in its migration profile and that sustained policy investment will be required to manage both humanitarian and economic migration flows in the medium term.

Keywords: Slovak Republic, migration, legal stay, stocks, flows

1. Introduction

Migration ranks among the most significant social, economic, political and demographic processes of the contemporary world. It represents the movement of populations between regions or states, with its causes being economic, social, security-related, environmental or cultural in nature. Given its complex character, migration has become the subject of inquiry across multiple academic disciplines, in particular demography, sociology, economics, political science, geography, international relations, law and public policy.

Migration is addressed by numerous international organisations that conduct research, monitor migration flows and formulate recommendations for public policy. Among the most prominent are the International Organization for Migration (IOM), the United Nations High Commissioner for Refugees (UNHCR), the Organisation for Economic Co-operation and Development (OECD), and the United Nations through its specialised agencies and statistical departments. These institutions collect migration data, analyse its causes and consequences, and provide expert foundations for the development of migration policies.

Among the best-known migration scholars in academic research are Douglas Massey (Massey et al., 1993; Massey, 1999), Stephen Castles (Castles, 2002; Castles, 2010), Hein de Haas (De Haas, 2010; De Haas, 2021), Saskia Sassen (Sassen, 2006; Sassen, 2005) and Alejandro Portes (Portes & Zhou, 1993; Portes & Rumbaut, 2014), who examine the economic, social and cultural aspects of

migration processes. Their work has contributed to the development of theoretical models explaining the causes of migration, migrant integration processes, and the impacts of migration on receiving societies.

In Slovakia, migration issues are addressed primarily by state institutions — the Statistical Office of the Slovak Republic, the Ministry of the Interior of the Slovak Republic, and the Migration Office of the Ministry of the Interior — as well as by the International Organization for Migration (IOM) operating in Slovakia. An important source of knowledge is also provided by research projects of the European Migration Network (EMN), which analyse migration trends, the integration of foreigners, and public attitudes toward migration. IOM Slovakia conducts research focused on migration trends, migrant integration, labour migration, and public opinion on migration. Migration, economic and labour market issues are traditionally discussed also by the author (Heriban, 2025).

Understanding migration processes is important not only from a scientific perspective, but also for the development of effective public policies. Analysis of migration enables a better understanding of demographic trends, labour market needs, processes of social integration, and the broader societal changes that migration brings at both national and international levels.

The aim of this article is to analyse the development of migration in Slovakia on the basis of available statistical data and to identify the main trends characterising migration processes in the Slovak Republic during the period under review.

The Slovak Republic is a landlocked country with an area of 49,034 km² with a density of 109.3 persons per sq. km. The length of the borders is 1,652.8 km, of which 610 km are water and 1,042.8 are land, the longest border is with Hungary at 655 km while the shortest with Ukraine at 98 km, which is also an external land border with a non-member state with 5 border crossings. (Table 1).

Table 1 Length of external and internal borders and number of border crossings

Geographic indicators			Length of border				Border crossings (b)	
				[km]	water	land	Total	126
Total area	49 033,9 sq.km		Total	1 652,8	610,0	1042,8	CR	23 ^(bi)
Population density	109,3 pers./sq.km (c)		CR	251,8	71,1	180,7	Austria	8 ^(int)
Number of regions	8		Austria	107,1	76,8	30,3	Hungary	26 ^(ext)
Number of districts	79		Hungary	654,9	355,0	299,9	Ukraine	5 ^(ext)
Number of towns ^(a)	141	53.5% ^(c)	Ukraine	97,9	2,1	95,8	Poland	56 ^(int)
Number of villages	2 890	46.5% ^(c)	Poland	541,1	105,0	436,1	Airports	8

(a) Municipalities with the status of town, declared by the National Council of the Slovak Republic

(b) Border crossings until joining the Schengen area 21 December 2007:

^(ext) External borders mean sections of the state border of the Slovak Republic, which represent the common land border with a non EU Member State, and airports for external routes (extra-Schengen); they include the land border – the state border of SR with the Ukraine, and the air border – Bratislava Airport, Poprad Airport and Košice Airport.

^(int) Internal borders mean sections of the state border of the Slovak Republic, which represent the common land border among the EU Member States of the Schengen area – they include the sections of the state border of SR with Austria, Hungary, Czech Republic, Poland and the airports for intra- Schengen flights.

(c) 1.1.2025 = 5361,6 ths. persons.

Source: Statistical Office of the Slovak Republic, Ministry of Interior of SR.

Since its accession to the European Union on 1 May 2004 and its full integration into the Schengen Area in December 2007, the Slovak Republic has undergone a significant transformation in its migration landscape. EU membership triggered a substantial increase in legal migration while irregular flows declined markedly. Since 2004, the number of legally residing foreigners has increased nearly twelvefold, rising from approximately 22,000 in 2004 to nearly 279,000 by the end of 2022. (IOM Slovakia, 2023). The abolition of internal border controls with EU Member States consolidated Slovakia's role as both a transit and destination country within the broader European migration system, placing heightened administrative demands on its border and alien police services.

The Russo-Ukrainian conflict from February 2022 altered the scale and composition of foreign nationals residing in the Slovak Republic. As a neighbouring country sharing a 98 km border with Ukraine, Slovakia became an immediate transit and host country for displaced persons. In response, Slovakia adopted the legislative package known as Lex Ukraine (updated several times over in the meantime), granting displaced persons temporary protection status with rights to reside, access the labour market, healthcare, and educational services. By early 2025, Slovakia had granted temporary protection to over 132,000 displaced persons from Ukraine, the overwhelming majority of whom were women, children, and elderly adults. (European Commission, 2025). This influx reshaped the demographic profile of legally resident foreigners in Slovakia and introduced new demands on public services, labour market administration, and integration infrastructure.

2. Legal stays, types, stocks, flows

In 2024, 2,080,51 persons legally crossed the external land border, 3.2% more year-on-year (+66 thousand persons). Of the total number of persons who crossed the external state border, third-country nationals accounted for 90.1%, compared to 90.6% in the previous year. The external air border consists of the airports of Bratislava, Poprad, Košice and 6 small airports. In 2024, 1,700,522 persons crossed the air border - up 6.7% year-on-year (+105 thousand persons). Of the total number of persons who crossed the external air border, third-country nationals accounted for 15.5%, compared to 14.2% in the previous year. In the first half of 2025, 973,077 persons legally crossed the external land border - up 2.7% year-on-year (+25 thousand persons). Of the total number of persons who crossed the external state land border, third-country nationals accounted for 89.3% as compared to 90.0% in the previous year. In the first half of 2025, 746,574 persons crossed the air border - up 18.1% year-on-year (+114 thousand persons). Of the total number of persons who crossed the external air border third-country nationals accounted for 24.2% as compared to 17.7% in the previous year (Tables 2, 3, 4).

Table 2 Total pressure at the state border - legal passages, 2020-2025

(in million persons)	2024			2025 – half year		
	Total	In	Out	Total	In	Out
Total	3,781	1,841	1,940	1,720	0,812	0,908
Border with:						
Ukraine	2,081	0,994	1,087	0,973	0,452	0,521
Airports	1,700	0,847	0,853	0,747	0,360	0,387

Note: Data refer only to the Schengen external borders (border with Ukraine and 3 international airports).

Source: Presidium of the Police Corps, Bureau of Border and Alien Police.

Table 3 Structure of legal movements across state borders in 2020–2025—in 1st half years

In thousands	Persons (half years)			Vehicle (half years)		
	2023	2024	2025	2023	2024	2025
Airports:	579,1	632,2	746,6	4,4	4,6	5,3
Bratislava	392,5	432,8	518,7	3,0	3,2	3,9
Poprad	22,6	41,9	48,2	0,2	0,3	0,3
Kosice	158,9	150,7	174,5	1,1	1,0	1,1
Small airports*	5,1	6,8	5,2	0,1	0,1	0,0
Road:	925,2	947,9	973,1	228,8	223,9	225,0
Vysne Nemecke	657,8	627,4	645,3	175,8	169,6	176,2
Ubla	166,1	179,5	158,7	46,6	48,0	41,9
Velke Slemence	56,3	63,1	66,6			
Cierna nad Tisou	39,4	72,9	98,2	3,6	3,8	4,5
Matovske Vojkovce	5,6	4,8	4,3	2,8	2,5	2,4
Total	1 504,3	1 580,1	1 719,7	233,2	228,5	230,3

Source: Presidium of the Police Corps, Bureau of Border and Alien Police.

** Small airports: airports Piešťany, Sliač, Nitra, Žilina, Prievidza and Jasná.*

Table 4 Overview of numbers of persons and transport means having crossed the external border legally by direction of movement, 2023- 2024

Legal migration by the State border		2023		2024	
		In	Out	In	Out
Land border	Persons by direction of movement	976 844	1 037 568	993 870	1 086 641
	- citizens of EEA (inc. citiz. of SR)	93 594	95 264	101 798	103 892
	- third country citizens	883 250	942 304	892 072	982 749
	Number of persons in total	2 014 412		2 080 511	
	Vehicles by direction of movement	230 476	249 425	217 326	242 091
	- passenger vehicles	162 118	171 914	153 857	161 710
	- buses	10 084	10 206	9 323	10 198
	- lorries	51 638	60 671	47 279	63 336
	- passenger trains	1 459	1 459	1 791	1 794
	- freight trains	4 781	4 777	4 537	4 544
	Other (eg motorcycles)	396	398	539	509
	Number of vehicles in total	479 901		459 417	
Air border	Persons by direction of movement	793 387	801 712	847 276	853 246
	- citizens of EEA (inc. citiz. of SR)	678 994	689 110	715 269	721 843
	- third country citizens	114 383	112 602	132 007	131 403
	Number of persons in total	1 595 099		1 700 522	
	Number of aeroplanes in total	5 619	5 524	6 066	5 707
	Number of aeroplanes in total	11 143		11 773	
Number of persons in total		3 609 511		3 781 033	
Number of transport means in total		491 044		471 190	

Note: In case of airports, passengers travelling at non-Schengen flights are counted only.

Source: Presidium of the Police Corps, Bureau of Border and Alien Police.

At the end of 2024, 337,140 persons had legal residence in the Slovak Republic - an increase of 8.3% (+25.7 thousand persons) as compared to 2023. Of the total number of valid residence permits for foreigners at the end of 2024, 281,648 were third-country nationals (year-on-year +10%, 25.7 thousand persons) and 55,492 were EU citizens (year-on-year less by 16 persons). At the end of 2024, temporary residence was granted to 110,113 persons (year-on-year +1,070 persons, +1%), permanent residence to 39,822 persons (year-on-year +7,190 persons, +22%), tolerated residence to 131,713 persons (year-on-year +17,490 persons, +15%). Of the number of residence permits granted to third-country nationals, 70% were Ukrainians (197,004 persons), of which 2/3 were tolerated stays (130,967 persons). Other nationalities were Serbians (17,508) and Vietnamese (10,186). Valid stays for EU citizens were mainly for citizens of the Czech Republic 12,690 (12,684 by the end of 2023), 9,843 Hungarians (9,631 by the end of 2023), 6,478 Romanians (6,658 by the end of 2023), 6,045 Polish (6,062 by the end of 2023).

Valid stays for third-country nationals according to the purposes of stay (as of the end of 2024):

- Temporary residence was granted mainly for business purposes to 43,614 persons (40% of all temporary stays), 28,255 persons for employment (26% of all temporary stays), 14,922 for family reunification (14% of all temporary stays), 13,697 persons for study (12% of all temporary stays),

- Permanent residence was granted mainly for long-term residence to 25,519 persons (64% of all permanent residences), for an unlimited period to 7,281 persons (18% of all permanent residences), for 5 years to 4,708 persons (12% of all permanent residences), but also to 363 asylum seekers (0.9% of all permanent residences),
- Tolerated residence was granted for the purpose of temporary refuge to 131,696 persons, 12 to unaccompanied minors and 5 persons for the purpose of respecting private and family life.

3. Stays and flows

In 2024, legal residence was granted to 100,237 foreigners in the Slovak Republic (605 persons less year-on-year, -0.6%), including 96,162 third-country nationals, 0.7% less than in 2023 (-653 persons) and 4,075 EU citizens, 48 persons more than in 2023 (+1.2%). Of the total number of residence permits granted to third-country nationals in 2024, temporary residence was granted to 60,344 persons (-766 persons, -1.3% year-on-year), permanent residence to 8,976 persons (+3,722 persons, +71% year-on-year) and tolerated residence to 26,842 persons (-3,609 persons, -12% year-on-year). Of the number of residence permits granted to third-country nationals, 62% were Ukrainians (59,191 persons), of which 47% were temporary residence permits (27,996 persons), 8% were permanent residence permits (4,499 persons), and 45% were tolerated residence permits (26,696 persons). Other nationalities were Serbians (6,733) and Vietnamese (4,791). Table 5.

Table 5 Inflow of residence permits for third-country nationals in Slovakia by nationality in 2023-2024 (Top 40)

2023	Inflow 2023				2024	Inflow 2024			
	Total	of which				Total	of which		
		Temp orary	Perm anent	Tolerat ed			Temp orary	Perm anent	Tolera ted
Ukraine	60 416	28 387	1 835	30 194	Ukraine	59 191	27 996	4 499	26 696
Serbia	7 938	7 304	634		Serbia	6 733	5 856	877	
Vietnam	4 250	3 745	504	1	Vietnam	4 791	3 996	794	1
Georgia	3 654	3 624	27	3	Georgia	2 850	2 771	76	3
Russia	3 434	2 951	399	84	Russia	2 830	2 252	484	94
India	2 602	2 554	48		India	2 234	2 134	99	1
Macedonia	1 826	1 704	122		Moldova	1 723	1 693	28	2
Moldova	969	956	8	5	Macedonia	1 400	1 267	132	1
Bosnia&Herz	902	861	41		Kyrgyzstan	1 307	1 288	19	
Belarus	857	819	33	5	Uzbekistan	1 253	1 241	11	1
Albania	840	783	57		Kazakhstan	899	855	41	3
Kyrgyzstan	830	826	4		Belarus	851	794	55	2
Kazakhstan	704	667	37		China	786	599	184	3
Turkey	607	530	63	14	Bosnia & Herz.	715	631	84	
China	528	378	149	1	Turkey	696	605	88	3
Korea	511	455	56		Azerbaijan	637	609	28	
US	430	239	190	1	Albania	622	591	31	
Azerbaijan	428	400	23	5	Philippines	619	580	39	
Uzbekistan	420	411	5	4	Korea	585	484	101	
Indonesia	413	408	5		Indonesia	503	498	5	
Iran	385	300	85		Israel	488	348	140	
Philippines	343	288	55		USA	429	244	183	2
Thailand	340	268	72		Thailand	421	363	58	
Israel	294	238	52	4	Iran	358	262	95	1
Syria	234	116	31	87	UK	192	90	102	
UK	182	75	106	1	Armenia	182	146	32	4

Armenia	178	126	47	5	Zimbabwe	174	172	2	
Montenegro	137	135	2		Syria	146	102	40	4
Egypt	136	76	53	7	Montenegro	144	131	13	
Nigeria	108	82	22	4	Kosovo	137	124	13	
Brasilia	107	75	32		Egypt	136	108	26	2
Japan	96	79	17		Canada	135	83	52	
Canada	93	69	24		Brasilia	119	96	23	
Kosovo	89	78	11		Nigeria	108	86	19	3
Mongolia	84	81	3		Colombia	99	87	10	2
Colombia	82	73	9		Mongolia	92	66	26	
Mexico	78	49	29		Nepal	91	87	3	1
Zimbabwe	66	64	2		Mexico	90	57	33	
Afghanistan	59	39	11	9	Japan	79	72	7	
Kenya	43	32	11		Tajikistan	74	72	1	1
Others	1 122	765	340	17	Others	1 243	808	423	12
Total	96 815	61 110	5 254	30 451	Total	96 162	60 344	8 976	26 842

Source: Presidium of the Police Corps, Bureau of Border and Alien Police.

Valid stays for third-country nationals according to the purposes of stay for 2024:

- Temporary residence was granted mainly for business purposes to 25,218 persons (42% of all temporary stays), 18,959 persons for employment (31% of all temporary stays), 8,610 for family reunification (14% of all temporary stays), 5,266 persons for study (8.7% of all temporary stays),
- Permanent residence was granted mainly for long-term residence to 6,873 persons (76.6% of all permanent residences), for an unlimited period to 525 persons (6% of all permanent residences), for 5 years to 967 persons (11% of all permanent residences) but also to 50 asylum seekers (0.6% of all permanent residences),
- Tolerated residence was granted for the purpose of temporary refuge to 26,821 persons, 11 to unaccompanied minors, 6 to respect for private and family life, and 4 for reasons of human trafficking.

Valid stays for third-country nationals according to the purposes of stay for the first half of 2025:

- Temporary residence was granted mainly for business purposes to 11,387 persons (43% of all temporary stays), 7,772 persons for employment (29% of all temporary stays), 3,984 for family reunification (15% of all temporary stays), 2,174 persons for study (8% of all temporary stays),
- Permanent residence was granted mainly for long-term residence to 3,927 persons (79% of all permanent residences), for an unlimited period to 180 persons (3.6% of all

- permanent residences), for 5 years to 629 persons (12.6% of all permanent residences), but also to 20 asylum seekers (0.4% of all permanent residences),
- Tolerated residence was granted for the purpose of temporary refuge to 6,827 persons, 8 to unaccompanied minors and 6 persons for the purpose of respecting private and family life.

4. Policy Implications

The data demonstrate that Ukrainian nationals constitute the dominant group among third-country nationals legally residing in Slovakia, accounting for approximately 70% of all valid stays held by non-EU citizens at the end of 2024. Of these, roughly two-thirds were held under the tolerated residence category in the form of temporary refuge, a status that is inherently transitional in nature. With temporary protection extended until March 2027 by government decree, Slovak authorities face a medium-term policy imperative to develop clear and accessible pathways for displaced Ukrainians to transition toward more stable residence statuses — particularly long-term or permanent residence — so as to reduce administrative uncertainty and support household planning. Policy-makers should consider streamlining the administrative procedures for status conversion and enhancing information provision to affected persons, particularly those in vulnerable categories such as children, single mothers and elderly individuals. The predominance of business and employment purposes among temporary residence grants — accounting for 43% and 29% respectively in the first half of 2025 — underscores the growing role of foreign nationals in sustaining Slovakia's labour market. This pattern reflects wider structural demand in sectors such as manufacturing, transportation, and social care, where domestic labour supply has not kept pace with economic expansion. The recently introduced electronic labour office consent system represents a step in the right direction, but further harmonisation of the legal framework governing the employment of foreign nationals across industries is warranted. The marked acceleration in air border crossings — up 6.7% in 2024 and 18.1% in the first half of 2025 relative to the equivalent prior-year periods — signals a structural shift in how third-country nationals enter and exit the Slovak Republic. The sharp rise in the share of third-country nationals at air borders, from 14.2% in 2023 to 24.2% in the first half of 2025, suggests a diversification of entry patterns that places new demands on airport-based border management capacity, particularly at Bratislava M.R. Štefánik Airport, which accounts for the majority of air border crossings. Policy-makers should prioritise investment in digital border management infrastructure, including the wider roll-out of automated border control systems and enhanced inter-agency data-sharing protocols, to accommodate rising throughput while maintaining robust entry controls consistent with Schengen obligations.

5. Conclusion

The data presented in this paper paint a picture of a Slovak Republic experiencing sustained and structural growth in its legally resident foreign population. Between 2023 and 2024, the total number of valid residence permits increased by 8.3%, reaching 337,140 persons, driven primarily by a 10% rise in third-country national stays. This trajectory is consistent with the mechanisms of cumulative causation described by Massey et al. (1993): once migration flows become established, social networks progressively lower the costs and risks of subsequent movement, embedding migration into the structural fabric of both sending and receiving societies. Ukrainian nationals, comprising roughly 70% of all valid TCN stays, remain the defining feature of Slovakia's contemporary migration landscape. The continued growth of tolerated stays — which expanded by 15% year-on-year to reach 131,713 persons — reflects both the scale of humanitarian displacement and the adaptive capacity of Slovakia's legal migration framework in responding to emergency conditions. As Castles (2010) argues, displacement-driven migration of this scale

constitutes a form of social transformation that reshapes receiving societies in ways that emergency legislative instruments alone cannot adequately manage.

Border crossing patterns further illustrate Slovakia's evolving migration geography. Total legal passages at external borders rose to 3.78 million in 2024, reflecting both regional integration with Schengen partners and the sustained importance of the Ukrainian land corridor. The sharp acceleration of air border crossings — up 18.1% in the first half of 2025 — and the rising share of third-country nationals using air entry points reflect a structural diversification of migration channels consistent with the broader reconfiguration of global migration systems identified by De Haas (2010). Looking ahead, the Slovak Republic faces the dual challenge of consolidating the management of large-scale humanitarian migration while simultaneously developing a long-term economic migration governance. The sustained predominance of business and employment purposes among newly granted temporary residence permits aligns with the aspirations-capabilities framework advanced by De Haas (2021): structural labour demand in Slovakia's manufacturing, transportation, and service sectors creates the conditions under which migrants with both the motivation and the means to move respond to economic opportunity. Sassen (2005) draws attention to a deeper tension inherent in this governance context: states embedded in supranational economic and legal frameworks — in Slovakia's case, the Schengen area and EU temporary protection obligations — face growing constraints on unilateral immigration control, a dynamic that renders coherent domestic policy design both more necessary and more complex. The extension of temporary protection for displaced Ukrainians until March 2027, together with the ongoing digitisation of the immigration system and the introduction of electronic procedures for labour consent, indicates that administrative modernisation is underway. However, the scale of integration demands — spanning housing, education, language acquisition, and labour market participation — requires sustained intergovernmental coordination and dedicated public investment. Portes and Rumbaut (2014) caution that immigration policies framed around either systematic exclusion or accelerated assimilation routinely generate unintended consequences; effective governance requires a differentiated, evidence-informed approach that recognises the diverse needs and trajectories of distinct migrant groups and residence categories. The statistical overview presented in this paper provides an empirical baseline for evidence-based policy development and serves as a reference point against which future migration trends in the Slovak Republic may be assessed.

Note:

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TRANSNATIONAL FINANCIAL FRAUD IN THE CONTEXT OF DIGITALIZATION: INSTITUTIONAL CHALLENGES OF KAZAKHSTAN AND INTERNATIONAL COUNTERMEASURES

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Abstract

The article examines transnational financial fraud as an institutional security challenge emerging in the context of Kazakhstan's accelerated digitalization. The study argues that the spread of mobile payments, digital public services, remote identification, platform-based communication, and cross-border financial instruments has changed not only the scale of fraudulent activity, but also its organizational logic. Contemporary fraud schemes increasingly combine social engineering, spoofed communications, foreign hosting, money-mule networks, crypto-asset conversion, and international payment routes. As a result, the effectiveness of counteraction depends less on isolated technical barriers than on the ability of institutions to coordinate in real time. The purpose of the article is to explain why digital financial fraud acquires a transnational character in Kazakhstan and to identify foreign institutional mechanisms that may be adapted to national practice. The study uses qualitative comparative institutional analysis based on policy documents, official reports, and academic literature on cybercrime, fraud victimization, governance capacity, and collaborative regulation. The article develops the concept of a digitalization-capacity gap, understood as the mismatch between the speed of criminal adaptation in digital ecosystems and the speed of institutional prevention, information exchange, urgent intervention, and cross-border cooperation. The results show that Kazakhstan's key vulnerabilities are temporal, informational, organizational, and jurisdictional. The comparative assessment of Singapore, the European Union, and the United States demonstrates the value of shared responsibility models, threat-intelligence platforms, complaint-based analytics, and rapid-response coordination. The article concludes that Kazakhstan requires an integrated anti-fraud governance architecture linking financial regulators, banks, telecom operators, law-enforcement bodies, digital platforms, and international partners.

Keywords: transnational financial fraud; digitalization; Kazakhstan; international security; cybercrime; institutional capacity; anti-fraud governance; interagency coordination; cross-border cooperation.

Introduction

Digitalization has become one of the central drivers of transformation in contemporary economies, financial systems, and public administration. In Kazakhstan, the State Programme «Digital Kazakhstan» set a policy framework for the accelerated modernization of infrastructure,

public services, and digital interaction between the state, business, and citizens [1]. The development of e-government platforms further normalized remote access to administrative services, while the expansion of payment instruments and online banking strengthened the everyday role of digital financial channels [2; 3]. These processes have produced clear gains in accessibility, speed, and convenience. At the same time, they have created a new environment in which criminal actors can exploit digital trust, the routine use of remote interfaces, and the rapid movement of funds.

Financial fraud in the digital environment is no longer adequately described as a series of isolated incidents involving individual victims. It increasingly operates as a scalable socio-technical system. Fraudsters may contact victims through spoofed phone numbers, redirect them to phishing interfaces, persuade them to disclose authentication data, transfer funds to accounts controlled by intermediaries, and then move assets through multiple layers of transactions or convert them into crypto-assets. Such schemes are economically rational from the offender's perspective because digital communication reduces the cost of reaching large audiences and because the probability of successful intervention declines as funds move faster and across multiple institutional boundaries [4]. The issue is therefore not limited to consumer protection or financial literacy. It concerns the resilience of institutions responsible for financial security, public trust, and cross-border cooperation.

The rapid development of digital identity systems, remote customer onboarding, and app-based financial services makes reliable verification an essential element of security governance. International standards emphasize that digital identity must combine accessibility with risk-sensitive assurance, especially in anti-money-laundering and counter-terrorist-financing environments [5]. The spread of crypto-assets and new payment technologies adds further complexity, because funds may be layered, obfuscated, or transferred through infrastructures that are not easily aligned with national investigative procedures [6]. For Kazakhstan, this creates a specific challenge: the country is expanding digital services at a high pace, while fraudulent actors can appropriate the symbolic authority of banks, government institutions, and recognizable digital platforms in order to influence user behavior.

A substantial body of research shows that online fraud succeeds not only because of technical weaknesses, but also because of social engineering. Victims are often manipulated through urgency, fear, apparent authority, scarcity, and the promise of profit [7]. Fraud should therefore be understood as an interaction between offender strategy, user vulnerability, platform design, and institutional response. Studies of scam ecosystems emphasize that victims encounter fraud through a chain of communications and financial actions, not through a single discrete event [8]. This perspective is important for policy design: measures limited to awareness campaigns are unlikely to be sufficient if the broader infrastructure of spoofing, mule accounts, and rapid fund transfer remains operational.

Cybercrime scholarship further indicates that digital offences are shaped by a combination of criminological, technological, and governance factors [9]. Wall's analysis of cybercrime demonstrated that the Internet transforms the relationship between place, time, and harm, thereby challenging territorially bounded models of law enforcement [10]. Brenner similarly argued that cybercrime creates structural tensions for international law because the location of offenders, victims, servers, and financial flows may be distributed across several jurisdictions [11]. These observations are particularly relevant to transnational financial fraud: a victim may be located in Kazakhstan, the communication channel may rely on a foreign service, the phishing page may be hosted abroad, the receiving account may be held by a local money mule, and the ultimate beneficiaries may operate elsewhere.

The organizational dimension of digital fraud also deserves attention. Research on cybercriminal groups indicates that such networks often operate through flexible role

differentiation rather than rigid hierarchical structures [12]. Online forums and social ties facilitate the distribution of illicit services, including access to compromised accounts, phishing kits, scripts, call-center techniques, and cash-out services [13]. This means that fraud networks can be resilient even when individual participants are detected. The system is modular: if one communication channel is blocked, another can be activated; if one mule account is frozen, funds can be routed through a substitute; if one phishing domain is removed, a new replica can appear. From the perspective of institutional security, this adaptive structure is a fundamental reason why reactive measures often lag behind criminal innovation.

The concept of institutional capacity helps explain this lag. Governance capacity is not reducible to the existence of formal laws or administrative bodies; it concerns the practical ability of institutions to identify problems, coordinate actors, enforce decisions, and adjust to changing circumstances [14]. In the field of cybersecurity, resilience increasingly depends on cooperation among state agencies, regulators, private firms, and international partners [15]. Dupont's argument concerning polycentric regulation is especially relevant: large-scale cybercrime cannot be controlled by police action alone, because the infrastructure enabling criminal activity is distributed across payment systems, telecommunications, hosting services, and platform economies [16]. The effectiveness of anti-fraud policy therefore depends on whether these actors are connected by operational protocols rather than by fragmented responsibilities.

Kazakhstan has already developed elements of a response architecture. Public institutions have strengthened attention to cybercrime, specialized initiatives such as CyberPol have been promoted, and awareness efforts have been expanded [17; 18]. Nevertheless, the rapid diffusion of digital services raises a deeper analytical question: can the speed of institutional response match the speed of digital fraud? This article argues that the answer depends on the presence or absence of a digitalization-capacity gap. The gap emerges when digitalization increases the scale, speed, and complexity of transactions faster than institutions build the capacity to prevent manipulation, share data, suspend suspicious flows, coordinate across sectors, and work with foreign partners.

The article addresses the following research question: why does financial fraud in Kazakhstan acquire an increasingly transnational character under conditions of digitalization, and which international institutional mechanisms may be adapted to the Kazakhstani context? The working hypothesis is that the persistence and scalability of digital financial fraud are driven not by digitalization itself, but by an institutional mismatch between the adaptive capacity of fraudulent networks and the operational capacity of legitimate institutions. This mismatch is expressed in four dimensions: temporal delay, informational fragmentation, organizational coordination barriers, and jurisdictional dependence on cross-border procedures.

The object of the research is transnational digital financial fraud as a security challenge. The subject of the research is the institutional architecture through which Kazakhstan and selected foreign jurisdictions attempt to prevent, detect, and interrupt such fraud. The purpose of the study is to conceptualize the digitalization-capacity gap and to identify anti-fraud governance mechanisms applicable to Kazakhstan. To achieve this purpose, the article pursues five objectives: first, to clarify the relationship between digitalization and the expansion of fraud opportunities; second, to systematize the operational mechanisms of transnational financial fraud; third, to identify institutional vulnerabilities in Kazakhstan's response model; fourth, to compare the experience of Singapore, the European Union, and the United States; and fifth, to formulate policy implications for a more integrated Kazakhstani anti-fraud architecture.

The scientific novelty of the article lies in the combination of international security analysis, cybercrime research, and governance theory within a single institutional model. Rather than presenting digital fraud as a purely criminal-law problem or as an unintended side effect of financial modernization, the article treats it as a transnational risk generated at the intersection of technological acceleration and institutional coordination. This framing is consistent with wider

studies of institutions, which show that rules matter most when they are accompanied by enforcement capacity and adaptive coordination [25], and with research on whole-of-government and collaborative governance, which emphasizes that complex risks often require structured interaction among public and private actors [26; 27]. The practical significance of the study lies in its effort to translate international experience into a policy-relevant framework for Kazakhstan.

Materials and Methods

The study is based on qualitative comparative institutional analysis. This design is appropriate because the article does not seek to prove a linear statistical causality between the overall level of digitalization and a specific number of registered fraud cases. Publicly available statistics are affected by underreporting, changes in legal qualification, differences in complaint behavior, and the fact that a single fraudulent network may generate multiple incidents across jurisdictions. Instead, the article focuses on mechanisms: how digital environments create fraud opportunities, how criminal actors operationalize cross-border infrastructures, and how institutions can reduce the gap between detection and intervention.

The research design combines conceptual modelling with structured comparison. The conceptual component develops the digitalization-capacity gap as an analytical framework. The comparative component examines Kazakhstan alongside three foreign reference models: Singapore, the European Union, and the United States. These cases were selected not as direct equivalents to Kazakhstan, but because each illustrates a different institutional response logic. Singapore is relevant for its shared responsibility approach across banks, telecommunications, and digital platforms [22]. The European Union is relevant for supranational threat assessment and cross-border analytical coordination, particularly through Europol's organized cybercrime reporting [19]. The United States is relevant for complaint aggregation, incident statistics, and targeted public alerts provided by IC3 and FinCEN [20; 21].

The empirical corpus includes four categories of materials. The first category consists of Kazakhstan's policy and institutional documents related to digitalization, e-government, payment infrastructure, and cybercrime response [1; 2; 3; 17; 18]. The second category consists of international policy and risk-reporting documents addressing identity assurance, cybercrime threats, online fraud patterns, public complaint reporting, and cross-sector responsibilities [5; 19-22]. The third category includes academic literature on online crime economics, victimization, cybercriminal networks, electronic crime, and cybercrime markets [4; 7; 8-13; 23; 24; 28]. The fourth category includes institutional and governance literature that helps interpret capacity, coordination, and adaptive regulation [14-16; 25-27; 29; 30].

The analytical procedure consists of five stages. First, the literature is used to distinguish between fraud as an individual deception event and fraud as a distributed transnational ecosystem. Second, official and analytical sources are used to identify the main operational mechanisms by which fraud is initiated, scaled, and monetized. Third, the Kazakhstani institutional environment is examined through the lens of response capacity, with attention to time, information, coordination, and jurisdiction. Fourth, foreign models are compared according to their dominant institutional mechanism: shared responsibility, supranational coordination, or complaint-based intelligence. Fifth, the article derives an applicability matrix that identifies which mechanisms are potentially transferable to Kazakhstan and under what constraints.

Table 1. Analytical Framework of the Study

Dimension	Analytical question	Operational indicators
Digitalization pressure	How do digital services expand fraud opportunities?	Remote payments; e-government interfaces; instant communication; digital identity dependence
Fraud ecosystem	How is deception transformed into scalable transnational harm?	Social engineering; spoofing; phishing; money mules; crypto conversion; foreign hosting
Institutional capacity	Where does response lag the threat?	Temporal, informational, organizational, jurisdictional, and analytical gaps
International coordination	Which foreign mechanisms may be adapted to Kazakhstan?	Shared responsibility; threat intelligence; complaint analytics; rapid escalation channels

Source: compiled by the author on the basis of [1-3; 5-8; 10; 12-14; 19-22; 25-27; 30].

The comparative method is not used to rank countries according to the absolute effectiveness of anti-fraud policy. Such ranking would be misleading because the jurisdictions differ in market structure, reporting culture, legal regime, and institutional resources. Instead, comparison is mechanism-based. The key analytical questions are: Which actor receives the first signal of fraud? How quickly can that signal be combined with information held by other actors? What type of intervention is possible within the first hours after a suspicious event? How are cross-border elements escalated? Which responsibilities are preventive and which are reactive? These questions make it possible to compare institutional architectures without assuming that one jurisdiction can be copied mechanically into another.

The study applies source triangulation. A conclusion is considered more reliable when it is supported by at least two types of evidence: academic interpretation, official institutional material, or comparative foreign practice. For example, the claim that fraud ecosystems are distributed and role-differentiated is grounded in cybercrime studies [12; 13; 24], while the argument that modern counteraction requires cross-sector coordination is supported by governance literature [16; 26; 27] and by the Singaporean shared responsibility framework [22]. This approach reduces the risk of overreliance on either sensational media cases or purely normative policy documents.

The article also introduces operational definitions. «Digital financial fraud» refers to deceptive practices aimed at the unlawful acquisition or redirection of money, credentials, or financial control through digital communication or digitally mediated financial transactions. «Transnational» refers to fraud schemes in which at least one significant element-offender location, hosting infrastructure, communication service, financial routing, platform governance, or asset conversion-crosses national borders. «Institutional capacity» refers to the ability of responsible actors to prevent, detect, exchange information about, and interrupt fraudulent activity within a time frame relevant to the speed of the scheme. «Digitalization-capacity gap» refers to the discrepancy between the velocity and modularity of fraud networks and the response capacity of legitimate institutions.

Several limitations must be acknowledged. The study relies on open sources and does not have access to operational datasets on suspicious-transaction freezes, real-time anti-fraud alerts, bank-telecom information exchanges, or international legal assistance requests. It does not estimate the precise economic loss associated with each fraud mechanism. Nor does it claim that foreign models can be transferred without institutional adaptation. These limitations define the article as an analytically grounded comparative study rather than a statistical impact assessment.

They also indicate directions for future research based on interviews with practitioners, incident-level case databases, and quantitative analysis of response time.

Results

The analysis produces six interrelated results. First, digitalization in Kazakhstan expands the opportunity structure for fraud by making remote identification, mobile communication, and instant payment practices routine. Second, transnational digital fraud is sustained by recurring operational mechanisms that combine deception, infrastructure, and liquidity extraction. Third, Kazakhstan's response architecture is developing, but it remains constrained by temporal, informational, organizational, and jurisdictional gaps. Fourth, international experience suggests that sustainable counteraction depends on institutionalized coordination rather than on isolated technical measures. Fifth, the most relevant foreign mechanisms for Kazakhstan are those that shorten the response cycle between signal detection and intervention. Sixth, the effectiveness of anti-fraud governance should be assessed through measurable indicators that capture speed, coordination, learning, and cross-border responsiveness.

Digitalization and the expansion of the fraud opportunity structure

Digitalization changes the context of financial fraud by transforming what citizens perceive as normal interaction. In a less digitalized environment, an unexpected request to transfer funds or provide credentials may appear exceptional. In a highly digitalized environment, however, citizens routinely receive notifications from banks, links to public services, verification messages, delivery updates, and investment offers. This normalization of remote interaction provides fraudsters with a broader symbolic repertoire. They no longer need to invent entirely new scenarios; they can imitate legitimate forms of digital communication already embedded in everyday life. Kazakhstan's policy emphasis on digital transformation, the expansion of e-government, and the growth of digital payment instruments provide the institutional background for this shift [1-3].

The first result is therefore that digitalization increases the «fraud opportunity structure». This does not mean that digitalization causes crime in a deterministic sense. Rather, it lowers the transaction costs of deception, increases audience reach, and compresses the time between persuasion and payment. Economic studies of online crime have long shown that offenders benefit from low-cost communication, large target pools, and the ability to iterate and automate attacks [4]. When these features are combined with instant payment mechanisms, the initial victim-contact phase and the extraction-of-funds phase can occur within a single uninterrupted communication session. The institutional challenge is that the fraud window becomes shorter, while the cost of verification remains distributed across several actors.

The second element of the fraud opportunity structure concerns digital identity and trust. The more public administration and financial services depend on remote authentication, the more valuable it becomes for fraudsters to appropriate signals of legitimacy: logos, interface design, familiar phone numbers, official language, and references to state or banking procedures. FATF guidance emphasizes that digital identity systems must be risk-sensitive because assurance failures can affect both access and abuse [5]. In the fraud context, this means that confidence in digital identity infrastructure can itself be weaponized. A user may not merely be deceived by a false message; the user may be deceived precisely because the message resembles an expected security notification or official request.

The third element is the widening role of financial instruments that are difficult to trace after rapid redistribution. Crypto-assets are not the only route for laundering or concealing fraudulent proceeds, but they may be used to accelerate cross-border movement or complicate recovery once funds leave the initial banking channel [6]. Fraudulent schemes can therefore be

structured in layers: first, the victim is persuaded to make a transfer; second, funds are fragmented through intermediary accounts; third, a part of the amount is transferred abroad or converted into alternative instruments. Each additional layer increases the burden on institutions that must reconstruct the transaction chain under time pressure.

Finally, digitalization reshapes the political meaning of fraud. When fraudsters imitate public institutions, exploit digital financial ecosystems, and operate through transnational infrastructures, the harm is not limited to private monetary loss. Repeated victimization erodes confidence in digital government, online banking, and the reliability of public warnings. It may also generate reputational pressure on regulators and law-enforcement institutions. For a state pursuing digital modernization, maintaining trust in the legitimacy and safety of digital channels becomes a component of institutional resilience, not merely a matter of customer service.

Operational mechanisms of transnational digital financial fraud

The second result concerns the operational architecture of fraud. The academic literature indicates that scams are rarely one-step events. They are sequences in which attention capture, persuasion, credential access, payment initiation, liquidity extraction, and concealment are distributed across several roles [7; 8; 12; 13]. This sequencing explains why single-point interventions are often insufficient. Blocking a phishing page may have little effect if the fraudulent campaign can shift to a new domain; freezing one account may not stop a network that uses many temporary mule accounts; public warnings may not reach victims already embedded in a high-pressure communication script.

A typical fraud scenario can begin with social engineering. The offender constructs a message that appears urgent, personalized, and institutionally plausible. The communication may refer to suspicious banking activity, unauthorized loans, unpaid taxes, investment opportunities, or urgent changes in account security. Victims are then guided toward an action that appears protective or profitable but is actually harmful. Research on fraud victimization shows that the decision to comply is often influenced by emotional pressure rather than a lack of general intelligence or technological ability [7; 8]. This is crucial for policy because anti-fraud messaging should not stigmatize victims; it should address the manipulative structure of the scheme.

The transnational dimension usually enters through infrastructure. Fraudsters may use foreign VoIP providers, number-spoofing services, rented hosting, anonymous registration, or platform accounts created outside the victim's jurisdiction. The fraudster's physical location may be irrelevant to the victim-facing interface. In practice, the victim experiences a local event an apparent call from a domestic bank or official body-while the technical architecture of the event is geographically dispersed. This mismatch undermines purely national models of intervention and supports the argument that cybercrime challenges traditional territorial assumptions [10; 11; 28].

The payment phase introduces another layer of complexity. Funds may first be sent to an account in Kazakhstan controlled by a money mule or an unwitting intermediary. The use of local accounts makes the transaction appear domestically manageable at the initial stage. Yet the subsequent movement of funds may rapidly cross sectors and jurisdictions. The money mule may transfer funds to other accounts, withdraw cash, purchase digital assets, or forward assets through international services. Cybercrime research shows that such ecosystems rely on division of labor and specialized roles, which increases resilience and makes the network harder to dismantle [12; 13; 24].

Table 2 systematizes the main operational mechanisms of transnational financial fraud and identifies the institutional response each mechanism requires. The table demonstrates that fraud control cannot be assigned to a single institution. Banks, telecom operators, platforms, regulators, and law-enforcement bodies each possess only part of the relevant signal. The policy problem is therefore one of connection and timing.

Table 2. Main Operational Mechanisms of Transnational Digital Financial Fraud

Mechanism	Fraud function	Transnational component	Required institutional response
Social engineering	Triggers compliance through urgency, fear, or profit expectations	Scripts and campaigns can be operated remotely from abroad	Victim-centered warnings; pattern-based analytics; complaint clustering
Spoofed calls and messaging	Imitates banks, regulators, police, or public services	VoIP, foreign telecom routing, anonymized accounts	Telecom filtering; caller authentication; bank–telecom escalation
Phishing and cloned interfaces	Captures credentials or legitimizes fraudulent payments	Foreign hosting, rapidly rotating domains, platform distribution	Fast takedown requests; domain monitoring; public alerts
Money-mule chains	Receives and redistributes stolen funds	Domestic first hop followed by cross-border transfers	Transaction monitoring; mule-account typologies; urgent freezes
Crypto-asset conversion	Obfuscates destination of illicit proceeds	Cross-border exchanges, wallets, and layered routes	Risk-based compliance; financial intelligence cooperation
Fraud-as-a-service resources	Supplies scripts, kits, accounts, and infrastructure	Online forums and market-like ecosystems	Intelligence-led disruption; international cybercrime cooperation

Source: compiled by the author on the basis of [6-8; 10-13; 19; 21; 24; 28].

Institutional vulnerabilities in Kazakhstan: the digitalization-capacity gap

The third result is that Kazakhstan's anti-fraud environment contains both developing strengths and persistent coordination vulnerabilities. The existence of specialized cybercrime initiatives, public communication, and growing attention to fraud prevention indicates that the problem has been recognized institutionally [17; 18]. However, recognition alone does not resolve the operational challenge. The central issue is whether fraud signals collected by different actors can be combined rapidly enough to prevent irreversible loss. The digitalization-capacity gap is therefore not a claim of institutional absence; it is a claim of institutional asymmetry between the speed of the threat and the speed of coordinated response.

The first dimension of the gap is temporal. Digital fraud often depends on urgency. Victims are encouraged to act immediately, while funds can be transferred within minutes. A response system that relies on sequential complaint registration, manual verification, and delayed coordination may be effective for investigation after the fact but less effective for prevention during the critical early period. The literature on institutional capacity emphasizes that governance should be evaluated by problem-solving ability, not by the mere existence of formal structures [14; 30]. In fraud prevention, problem-solving capacity is inseparable from response time.

The second dimension is informational. A bank may detect an unusual transaction pattern; a telecom operator may notice suspicious traffic or spoofed call characteristics; a platform may identify a fraudulent advertisement or cloned page; the police may receive a cluster of similar

complaints. If these data remain isolated, the fraud scheme is visible only in fragments. If they are connected through standardized risk categories and urgent communication protocols, institutions can move from reactive processing to pattern recognition. Whole-of-government literature and collaborative governance theory both suggest that complex risks require structured information-sharing arrangements rather than ad hoc cooperation [26; 27].

The third dimension is organizational. Different actors have distinct legal mandates, commercial incentives, data systems, and internal decision rules. Banks are concerned with fraud loss, regulatory compliance, and customer relations; telecom operators focus on traffic integrity and service obligations; law-enforcement agencies require procedural certainty; regulators must maintain proportionality and legal safeguards. Without a clear coordination architecture, each actor may fulfill its formal role while the system as a whole remains slow. This illustrates why collaborative governance must be designed, not merely expected [27].

The fourth dimension is jurisdictional. Transnational fraud may depend on servers abroad, messaging services administered outside Kazakhstan, foreign payment intermediaries, and actors located in multiple countries. National institutions may have strong domestic authority but limited ability to compel immediate action by foreign providers. The problem is intensified when urgent financial intervention requires faster cooperation than conventional mutual legal assistance procedures can deliver. International cybercrime scholarship has long emphasized that territorial jurisdiction and digital evidence often operate on different timelines [11; 28]. The digitalization-capacity gap thus includes a cross-border component that cannot be solved solely through domestic reform.

A fifth dimension is analytical. Fraud evolves through imitation, experimentation, and platform migration. New schemes may combine older elements—phone deception, phishing, investment manipulation with newer tools such as synthetic media or AI-generated scripts. FinCEN’s alert concerning deepfake-enabled fraud illustrates how rapidly deceptive techniques can evolve and how financial-compliance institutions must be updated accordingly [21]. The challenge for Kazakhstan is not only to block known schemes but also to build a learning system capable of detecting pattern shifts before they become routine.

Table 3 summarizes these dimensions and shows how each gap affects prevention, detection, or response. The table also clarifies that anti-fraud policy should be evaluated as an integrated governance system rather than as a set of isolated measures.

Table 3. Institutional Dimensions of the Digitalization-Capacity Gap in Kazakhstan

Gap dimension	Manifestation	Consequence	Priority response
Temporal	Funds move faster than review, complaint processing, and coordinated blocking	Lower probability of interruption and recovery	First-hour response protocols; temporary risk-based intervention
Informational	Signals are separated among banks, telecom operators, platforms, and police	Fragmented understanding of fraud clusters	Shared risk taxonomy; secure data-exchange procedures
Organizational	Actors have different mandates, systems, and incentives	Coordination remains ad hoc	Permanent interagency and public-private anti-fraud mechanism
Jurisdictional	Hosting, communication, offenders, and assets may be outside Kazakhstan	Domestic authority is insufficient for urgent action	Rapid liaison channels; standardized cross-border referrals
Analytical	Fraud schemes evolve faster than threat classifications	Delayed recognition of new patterns	Unified incident analytics; periodic threat assessment

Source: compiled by the author on the basis of the institutional analysis presented in the article and [14; 21; 25-27; 30].

International institutional models and their relevance for Kazakhstan

The fourth result is that international experience offers three complementary models of anti-fraud governance. The first is the shared responsibility model represented by Singapore. The Shared Responsibility Framework introduced by the Monetary Authority of Singapore and the Infocomm Media Development Authority distributes obligations among banks and telecommunications companies in relation to scam-related harms [22]. The importance of this model lies not only in liability allocation. Its deeper contribution is institutional: it recognizes that fraudulent harm is produced through a chain of interacting services, and therefore prevention requires a chain of responsibility.

For Kazakhstan, the Singaporean experience is relevant because many fraud schemes combine a communication component and a payment component. A bank may be able to identify suspicious transfers, but it cannot alone prevent spoofed calls. A telecom operator may be able to reduce fraudulent traffic, but it cannot independently assess payment risk. Shared responsibility frameworks can reduce the tendency to shift blame after victimization and instead promote ex ante operational standards. Nevertheless, direct copying would be inappropriate. Any Kazakhstani adaptation would need to consider domestic banking structure, telecom regulation, consumer-protection norms, and the legal basis for information exchange.

The second model is the European Union's emphasis on supranational threat intelligence and cross-border coordination. Europol's IOCTA reporting provides a structured assessment of organized cybercrime, including scam ecosystems, criminal services, automation, and transnational infrastructures [19]. The value of such reporting is not limited to public awareness. It helps create a common analytical language among law-enforcement bodies and regulators. For Kazakhstan, this suggests the importance of a standardized national classification of digital fraud

mechanisms and a stronger link between domestic incident analysis and international threat intelligence.

The third model is the United States' complaint-based analytical architecture. IC3 collects and publishes structured information on internet-enabled crime, while FinCEN issues alerts that translate emerging fraud patterns into compliance-relevant guidance for financial institutions [20; 21]. These instruments are important because they transform dispersed complaints into a knowledge base. They help identify trends, prioritize threats, and align public awareness with institutional risk management. Kazakhstan could benefit from a unified fraud-incident registry that integrates complaints, financial indicators, and information from digital service providers, subject to privacy and procedural safeguards.

International models also highlight that anti-fraud governance should combine prevention, interruption, and learning. Prevention reduces exposure to fraudulent communication. Interruption stops or slows fund movement during the critical window. Learning transforms incidents into institutional knowledge that improves future detection. A system that performs only one of these functions remains incomplete. Table 4 compares Kazakhstan with Singapore, the European Union, and the United States according to their dominant institutional mechanisms and the lessons most relevant for national adaptation.

Table 4. Comparative Institutional Models for Countering Digital Financial Fraud

Jurisdiction	Dominant mechanism	Strength of the model	Relevance for Kazakhstan
Singapore	Shared responsibility framework	Connects preventive duties of banks and telecom actors	Useful for distributed responsibility and ex ante coordination
European Union	Threat intelligence and supranational coordination	Creates common threat vocabulary and cross-border analytical focus	Relevant for classification systems and international information exchange
United States	Complaint-based analytics and compliance alerts	Transforms dispersed incidents into strategic intelligence	Applicable to a unified incident registry and risk-alert system
Kazakhstan	Developing cybercrime initiatives and public awareness	Institutional recognition of fraud as a security issue	Needs stronger real-time coordination and integrated analytics

Source: compiled by the author on the basis of [17-22].

Applicability of foreign mechanisms to Kazakhstan

The fifth result is that the most transferable foreign mechanisms are those that strengthen coordination without requiring the wholesale transplantation of another country's legal regime. Four mechanisms appear especially relevant. First, Kazakhstan could develop a formal multi-actor anti-fraud coordination protocol connecting banks, telecom operators, regulators, and specialized law-enforcement units. Second, a unified incident analytics system could help detect clusters of similar schemes and generate early warnings. Third, rapid temporary intervention procedures could be defined for high-risk transaction patterns, subject to legal review and proportionality. Fourth, international liaison channels could be strengthened for urgent requests related to fraudulent domains, communication infrastructure, and asset tracing.

The literature on institutions and collaborative governance suggests that transferability depends on fit rather than imitation [25-27; 30]. A model that works in a highly centralized city-state may require adaptation in a larger jurisdiction with different market actors. A supranational

system such as the European Union cannot be reproduced domestically, but its emphasis on shared indicators and common threat classification can be adopted at national and regional levels. Similarly, the United States' complaint-based analytics may inspire a Kazakhstani system even if the institutional histories differ.

Table 5 provides an applicability matrix. It distinguishes between high-priority mechanisms that can plausibly be advanced through national coordination and medium-term mechanisms that require more extensive legal, technical, or international alignment. The matrix is intended as an analytical tool, not as a final legislative blueprint.

Table 5. Applicability Matrix of Foreign Anti-Fraud Mechanisms for Kazakhstan

Mechanism	Priority	Expected effect	Main implementation constraint
Multi-actor anti-fraud coordination protocol	High	Reduces delay between signal detection and escalation	Requires clear legal mandates and responsibility mapping
Unified fraud-incident analytics platform	High	Improves clustering, trend detection, and early warning	Requires interoperable data standards and privacy safeguards
Rapid temporary intervention for high-risk transfers	High	Increases chance of preserving funds during the critical window	Requires proportionality, appeal procedures, and accountability
Telecom and platform anti-spoofing coordination	Medium–High	Limits the initial reach of impersonation campaigns	Depends on technical standards and operator cooperation
Cross-border urgent referral channels	Medium	Improves take-downs, evidence preservation, and asset tracing	Depends on foreign partner responsiveness and legal compatibility

Source: compiled by the author on the basis of the comparative analysis and [22; 25; 26; 27; 30].

Evaluation indicators for anti-fraud governance

The sixth result concerns measurement. Anti-fraud governance is often discussed through legal reforms, public campaigns, or the number of detected cases, but these indicators do not fully reflect institutional effectiveness. A growing number of detected cases may indicate improved enforcement, wider victimization, better reporting, or all three simultaneously. For policy purposes, Kazakhstan needs a more operational set of indicators that measure whether institutions are becoming faster, more coordinated, and more capable of learning from incidents. Governance scholarship emphasizes that institutional capacity should be assessed by problem-solving performance rather than by formal institutional presence alone [14; 30].

A first group of indicators should measure time. These include the interval between the first suspicious signal and its escalation, the time between a victim's report and a temporary transaction freeze where legally permissible, and the time needed to issue sector-wide warnings when a recurring scam pattern is identified. A second group should measure coordination: the number of standardized cross-sector alerts, the share of major fraud patterns that trigger joint analysis, and the proportion of cases in which banks, telecom operators, and law-enforcement bodies exchange operationally relevant information under defined procedures. Such indicators correspond to whole-of-government and collaborative governance approaches, which evaluate institutions through their capacity to connect fragmented actors [26; 27].

A third group should measure learning and international responsiveness. These indicators may include the frequency of updated fraud typologies, the speed of referral to foreign partners when domains or payment routes are located abroad, and the share of recurring schemes for which preventive guidance was issued before a significant escalation of harm. None of these indicators is simple to implement, and some require legal and technical prerequisites. Yet without a measurement framework, anti-fraud policy risks being evaluated only through general statements rather than through the operational features that determine whether losses can actually be prevented. Table 6 offers a compact indicator set for future institutional monitoring in Kazakhstan.

Table 6. Suggested Evaluation Indicators for Anti-Fraud Governance in Kazakhstan

Indicator group	Illustrative metric	Policy meaning	Primary institutional users
Response speed	Time from first risk signal to escalation	Shows whether institutions can act within the fraud window	Banks; regulator; police
Intervention speed	Time from complaint to legally permissible temporary freeze	Measures practical capacity to preserve funds	Banks; police; judiciary where required
Coordination density	Number of standardized cross-sector alerts and joint analyses	Shows whether fragmented signals are being connected	Banks; telecom operators; platforms; regulator
Learning capacity	Frequency of updated scam typologies and sector guidance	Measures adaptation to evolving fraud scripts	Regulator; police; financial intelligence actors
International responsiveness	Time to urgent foreign referral for infrastructure or asset-tracing requests	Captures the cross-border dimension of response	Law enforcement; international liaison units
Preventive effectiveness	Share of recurring fraud patterns addressed by guidance before large-scale escalation	Assesses whether institutions move from reaction to anticipation	All anti-fraud governance participants

Source: compiled by the author as a prospective monitoring framework, drawing on [14; 26; 27; 30].

Discussion

The findings support the article's central hypothesis: the rise and persistence of transnational financial fraud in digitalizing environments are best explained not by technological change alone, but by the relationship between technological acceleration and institutional response capacity. Digitalization increases the availability of rapid transactions, normalized remote communication, and platform-mediated interaction. Fraud networks exploit these conditions by operating across multiple infrastructures and by breaking the scheme into modular roles. When institutions detect only fragments of the chain, or when intervention is slower than the circulation of funds, the system creates an opportunity for repeated victimization. The digitalization-capacity gap therefore describes a governance problem rather than a simple technological deficit.

This interpretation adds to the literature in several ways. The economics of online crime emphasizes reduced offender costs and scalable attack models [4]. Fraud victimization studies explain how persuasion, urgency, and authority facilitate compliance [7; 8]. Cybercrime research analyzes the territorial ambiguity of digital harm and the distributed nature of criminal networks [10-13; 23; 24]. Governance scholarship, in turn, focuses on implementation capacity, coordination, and institutional learning [14; 25-27; 30]. The digitalization-capacity gap brings these strands together. It explains why technical measures, user education, and criminal prosecution are all necessary but insufficient when they are not embedded in a coordinated response architecture.

The concept also clarifies the limits of an exclusively victim-centered approach. Public campaigns warning citizens against suspicious links, unknown callers, or unrealistic investment returns remain important. Yet they cannot neutralize fraud at scale if offenders continuously imitate legitimate communication channels and if payment infrastructures allow rapid extraction after a victim's initial compliance. A mature anti-fraud system must place responsibility not only on individual caution but also on institutional design. In this respect, the article aligns with research on electronic crime, which emphasizes that technological systems create specific opportunity structures that require corresponding prevention models [28].

A second implication concerns public-private coordination. In many fraud cases, no single actor sees the entire threat. Telecom providers may detect anomalous call patterns without knowing whether a payment follows. Banks may detect unusual transfer behavior without knowing that the customer is simultaneously speaking to a spoofed caller. Platforms may identify fraudulent advertisements without access to downstream transaction data. Law-enforcement bodies may receive complaints after the funds have already moved. Collaborative governance theory suggests that such problems require structured interaction based on clear roles, information protocols, and shared objectives [27]. Whole-of-government approaches also indicate that complex risks should not be split into rigid administrative silos when effective response depends on synchronization [26].

The Singaporean shared responsibility framework is important in this regard because it recognizes the chain character of scam-related harm [22]. Its relevance for Kazakhstan lies less in the specific legal allocation of losses and more in the institutional principle of distributed prevention. Fraud prevention should be organized before the moment of loss, not only through post-factum dispute resolution. Banks, telecom operators, regulators, and digital platforms should know in advance which alerts can be transmitted, which temporary actions are legally permissible, and which authority coordinates escalation when a scheme appears to be spreading.

The European Union and the United States provide different but complementary lessons. Europol's threat assessments demonstrate the value of continuously updated analytical knowledge that connects separate fraud categories to wider organized cybercrime markets [19]. IC3 and FinCEN show how complaint collection and compliance alerts can transform incident reporting into strategic intelligence [20; 21]. For Kazakhstan, a comparable system would not necessarily require a large new institution. It could begin with standardized fraud typologies, shared incident tags, interoperable reporting channels, and periodic analytical reviews involving the regulator, financial sector, telecom operators, and law-enforcement bodies.

The article also has implications for international cooperation. Transnational fraud frequently depends on infrastructure located outside the victim's jurisdiction. Rapid take-down requests, domain suspension, exchange of payment-risk indicators, and asset tracing may require communication with foreign authorities or private entities that operate under different legal regimes. Traditional mutual legal assistance remains relevant, but its timelines may not always match the urgent phase of fraud interruption. This does not mean that due process should be bypassed. It means that states need parallel channels for operational indicators, emergency referrals, and standardized evidence preservation. International cybercrime research has long noted that the velocity of digital evidence challenges conventional jurisdictional routines [11; 28].

The Kazakhstani case is particularly significant because it reflects a broader dilemma faced by rapidly modernizing states. Digital transformation strategies frequently focus on infrastructure, access, and service delivery. Those priorities are justified. However, the legitimacy of digital modernization depends on whether citizens experience the system as trustworthy. If public institutions promote digitalization while fraudulent actors exploit the same channels more effectively than responsible authorities can respond, a credibility deficit may emerge. The digitalization-capacity gap thus concerns not only fraud reduction but also the political sustainability of digital governance.

The institutional perspective also helps avoid two simplifications. The first is technological determinism, the assumption that fraud increases simply because digital tools exist. The article shows that organizational and jurisdictional conditions determine whether tools become systematic vulnerabilities. The second is formal legalism, the assumption that new laws alone solve coordination problems. Institutional theory emphasizes that rules matter when they are implemented through incentives, routines, capacities, and enforcement mechanisms [25]. Problem-solving capacity requires not only legal authority but also trained personnel, compatible data systems, actionable metrics, and institutional feedback loops [30].

From a policy perspective, five priorities follow. First, Kazakhstan would benefit from a permanent anti-fraud coordination platform that includes financial regulators, banks, telecom operators, specialized police units, and selected digital-service providers. Second, high-risk fraud indicators should be standardized so that actors can exchange operationally meaningful signals rather than unstructured complaints. Third, urgent intervention procedures should be designed for the first hours after a suspicious transaction, when interruption may still be feasible. Fourth, complaint data should be converted into analytical intelligence rather than remaining a record of completed harm. Fifth, international liaison mechanisms should focus on speed, evidence preservation, and infrastructure disruption in addition to conventional investigative cooperation.

These recommendations require legal safeguards. Expanded coordination should not become a justification for indiscriminate surveillance, opaque blocking, or disproportionate restrictions on digital access. Anti-fraud governance must balance effectiveness with data protection, due process, and transparency. A citizen whose transaction is temporarily delayed because of a risk trigger should have access to clear procedures and correction mechanisms. A financial institution sharing risk information should operate within defined legal boundaries. A telecom operator limiting suspicious traffic should do so through accountable technical standards. The legitimacy of anti-fraud policy depends on both protection and restraint.

The article also opens a regional research agenda. Kazakhstan shares with several Central Asian states a combination of rapid digitalization, expanding mobile connectivity, and evolving institutional capacity. Comparative research could examine whether similar fraud ecosystems emerge across the region, how regulatory and law-enforcement structures differ, and whether regional cooperation mechanisms could improve early-warning systems. Such analysis would enrich both international relations scholarship and practical policy debate by connecting cyber-enabled fraud to broader questions of regional resilience and transboundary risk governance.

Finally, the proposed model should be tested empirically. Future studies could use incident-level datasets to measure the time between victim contact, transaction initiation, bank response, complaint registration, and fund freezing. Interviews with banks, telecom operators, regulators, and investigators could identify bottlenecks in real-time coordination. Comparative case studies could examine failed and successful interventions to determine which mechanisms most effectively reduce loss. The digitalization-capacity gap is designed as a starting framework for such inquiry, not as a closed explanation.

Conclusion

Transnational financial fraud in the context of digitalization should be understood as a multidimensional security challenge located at the intersection of financial modernization, cybercrime, institutional capacity, and international cooperation. The Kazakhstani case demonstrates that the expansion of digital services and payment instruments creates major benefits for citizens and the economy, but it also increases the relevance of rapid and coordinated anti-fraud governance. Fraudsters do not merely exploit technical weaknesses; they exploit the interaction between digital trust, urgent communication, fragmented institutional signals, and the speed of financial flows.

The article proposed the concept of a digitalization-capacity gap to explain this problem. The gap arises when the adaptive speed of fraudulent networks exceeds the speed with which legitimate institutions can prevent, detect, exchange information about, and interrupt fraudulent activity. In Kazakhstan, this gap is expressed through four core dimensions: temporal delay, informational fragmentation, organizational coordination barriers, and jurisdictional dependence on cross-border procedures. An additional analytical challenge lies in the ability of institutions to learn from emerging fraud patterns before they become routine.

The comparative analysis of Singapore, the European Union, and the United States shows that successful anti-fraud policy is not limited to public warnings or post-incident prosecution. It depends on shared responsibility, structured threat intelligence, complaint-based analytics, rapid coordination, and the ability to convert isolated signals into timely interventions. These lessons are directly relevant for Kazakhstan, although they must be adapted to national legal, administrative, and market conditions rather than copied mechanically.

The practical conclusion is that Kazakhstan would benefit from an integrated anti-fraud governance architecture. Such an architecture should include a permanent coordination mechanism among banks, telecom operators, regulators, law-enforcement bodies, and digital platforms; standardized fraud typologies; a unified incident-analytics layer; clear procedures for urgent temporary intervention; and strengthened international channels for infrastructure disruption and asset tracing. These mechanisms should be accompanied by safeguards for data protection, proportionality, and transparency.

The broader significance of the article lies in its attempt to connect digitalization policy with questions of international security and institutional resilience. States that digitize quickly must not treat fraud prevention as a secondary technical issue. It is part of the trust infrastructure of the digital state. Further research should test the proposed framework with empirical datasets, regional comparisons, and expert interviews. Such work would help move the debate from reactive fraud control toward a more anticipatory model of transnational digital risk governance.

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ЦИФРЛАНДЫРУ ЖАҒДАЙЫНДАҒЫ ТРАНСҰЛТТЫҚ ҚАРЖЫЛЫҚ АЛАЯҚТЫҚ: ҚАЗАҚСТАННЫҢ ИНСТИТУЦИОНАЛДЫҚ СЫН-ҚАТЕРЛЕРІ ЖӘНЕ ХАЛЫҚАРАЛЫҚ ҚАРСЫ ІС- ҚИМЫЛ ТЕТІКТЕРІ

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Аңдатпа. Мақалада трансұлттық қаржылық алаяқтық Қазақстандағы жедел цифрландыру жағдайында қалыптасып отырған институционалдық қауіпсіздік сын-қатері ретінде қарастырылады. Мобильді төлемдердің, цифрлық мемлекеттік қызметтердің, қашықтан сәйкестендіру жүйелерінің, платформалық коммуникацияның және трансшекаралық қаржы құралдарының кеңеюі алаяқтық әрекеттердің ауқымын ғана емес, олардың ұйымдасу логикасын да өзгертетіні негізделді. Қазіргі схемалар әлеуметтік инженерияны, байланыс арналарын бұрмалауды, шетелдік хостингті, дропперлер желісін, қаражатты криптоактивтерге конвертациялауды және халықаралық төлем маршруттарын ұштастыра қолданады. Нәтижесінде қарсы іс-қимылдың тиімділігі жекелеген техникалық тосқауылдарға емес, институттардың қауіптің даму жылдамдығымен салыстырмалы режимде үйлесімді әрекет ету қабілетіне тәуелді болады. Мақаланың мақсаты - Қазақстандағы цифрлық қаржылық алаяқтықтың не себепті трансұлттық сипат алып отырғанын түсіндіру және ұлттық тәжірибеге бейімдеуге болатын шетелдік институционалдық тетіктерді айқындау. Зерттеу саясат құжаттарын, ресми есептерді және киберқылмыс, алаяқтықтан виктимизация, институционалдық әлеует пен бірлескен реттеу

мәселелеріне арналған академиялық әдебиеттерді сапалық салыстырмалы-институционалдық талдау негізінде жүргізілді. Мақалада «цифрландыру мен институционалдық әлеует арасындағы алшақтық» тұжырымдамасы дамытылады; ол цифрлық экожүйелердегі қылмыстық бейімделу қарқыны мен институционалдық алдын алу, ақпарат алмасу, жедел араласу және трансшекаралық ынтымақтастық мүмкіндіктерінің жылдамдығы арасындағы сәйкессіздік ретінде түсіндіріледі. Зерттеу нәтижелері Қазақстанның негізгі осал тұстары уақыттық, ақпараттық, ұйымдастырушылық және юрисдикциялық өлшемдерде көрінетінін көрсетеді. Сингапур, Еуропалық одақ және АҚШ тәжірибесін салыстырмалы бағалау бөлінген жауапкершілік модельдерінің, қауіптерді талдау платформаларының, шағымдарға негізделген аналитиканың және жедел әрекет ету механизмдерінің маңызын айқындайды. Қорытындыда Қазақстанда қаржы реттеушілерін, банктерді, телекоммуникация операторларын, құқық қорғау органдарын, цифрлық платформаларды және халықаралық серіктестерді біріктіретін алаяқтыққа қарсы интеграцияланған басқару архитектурасын қалыптастыру қажеттігі негізделеді.

Түйін сөздер: трансұлттық қаржылық алаяқтық; цифрландыру; Қазақстан; халықаралық қауіпсіздік; киберқылмыс; институционалдық әлеует; алаяқтыққа қарсы басқару; ведомствоаралық үйлестіру; трансшекаралық ынтымақтастық.

ТРАНСНАЦИОНАЛЬНОЕ ФИНАНСОВОЕ МОШЕННИЧЕСТВО В УСЛОВИЯХ ЦИФРОВИЗАЦИИ: ИНСТИТУЦИОНАЛЬНЫЕ ВЫЗОВЫ КАЗАХСТАНА И МЕЖДУНАРОДНЫЕ МЕХАНИЗМЫ ПРОТИВОДЕЙСТВИЯ

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Аннотация. В статье транснациональное финансовое мошенничество рассматривается как институциональный вызов безопасности, формирующийся в условиях ускоренной цифровизации Казахстана. Обосновывается, что распространение мобильных платежей, цифровых государственных услуг, дистанционной идентификации, платформенной коммуникации и трансграничных финансовых инструментов изменило не только масштабы мошеннической активности, но и её организационную логику. Современные схемы всё чаще сочетают социальную инженерию, подмену коммуникаций, зарубежный хостинг, сети дропперов, конвертацию средств в криптоактивы и международные платежные маршруты. В результате эффективность противодействия определяется не столько отдельными техническими барьерами, сколько способностью институтов координироваться в режиме, сопоставимом со скоростью развития угрозы. Цель статьи- объяснить, почему цифровое финансовое мошенничество в Казахстане приобретает транснациональный характер, и определить зарубежные институциональные механизмы, которые могут быть адаптированы в национальной практике. Исследование выполнено на основе качественного сравнительно-институционального анализа документов политики, официальных отчётов и академической литературы по киберпреступности, виктимизации от мошенничества, институциональной ёмкости и совместному регулированию. В статье развивается концепция «разрыва между цифровизацией и институциональной ёмкостью», понимаемого как несоответствие между скоростью криминальной адаптации в цифровых экосистемах и скоростью институциональной превенции, обмена информацией, срочного вмешательства и трансграничного сотрудничества. Результаты показывают, что ключевые уязвимости Казахстана имеют временное, информационное, организационное и юрисдикционное измерения. Сравнительная оценка опыта Сингапура, Европейского союза и США демонстрирует значимость моделей распределённой ответственности, платформ

аналитики угроз, жалобо-ориентированной аналитики и механизмов быстрого реагирования. Делается вывод о необходимости формирования в Казахстане интегрированной архитектуры антифрод-управления, объединяющей финансовых регуляторов, банки, телеком-операторов, правоохранительные органы, цифровые платформы и международных партнёров.

Ключевые слова: транснациональное финансовое мошенничество; цифровизация; Казахстан; международная безопасность; киберпреступность; институциональная ёмкость; антифрод-управление; межведомственная координация; трансграничное сотрудничество.

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From Authoritative Pronouncement to Dialogic Repair: Digital Leadership and Public Resonance in Corporate Crisis Communication

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Abstract

Digital platform has fundamentally changed enterprise crisis communication and changed crisis interpretation from organizational control to continuous public negotiation. Though the existing researches have extensively investigated crisis coping strategies and digital leadership, relatively little attention has been paid to how business leaders modify organizational discourse to cope with the ever-changing public interpretation. In order to solve this gap, this study investigates how digital leadership makes the organization change from authoritative statement to dialogue repair during the enterprise crisis. Using a retrospective multi-case design, this study compares three high-profile corporate crises, involving United Airlines, Facebook's Cambridge Analytica scandal, and Starbucks' Philadelphia incident. The analysis is based on a selected online corpus of 42 public texts related to the event, including company statements, executive communications, media reports, regulatory documents and public discourse. By comparative qualitative analysis, this study found a common process of connecting closed authoritative meaning, public anti-frame, discourse dislocation, dialogue repair and differentiated public resonance. The results show that the initial response of enterprises often fails, not because of insufficient information, but because the definition of crisis is different from that of the affected public. Only when organizations recognize the legitimacy of public experience, expand the responsibility from individuals to organizational systems, and institutionalize corrective measures through observable organizational changes will dialogue repair be effective. In this study, three kinds of repair trajectories-forced reversal, gradual responsibility expansion and rapid relationship absorption-are further identified, which have partial, controversial and repair resonance respectively. By conceptualizing digital leadership as a discourse and relational ability, rather than just a technical ability, this study expands the research on digital leadership, crisis communication and organizational legitimacy in the public environment of digital networks.

Keywords: Digital leadership; Crisis communication; Dialogic repair; Public resonance; Corporate crisis; Comparative case study

1. Introduction

1.1 Enterprise Crisis and Leadership Challenge on Digital Platform

The enterprise crisis on the digital platform is no longer told by a single organization center. Though a company may issue its first official statement, it cannot determine the final meaning of an event. Smartphone videos, user testimonies, employee accounts, news surveys, labels and platform comments allow different interpretations to be spread before an organization stabilizes its accounts. Thus, the online public does more than just receive and evaluate company information: they participate in defining what a crisis is, whose experience is important and who should be responsible. Therefore, social media public opinion is better understood as a temporary

evolution configuration of interactive voices, rather than a unified audience waiting for authoritative information (Frandsen & Johansen, 2017; Zhang et al., 2022). Thus, the voice of enterprises has changed from an authoritative endpoint to a controversial contribution in the field of production in a broader sense.

The different reactions of three world-renowned companies make this change particularly obvious. After forcibly removing a passenger from United Express Flight 3411, United Airlines initially foretold its operating procedures and employee behaviors, and then turned to clear apologies, organizational responsibilities and corrective measures (United Airlines, 2017). In analyzing the controversy in Cambridge, Facebook first emphasized the violation of platform rules by third parties, but then acknowledged the broader weaknesses in platform governance and announced additional restrictions on data access (Facebook, 2018). In contrast, Starbucks quickly upgraded the arrest of two blacks in a store in Philadelphia to the level of CEO, and linked its public apology with stakeholder participation, national racial prejudice education and policy reflection (Starbucks, 2018). All three companies face the same general challenge-the legitimacy crisis of digital amplification-but follow obviously different paths of cognition, responsibility and organizational correction.

1.2 The Research Paradox and Explanatory Puzzle

1.2 Research paradox and explanation confusion

Traditional crisis management logic regards timeliness, factual accuracy and information consistency as prerequisites for effective organizational response. However, these three cases reveal a persistent paradox: organizations may respond quickly and provide explanations that are consistent with the facts, but they will still aggravate public opposition. Companies may explain that the established procedures have been followed, but they seem indifferent to the consequences of these procedures, blaming external actors, not checking the favorable organizational structure, or expressing sympathy, but not taking responsibility and not linking communication with observable changes. Therefore, the core question is no longer whether the organization responds, or even whether their information is accurate, but why some responses help to restore legitimacy, while others become lasting evidence of organizational detachment, evasion or moral failure.

Situation crisis communication theory explains how attribution responsibility shapes reputation threats and the strategic appropriateness of different organizations (Coombs, 2007, 2022). Image restoration research also regards denial, shirking responsibility, corrective actions and humiliation as important discourse resources available to organizations under threat (Benoit, 1997). Generally speaking, these viewpoints show that the content of countermeasures is very important. However, they rarely explain why the public will reinterpret events, challenge the definition of organizational problems, and re-disseminate corporate statements through opposing narratives once the actually consistent or strategically appropriate responses enter the digital network environment, thus often losing legitimacy.

From this perspective, crisis escalation often stems from the mismatch between the questions answered by the organization and the questions that the online public thinks must be answered. Company statements usually define disputes in operational, legal or technical terms, while the public reconstructs disputes in terms of dignity, fairness, privacy, discrimination and responsibility. When it is spread on the digital platform, the original company explanation becomes searchable and citable, and can be easily re-contextualized as evidence of organizational separation rather than organizational responsibility. Therefore, the phenomenon that needs to be explained is not whether organizations apologize, but how they realize the inconsistency of words and turn from authoritative statement to relationship repair.

1.3 Theoretical Tension, Research Problems and Contributions

The existing research only leaves some visible processes. Digital Leadership Scholarship largely examines how leaders develop digital vision, promote technology adoption and guide organizational transformation. Even if the field has been expanded, its dominant focus is still internal competence, employee adaptation, innovation and organizational performance, rather than leadership in front of the external network public (Avolio et al., 2014; Khaw et al., 2022). The orientation explains how leaders mobilize organizations to make digital changes, but it provides less leverage for understanding how executives respond when the digital public questions the interpretation, responsibility and legitimacy of organizations. An unresolved question is not whether leadership is generated through digital technology, but how leadership is decentralized when organizational authority itself becomes open for negotiation.

The study of crisis communication provides the second important foundation. Image restoration theory and situational crisis communication theory provide powerful explanations for organizations to choose denial, dilution, reconstruction, apology and corrective action strategies to deal with different crisis responsibility allocation (Benoit, 1997; Combs, 2007). These methods, however, are easier to explain which response may be appropriate, rather than openly refuting how to enter the subsequent administrative discourse and change the organization's definition of crisis. By regarding the response as an identifiable strategy, the existing model may underestimate the recursive nature of the digital media crisis, in which each organization statement will generate a new explanation and may need further adjustment. Therefore, polysemy requires more attention to the interaction between different voices and the structure of the crisis meaning evolving with time (Frandsen & Johansen, 2017).

Research on dialogue communication and organizational listening is closer to this problem by emphasizing the reciprocity, responsiveness and the ability of organizations to receive public voices (Kent & Taylor, 2002; McNamara, 2016). However, the key link between listening and repair has not been fully developed. People may have the opportunity to express their opinions, and their concern will not change the judgment of the organization. Managers may use empathetic language without modifying their responsibilities. Enterprises may commit to dialogue while retaining their original explanations and practices. So, the theoretical question is not only whether an organization listens, but when public debate becomes important enough to reshape the words and actions of enterprises.

In this context, this study raises three questions: How did business leaders initially establish their authority through crisis discourse? What can the online public and media actors do to reconstruct the enterprise crisis and expose the imbalance of cognition, emotion and norms? What kind of discourse and organizational practice has the company produced remedial, partial or anti-resonance? The comparative qualitative analysis of United Airlines, Facebook and Starbucks combines digital discourse analysis with time tracking of cross-company statements, administrative communications, media texts and public online comments.

The study develops dialogue repair into a recursive process, through which organizations recognize public experience, correct the meaning of crisis, expand the boundary of responsibility, and link the corrected words with observable actions. In doing so, it puts forward three related arguments. At first, it repositions digital leadership from the internal guiding ability of managing technological change to the practice of public, discourse and relationship with coordinated meaning. Second, it extends the study of crisis communication beyond the choice of static response by explaining how corporate discourse changes in round after round of public debates. Third, it defines public resonance not only as favorable reaction or information dissemination, but also as the degree to which organizational discourse is consistent or contrary to public explanation, emotion and normative judgment. Therefore, digital leadership is not demonstrated by speaking first or maintaining the ability of explanatory control. It is manifested in the ability to allow public

debate to reshape organizational decision-making and response.

2. Literature Review and Theoretical Framework

2.1 Digital Leadership: From Technological Change to Relationship Governance

2.1.1 Technical and organizational direction

Digital leadership research stems from the understanding that information technology has reshaped the generation, dissemination and reception of leadership influence. Early e-leadership scholarships conceptualized leadership as an interactive process embedded among leaders, followers, organizational structure and technology (Avolio et al., 2000, 2014). The following research examines how leaders express their digital vision, promote technology adoption, and keep organizational culture consistent with the changes in digital support. It has been confirmed by recent reviews that this field is still strongly oriented towards internal transformation and results, such as organizational agility, employee adaptability, innovation and sustainable performance (Khaw et al., 2022; Bauwens & Cortellazzo, 2025).

2.1.2 Blind spots in external relations

These documents explain how leaders mobilize organizations to carry out digital changes, but when the organization authority is questioned by the external network public, it does not provide a lever to understand leadership. The digital platform exposes corporate statements to direct scrutiny by consumers, journalists, activists, regulators and affected communities. Therefore, leadership includes not only guiding change, but also negotiating the public significance of organizational behavior. As part of leadership is made up of framing questions, assigning responsibilities and legalizing the language of specific responses (Fairhurst and Grant, 2010), this study defines digital leadership as the ability to identify public debates, recalibrate organizational discourse and responsibilities, and mobilize organizational change to meet the challenges of digital media.

2.2 Enterprise Crisis Discourse: From Coping Strategies to Meaning Control

2.2.1 Strategic response to tradition

The theory of image restoration holds that denying, evading responsibility, reducing aggression, corrective action and humiliation are the strategies for an organization to defend or restore its image (Benoit, 1997). Context crisis communication theory further explains how crisis types, attribution responsibilities and reputation threats affect the appropriateness of refusing, reducing and rebuilding responses (Coombs, 2007, 2022). These traditions believe that crisis discourse is very important because it affects the attribution of public responsibility and the evaluation of organizational legitimacy.

2.2.2 From static response to authoritative statement

However, their main explanation focuses on matching identifiable countermeasures with specific crisis configurations. This orientation masks the recursion of the digital crisis, in which corporate statements will lead to criticism, counterclaims and modification requirements. In contrast, polysemy conceptualizes crisis communication as a stage where organizations, news, politics and public voices compete to define events and assign responsibilities (Frandsen & Johansen, 2017). Therefore, the unresolved issue is not only which coping strategy an organization chooses, but how the public anti-framework changes its subsequent discourse.

The authoritative statement is defined as a kind of discourse practice on the basis of these viewpoints. Through this practice, the company uses its institutional position, information advantages and procedural expertise to give a relatively closed explanation of the crisis facts, responsibilities and legal explanations. It usually operates through fact closure, procedural

legitimacy, liability limitation and positioning the public as the receiver of meaning rather than the co-producer. Authoritative statements are not inherently invalid, because clarity of facts may be indispensable under uncertain circumstances. Procedural interpretation becomes a problem when it is used to end an argument that the public has reconstructed into dignity, justice, privacy, discrimination or organizational responsibility.

2.3 Networked Publics and Discursive Misalignment

2.3.1 Publics as Producers of Crisis Meaning

Framing theory demonstrates that communication does more than select information: it defines problems, identifies causes, makes moral evaluations, and recommends remedies (Entman, 1993). Networked publics participate directly in these functions. Through videos, personal testimony, hashtags, comments, and recirculated corporate statements, publics may shift a crisis from an operational frame to a moral one, or from individual misconduct to structural responsibility. Crisis information therefore circulates among organizations, social-media creators, and followers rather than through a single organizational channel (Austin et al., 2012). Recent research similarly characterizes online opinion as configurations of interacting groups and as an ongoing negotiation of publicly acceptable positions (Zhang et al., 2022; Baden et al., 2025).

2.3.2 Three Forms of Discursive Misalignment

These dynamics create discursive misalignment: a divergence between the corporate account and public constructions of what the crisis is, how it should be felt, and who should answer for it. Cognitive misalignment concerns competing definitions of the event or its causes. Affective misalignment emerges when procedural or legally cautious language fails to acknowledge visible suffering, anger, or humiliation. Normative misalignment arises when corporate appeals to procedural compliance conflict with public judgments about fairness, dignity, privacy, and responsibility.

This distinction matters because additional facts cannot necessarily resolve a conflict centered on moral recognition rather than informational uncertainty. A corporation may therefore provide increasingly detailed explanations without addressing the issue that has come to organize public judgment. Under such conditions, more communication can reproduce rather than correct the original misalignment.

2.4 Dialogue, Organizational Listening, and Repair

2.4.1 From Technical Interactivity to Substantive Dialogue

Dialogic public-relations theory challenges the treatment of publics as targets of organizational messaging. Dialogue requires mutuality, openness, responsiveness, commitment, and a willingness to accept the risks associated with interaction (Kent & Taylor, 1998, 2002). Yet comment functions, social-media replies, and interactive channels do not themselves establish dialogue. Research on digital dialogic communication identifies a persistent tendency to equate technological interactivity with relational engagement, even when organizations remain unwilling to revise their positions or practices (Sommerfeldt & Yang, 2018; Kent, 2021).

The distinction is consequential. An organization may invite questions while determining in advance which questions count as legitimate. It may respond frequently while repeatedly reproducing its original account. Dialogue must therefore be distinguished from the mere circulation of messages between organizational and public actors.

2.4.2 Organizational Listening and Revisability

Organizational-listening research sharpens this critique by distinguishing opportunities to speak from institutional capacities to hear. Organizations frequently invest heavily in message

production while lacking structures that recognize, interpret, circulate, and act upon public input (Macnamara, 2016, 2018, 2023). Recent research has begun to connect crisis response with dialogic competency, but has focused primarily on internal publics and immediate relational outcomes (Kim et al., 2023). The decisive criterion is therefore revisability: public voice becomes organizationally consequential only when it can alter sensemaking, responsibility attribution, or action.

From this perspective, listening is not demonstrated by the collection of comments or the performance of empathy. It requires an organizational pathway through which public contestation can reach decision-makers, challenge existing assumptions, and produce observable changes in discourse or practice. The theoretical question consequently shifts from whether an organization permits public expression to whether it becomes answerable to what publics express.

2.4.3 Dialogue repair and its limitations

On the basis of these traditions, this study defines dialogue repair as a recursive process. Through this process, organizations can cope with discourse dislocation by recognizing public experience, reconstructing crisis, expanding organizational responsibility and linking corrected discourse with corrective action. Accreditation verifies the relevance between the experience of the affected public and the organizational account. Reconstruction brings the elements of public anti-frame into the definition of crisis. Responsibility goes beyond externalized or isolated personal accusations. Action endows discourse change with institutional credibility.

Dialogue has become restorative, not because corporate language has become more sympathetic, but because public debate has gained the ability to change organizational words and deeds. In contrast, the performance dialogue borrows the language of listening, openness and empathy, while retaining the existing responsibility boundaries and organizational practices. This kind of communication may aggravate distrust, because it raises the expectation of recognition and inhibits substantive changes. Therefore, we must evaluate the repair through the relationship between words, responsibilities and behaviors, not through the stylistic enthusiasm of apology.

2.5 From response effect to public resonance

2.5.1 Consensus of the public resonance

Crisis response is usually evaluated by organizational reputation, trust, anger, forgiveness, purchase intention or information sharing. These indicators are still valuable, but they do not fully reflect whether a company's account can be used in public interpretation. High visibility is particularly vague: a statement may be circulated because it is accepted, but it may also be circulated because it symbolizes the indifference, evasion or hypocrisy of the organization.

According to the frame resonance research and the recent public opinion negotiation theory of digital media, public resonance is defined as the degree to which corporate discourse is understood, recycled and incorporated into public explanation, emotion and normative judgment (Benford & Snow, 2000; Baden et al., 2025). Restorative resonance reflects the substantial consistency between the revised corporate discourse and the public definition of injury and responsibility. When the public accepts a specific explanation or reform, and the broader relationship distrust persists, it will have a partial resonance. When corporate discourse is widely spread, but it is used to strengthen opposing explanations, it will produce anti-resonance.

2.5.2 Comprehensive framework

Then there are three related theoretical gaps. First of all, digital leadership research underestimates the leadership in front of the external network public. Secondly, the crisis communication theory explains the choice of response more effectively than the discourse changes in successive rounds of public debates. Thirdly, the study of dialogue and organizational

listening establishes the conditions of response, but it does not fully explain the connection mechanism between public voice and enterprise repair.

The framework developed here links these documents through a process model. The closure of authoritative meaning promotes public reconstruction; Public reconstruction exposes the dislocation of cognition, emotion and norms; Organization reacts through cognition, reconstruction, responsibility and action, resulting in repair, partial or anti-resonance. Therefore, the focus of explanation shifts from whether the company communicates to whether the public debate can modify the words and behaviors of the organization.

3. Research Design

3.1 Research Methods

3.1.1 Abductive Comparative Case Study

This study employs an abductive comparative case study design to explain how corporate crisis discourse changes during multiple rounds of public discourse. Comparative case studies are appropriate when the research objective is theoretical explanation rather than statistical presentation (Eisenhardt, 1989). Abductive reasoning allows for iteration between empirical materials and heuristic concepts, enabling unexpected observations to correct the initial framework rather than forcibly categorizing data into presupposed categories (Dubois & Gadde, 2002). Therefore, this study's analysis starts with authoritative statements, discourse misalignment, dialogue repair, and public resonance, while remaining open to other mechanisms and counter-evidence.

3.1.2 Digital Discourse Analysis and Temporal Process Tracking

This study combines digital discourse analysis and temporal process analysis. Digital discourse analysis views online texts as practices by which actors construct events, identities, responsibilities, and legitimacy (Tamássy & Géring, 2022). Time-based analysis reconstructs how these constructs change during a crisis, rather than linking isolated statements to subsequent reputational outcomes (Langley, 1999). The core analytical unit is the discourse event: official statements, the resulting media and public reactions, and any subsequent organizational revisions or actions.

3.2 Case Selection and Theoretical Comparison

3.2.1 Selection Criteria

The authors carefully selected the United Airlines Flight 3411 incident, the Facebook-Cambridge Analytica incident, and the Philadelphia Starbucks arrest incident as case studies. Each case involves a globally renowned company, has extensive digital exposure, and has undergone multiple rounds of official responses, executive intervention, and publicly visible corrective actions. Furthermore, these cases differ in the crisis domain, the visibility of damage, the speed of response, accountability, and the observability of actions. Therefore, their distinctly different trajectories allow us to examine the impact of public protest on organizations.

3.2.2 Event-Defined Sampling Window

The sampling window for each case is limited to the period between the first major public communication or disclosure event and the milestone event of the first substantial corrective action. This window covers the initial exposure, the first official response, intense public and media debate, and revisions by executives or the organization. Subsequent material is only included when directly assessing the implementation or impact of announced reforms. This event-based boundary maintains temporal comparability without assuming that crises unfold at the same pace.

3.3 Data Sources and Corpus Construction

3.3.1 Organizational Texts, Media Texts, and Public Texts

This corpus integrates three types of publicly available texts. Organizational texts include company statements, executive letters and interviews, official social media posts, testimonies, and policy announcements. Media texts include reports and commentaries from authoritative media outlets at key turning points. Public texts include highly interactive comments, cited posts, hashtag discussions, and statements from relevant advocates or experts. All eligible organizational texts were retained; the sampling of media and public texts was purposeful, aiming to capture different framing, temporal changes, and supportive and critical responses.

3.3.2 Documentation Rules

Duplicate entries, unverifiable screenshots, posts suspected of being automatically posted, and materials from private or closed spaces were excluded. Each retained entry records its source type, platform, posting time, URL, case, crisis stage, and relationship to a specific discourse event. This source log establishes a traceable chain between original materials, coded decisions, and theoretical claims.

3.4 Data Analysis

3.4.1 Internal Reconstruction and Coding of Cases

The analysis was conducted in three phases. First, a chronological narrative and event diagram were constructed for each case. Second, the text was open-ended coded, focusing on fact-finding, procedural legitimacy, externalization of responsibility, public counterframing, acknowledgment, reconstruction, extension of responsibility, corrective action, and resonance. Coding memos documented category revisions and anomalous passages.

3.4.2 Cross-Case Mechanism Comparison

Third, a time matrix linked corporate discourse, public response, organizational reform, and action. The comparison focused on the timing of responses, depth of responsibility, visibility of action, and persistence of counterframing. Other interpretations, including crisis severity, visual evidence, prior reputation, and regulatory pressure, were compared and evaluated against the observed sequence. Continuing criticism after apologies or reforms was retained as negative evidence rather than considered analytical noise.

3.5 Credibility and Research Ethics

Credibility was enhanced through information source triangulation, chronological tables, reflective memos, transparent chains of evidence, and explicit reporting of contradictory materials (Cloutier & Ravasi, 2021). Public access to information does not automatically grant ethical permission. Private spaces are excluded, ordinary users are anonymized, and searchable comments are rewritten unless absolutely necessary for analysis. Verbal quotations are primarily reserved for corporate actors, public officials, mainstream media, and others speaking in a clearly defined public capacity (franzke et al., 2020).

4. Findings

This section reports the results of a comparative qualitative analysis of a selected online corpus containing 42 public texts related to events (14 for each crisis). This corpus includes company statements, executive communications, regulatory documents, major news reports, and publicly indexed social media discourse. This analysis does not treat the three crises separately, but rather compares recurring narratives in different cases to identify common mechanisms and explain the differences in the outcomes of the repairs.

The encoding process progresses from primary expression to secondary themes and aggregation processes. The twelve primary codes are summarized into four higher-order dimensions: authoritative meaning closure, public anti-framing, dialogical acceptance, and remediation credibility. Thus, the analysis traces a common process: organizations initially narrow the scope of the crisis, the public subsequently broadens its meaning, and corporate leaders differ in whether and how they incorporate external controversy into organizational reform.

Table 4.1. Composition of the Web Corpus

Case	Corporate/executive	Regulatory/advocacy	Media/public discourse	Total
United Airlines	4	0	10	14
Facebook-Cambridge Analytica	5	1	8	14
Starbucks Philadelphia	4	3	7	14
Total	13	4	25	42

Table 4.2. Data Structure Used in the Findings

Representative first-order codes	Second-order themes	Aggregate dimensions
Using technical or procedural vocabulary to depersonalize harm	Proceduralizing the event	Authoritative meaning closure
Defining misconduct as a breach by employees, users, or third parties	Externalizing responsibility	Authoritative meaning closure
Presenting existing rules as the primary legitimacy standard	Privileging compliance	Authoritative meaning closure
Using video, testimony, or lived experience to redefine the event	Making harm publicly visible	Public counter-framing
Mocking or reusing corporate wording against the organization	Semantically appropriating corporate language	Public counter-framing
Connecting individual incidents to culture, architecture, or systemic bias	Structuralizing responsibility	Public counter-framing
Naming the experienced harm in terms used by affected publics	Recognizing public experience	Dialogic uptake
Changing the corporate definition of what the crisis concerns	Reframing the crisis	Dialogic uptake
Moving blame from isolated actors toward policies and systems	Expanding organizational responsibility	Dialogic uptake
Linking revised discourse to	Institutionalizing corrective	Dialogic uptake

Representative first-order codes	Second-order themes	Aggregate dimensions
concrete policy or governance changes	action	
Making action visible, costly, and assessable to external actors	Increasing action observability	Repair credibility
Retaining criticism where reforms remain delayed, opaque, or narrow	Sustaining counter-frames	Resonance outcome

4.1 Closure of Authority: Narrowing the Scope of Responsibility

In all three cases, the organizations attempted to reduce uncertainty by clearly defining the sequence of events and attributing responsibility. Despite differing communication strategies, coding analysis consistently identified three recurring themes—proceduralization of the incident, externalization of responsibility, and emphasis on compliance—which together constituted closure of authority.

United Airlines relied most heavily on procedural discourse. Its initial statement described the incident as an operational disruption requiring "rescheduling" for customers, while subsequent internal communications emphasized that employees followed established procedures. The airline did not deny the incident but characterized it as an operational issue whose legitimacy depended on adherence to existing rules.

Facebook employed a legal-technical framework. Early statements emphasized Cambridge Analytica's violation of platform policies and distinguished the incident from a technical data breach. Therefore, responsibility remained focused on the misconduct of a third party, rather than Facebook's own platform architecture or governance practices.

Starbucks initially responded with an incident review framework but quickly revised its position. Within two days, CEO Kevin Johnson acknowledged that internal rules and training led to the incident and stated that calling the police was inappropriate. Unlike the other two companies, Starbucks did not continue to defend its actions by citing existing procedures as sufficient evidence of organizational legitimacy.

In these three cases, the authoritative conclusions did not rely on denying the facts, but rather on narrowing the scope of accountability. Companies defined the crisis as a procedural compliance issue or isolated misconduct, while the public increasingly viewed these incidents as broader issues of organizational responsibility.

Cross-case analysis findings: Initial communication failures were not due to a lack of information on the part of the companies, but rather because their definition of the problem was narrower than the public perceived.

4.2 Public Counter-Framework: Expanding Harm, Liability, and Legitimacy

Public counter-framework systematically expands the company's definition of a crisis by altering the constituent elements of evidence, liability, and legitimacy.

In the United Airlines and Starbucks cases, smartphone videos, by directly presenting the harm, superseded the company's official explanations. Images of passengers being forcibly dragged off planes and two customers being handcuffed in coffee shops transformed abstract organizational processes into shocking instances of coercion, humiliation, and unequal treatment. Once the harm becomes publicly visible, procedural explanations are no longer seen as neutral descriptions but as evidence of a company's misunderstanding of the nature of the crisis.

Facebook took a different approach because similar visual evidence was absent. Instead,

journalists, tech commentators, and public figures transformed technical issues concerning API permissions and data sharing into everyday concerns about privacy, user control, and democratic accountability. The DeleteFacebook movement further condensed these concerns into a broader critique of platform governance, although some commentators also pointed out that many users had no viable alternative but to leave the platform.

Public discourse itself appropriated corporate language. United Airlines' wording regarding "rescheduling" and "volunteers" was widely ridiculed in news commentary, dictionary entries, and online parodies. Instead of conveying meaning for a stable organization, official language became a persistent symbol of bureaucratic indifference.

In all three cases, the scope of responsibility expanded from individual actors to the entire organizational system. The public is increasingly inclined to interpret these crises as reflections of organizational culture, governance, and institutional design, rather than isolated operational failures.

Cross-case analysis reveals that the public's reverse framing does more than just amplify negative emotions; it redefines what constitutes harm, who should bear responsibility, and what legitimacy standards corporate responses should adhere to.

4.3 Discursive Misalignment: Why Initial Responses Intensified the Crisis

Comparative analysis revealed three closely related forms of discursive misalignment.

Cognitive misalignment emerged because organizations and publics defined different problems. United discussed operational procedures, whereas publics discussed dignity and organizational power. Facebook emphasized third-party rule violations, while public discourse increasingly focused on platform governance and structural accountability. Starbucks rapidly shifted from an individual store incident to broader concerns regarding racial discrimination and organizational culture.

Affective misalignment reflected differences in emotional orientation. Procedural, legal, and technical language created considerable emotional distance from visible experiences of harm. This distance was greatest in the United Airlines case, where administrative language appeared alongside graphic images of physical coercion. Starbucks reduced this gap earlier by explicitly acknowledging wrongdoing and expressing personal responsibility through its CEO.

Normative misalignment concerned competing standards of legitimacy. Organizations initially relied on procedural compliance, whereas publics questioned whether the procedures themselves were morally acceptable. Across all three cases, detailed explanations of organizational rules failed to reduce criticism because they addressed authorization rather than justification.

These findings explain why rapid communication can itself produce a secondary crisis. Once an initial frame becomes publicly interpreted as evasive, subsequent communication must repair not only the original incident but also the organization's earlier interpretation of that incident.

Cross-case finding. Discursive misalignment originated from competing definitions of legitimacy rather than from insufficient factual information.

4.4 Dialogic Uptake: Transforming Public Contestation into Organizational Revision

Dialogic repair began when organizations recognized public interpretations as legitimate inputs into organizational meaning-making. Although timing differed substantially, all three cases displayed four sequential components: recognition, reframing, responsibility expansion, and institutionalization.

Recognition involved acknowledging the public experience of harm. United eventually abandoned procedural language and directly apologized to the removed passenger. Facebook reframed the incident as a breach of trust between the company and its users. Starbucks explicitly accepted responsibility and acknowledged that police intervention should never have occurred.

Reframing followed recognition. United shifted attention from operational disruption toward customer dignity and service failure. Facebook broadened the crisis from third-party misconduct to platform responsibility, culminating in Zuckerberg's Senate testimony that leadership bore responsibility for what occurred on the platform. Starbucks reframed the incident as evidence of organizational vulnerability involving implicit bias, inclusion, and company culture.

Responsibility then expanded from individual actors toward organizational systems. United revised boarding policies and crew management procedures. Facebook acknowledged shortcomings in API governance, platform oversight, and executive accountability. Starbucks identified training practices and organizational culture as contributing factors rather than treating the incident as an isolated managerial error.

Finally, revised discourse became credible only when accompanied by observable action. United introduced ten operational reforms concerning passenger boarding and law-enforcement involvement. Facebook implemented technical governance reforms and later became subject to strengthened regulatory oversight. Starbucks closed more than 8,000 stores for nationwide bias training involving external civil-rights experts. Although all three organizations implemented reforms, public evaluations differed according to the visibility and assessability of these actions.

Cross-case comparison indicates that repair became credible only when recognition, responsibility, and action remained closely coupled. Apologies without organizational revision appeared symbolic, whereas technical reforms without public recognition remained insufficiently persuasive.

Cross-case finding. Dialogic repair occurred when public interpretations reshaped organizational meaning, responsibility, and institutional practice simultaneously.

4.5 Repair Trajectories and Differentiated Public Resonance

The comparative analysis identified three distinct repair trajectories differing primarily in responsiveness, responsibility expansion, and action observability.

Table 4.3. Cross-Case Repair Trajectories

Case	Initial closure	Dominant counter-frame	Revision pattern	Action observability	Resonance outcome
United Airlines	Procedure and passenger compliance	Bodily harm, dignity, coercive power	Rapid forced reversal	High: ten directly linked policy changes	Partial resonance; initial wording remains iconic
Facebook	Third-party violation and non-breach classification	Platform architecture, consent, privacy, democracy	Gradual responsibility expansion	Medium: substantial but technically opaque; later regulatory oversight	Limited/contested resonance
Starbucks	Store incident and review	Racial profiling, unequal belonging, organizational discretion	Rapid relational uptake	High: visible nationwide closure and expert-designed training	Comparatively reparative but conditional resonance

United Airlines followed a trajectory that was forced to reverse. Before the company admitted the responsibility, the strong procedural closure had a wide-ranging anti-resonance. The initial statement is still a lasting symbol of the organization's indifference, although the subsequent operational reform directly solved many public concerns. Therefore, the company only partially resonated.

Facebook follows a gradually institutionalized track. With major technological reforms, the responsibility has gradually expanded from third-party misconduct to broader platform governance. Nevertheless, many reforms are still difficult for ordinary users to evaluate, and finally strengthened through external regulatory intervention. Therefore, public trust is only partially restored, leading to limited or controversial resonance.

Starbucks has followed a track of rapid development of relations. Early administrative intervention, clear responsibilities, participation of stakeholders and highly visible organizational actions make the public's concern about racial discrimination enter the enterprise discourse and organizational practice. Though critics question whether one-off bias training can produce lasting structural changes, Starbucks has a relatively stronger restorative resonance than the other two companies.

The comparison of three trajectories determines three conditions for forming resonance results. First of all, reactivity affects whether the initial corporate framework will be permanently associated with organizational evasion. Second, the depth of responsibility determines whether the repair is aimed at isolated individuals or potential organizational systems. Thirdly, the observability of action affects whether the public can evaluate organizational commitment beyond symbolic communication. These conditions work together, not independently.

Therefore, the main findings are procedural. Digital leadership in crisis is not implemented by retaining the authority of the original narrative, but by making the narrative modifiable according to public debate. Only when external criticism crosses three organizational thresholds can repair become effective: recognition as legal evidence, transformation into expanded organizational responsibility, and institutionalization through visible corrective actions.

5. Discussion

The comparison results show that enterprise crisis communication in digital environment is better understood as a dynamic process of meaning negotiation, rather than the implementation of discrete communication strategies. In these three cases, the organization did not fail because of lack of information or slow response in each case. On the contrary, when their initial explanation no longer conforms to the public's understanding of harm, responsibility and legitimacy, they fail. Therefore, these findings expand the current understanding of digital leadership, crisis communication and public resonance by emphasizing the importance of dialogue correction in the whole crisis response process.

5.1 Digital leadership as a discourse and relationship practice

These findings broaden the general understanding of digital leadership by shifting attention from technical ability to public meaning management. Existing research mainly conceptualizes digital leadership as the ability to promote digital transformation, integrate emerging technologies or support data-driven decision-making. Although these abilities are still very important, this study shows that digital leaders are increasingly operating in the networked public sphere, in which the legitimacy of organizations is constantly negotiated rather than maintained by the administration.

In all three cases, administrative intervention becomes important, not because senior leaders have more formal power, but because they have the ability to modify organizational interpretation to deal with external disputes. Therefore, digital leadership is not only to convey organizational decisions. It also includes identifying when organizational narrative is out of touch

with public explanations, and enabling these explanations to reshape subsequent communication and organizational actions.

These findings show that the authority in the digital environment no longer mainly comes from the control of information. On the contrary, authority increasingly depends on whether leaders can promote organizational adaptation by integrating external feedback into the evolving crisis definition. Therefore, effective digital leadership represents a kind of relationship ability, through which organizations can constantly negotiate with different public, instead of maintaining explanatory control, thus maintaining legitimacy.

5.2 From information deficiency to cognitive deficiency

These findings are also helpful for crisis communication research by redefining the source of communication failure. The traditional methods often interpret unsuccessful crisis response as the result of delayed disclosure, insufficient information or improper strategic choice. Although these factors are still relevant, the current comparison shows that communication barriers often stem from cognitive errors rather than information errors.

Both United Airlines and Facebook provided a lot of facts in the early stage of the crisis. But these explanations mainly involve procedural compliance, legal differences or technical classification, rather than damage forms recognized by the affected public. Therefore, the additional information failed to reduce the controversy, because the organization continued to answer questions that the public no longer asked.

In this case, recognition does not mean unconditional acceptance of every public claim. On the contrary, it refers to the recognition that public experience constitutes legal evidence to define organizational problems. Only after organizations realize that humiliation, loss of privacy, discrimination or unequal treatment are not only emotional reactions, but also meaningful explanations that need organizational response can dialogue repair become possible.

This view shifts crisis communication from communication mode to relationship mode. Success of communication lies not only in the accurate information provided by the organization, but also in the fact that the accountant of the organization recognizes the legitimacy of public experience and integrates this experience into the revised explanation of responsibility.

5.3 Dialogue repair as a recursive organization process

Another contribution is about the conceptualization of crisis recovery itself. The existing crisis communication framework often divides organizational responses into relatively independent categories, such as denial, excuse, apology, compensation or corrective measures. Although useful in analysis, these typologies usually regard countermeasures as isolated strategic choices rather than interrelated stages in the evolution process.

On the contrary, comparative analysis shows that dialogue correction is recursive. As the evolution of public interpretation, organizations have repeatedly revised their responses, and experienced recognition, reconstruction, responsibility expansion and institutionalization. Repair does not happen once, but develops through continuous interaction between organizational communication and public feedback.

The three repair trajectories further show that different time patterns will produce different relationship results. As United Airlines has demonstrated, forced reversal enables organizations to finally make policies meet public expectations, but it cannot eliminate the symbolic significance of the initial defensive response. Facebook's example shows that the gradual expansion of responsibilities reduces legal and organizational risks, but it seems not enough, because institutional reform is still difficult for ordinary users to evaluate. Rapid relationship absorption demonstrated by Starbucks has produced relatively stronger public acceptance, because identification, responsibility and visible actions are closely linked. However, even this

trajectory has not eliminated the public's persistent concern about the persistence of organizational change.

These comparisons show that crisis recovery should be understood as an iterative organizational learning process, rather than a single communication event.

5.4 Conditions for public resonance and theoretical contribution

This comparison determines three conditions for the formation of public resonance.

Firstly, time responsiveness affects whether the initial organizational explanation is institutionalized as a lasting symbol of organizational escape. Once the defensive framework is widely circulated, the subsequent corrective communication will face an additional challenge, that is, repairing the organization's early explanation of the crisis.

Secondly, responsibility expansion determines the depth of relationship repair. It is not enough to express sympathy unless it is accompanied by a clear organizational accountability system. When organizations shift their responsibilities from isolated individuals to the policies, governance structures and organizational systems they control, repair becomes more convincing.

Third, the observability of actions affects whether the public thinks communication is credible. Visible and concrete corrective actions with high organizational costs have a stronger resonance, because they enable external audiences to evaluate whether organizational commitment has been transformed into institutional change. On the contrary, despite a large amount of organizational investment, technically opaque or difficult-to-verify reforms have produced more limited relationship results.

Generally speaking, these findings contribute to three research directions.

First of all, they expanded the research of digital leadership by conceptualizing leadership as discourse and relationship ability exercised in digital network public space, not just organizational ability of digital transformation.

Secondly, they put forward that dialogue repair is a recursive process, through which organizations constantly modify the definition of problems, the attribution of responsibilities and organizational actions to deal with public disputes, thus making contributions to the academic field of crisis communication.

Finally, by distinguishing communication visibility from public resonance, they made contributions to the study of public opinion and organizational legitimacy. Organizations can achieve extensive message dissemination without generating relationship acceptance. Therefore, this study distinguishes between restorative resonance, partial resonance and controversial resonance, indicating that the effectiveness of crisis communication depends not so much on the arrival of information, but on the degree of organizational communication and public explanation readjustment.

Generally speaking, the research results show that digital leadership in crisis is not achieved through stronger control of organizational narratives, but through the ability to modify these narratives by acknowledging public experience, expanding organizational responsibility and institutionalizing observable changes. Therefore, in the digital network environment, the restoration of legitimacy depends not so much on authoritative statements as on continuous dialogue participation.

6. Conclusion

By comparing three prominent organizational crises, namely United Airlines, Facebook and Starbucks, this study examines how digital leaders shape corporate crisis communication. The study does not regard crisis response as an isolated communication strategy, but conceptualizes crisis communication as a dynamic process, through which organizations negotiate with the digital network public about significance, responsibility and legitimacy. Through the comparative analysis

of the online corpus of event definition, this study traces a common process of connecting closed authoritative meaning, public anti-frame, discourse dislocation, dialogue repair and differentiated public resonance.

These findings have produced three main conclusions.

First of all, authoritative enterprise communication will not necessarily fail because the information provided by the organization is inaccurate or insufficient. Conversely, when the problems defined by the organization are different from those recognized by the affected public, communication becomes ineffective. In these three cases, the initial response emphasized procedures, rules and compliance, while public discourse increasingly evaluated dignity, fairness, privacy and organizational responsibility. Therefore, the escalation of the crisis reflects different interpretations of legitimacy, rather than a simple lack of information.

Second, dialogue repair occurs when organizations allow public explanations to reshape their own understanding of the crisis. Effective repair requires more than an apology or symbolic expression of sympathy. The organizations realize that the public experience is legal, expand the responsibility from the individual to the organizational system, and translate the revised explanation into observable institutional actions, and they achieve greater relationship recovery. Therefore, dialogue revision should be understood as a continuous organizational learning process, rather than a single communication event.

Third, digital leadership goes beyond technical ability or communication efficiency. Leadership is increasingly dependent on the ability to identify discourse dislocation, modify organizational narrative according to external feedback and coordinate meaningful organizational changes in the digital network environment. Therefore, digital leadership is achieved through constant consultation on the legitimacy of the organization, rather than by maintaining the authority of interpretation.

Several limitations should be acknowledged. First of all, the analysis relies entirely on the public text, so it can't fully capture the decision-making process of internal organizations or the strategic consideration before public communication. Second, the online corpus is designed for theoretical comparison rather than statistical representation; Therefore, the survey results should be interpreted as an explanatory mechanism, rather than a general model of public opinion. Finally, the study focuses on three noticeable enterprise crises in the western platform environment, and whether the proposed mechanism can be transplanted to other institutions or cultural environments needs further study.

Future research may expand this work in several directions. By combining public discourse analysis with executive interviews or internal organizational data, we can more comprehensively understand how dialogue repair develops within the organization. Experimental research can further test how different combinations of cognition, responsibility and corrective measures affect public trust and organizational legitimacy. The comparative study of cross-industry, political background and cultural background will also help to evaluate the wider applicability of dialogue repair as a digital leadership model in crisis communication.

Generally speaking, the study believes that digital leadership in crisis is not defined by faster or more authoritative communication skills. On the contrary, it lies in the ability to identify when organizational explanations are no longer consistent with public understanding, and to transform external arguments into meaningful organizational learning, institutional change and new legitimacy.

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Economic Sciences

Digital Analytics in the AI Era: Comparative Analysis of 15 Marketing Models and Their Effectiveness

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ABSTRACT

The rapid integration of artificial intelligence (AI) into digital marketing has fundamentally transformed how organizations apply and evaluate marketing models. This paper presents a systematic comparative analysis of 15 of the most widely cited marketing models, selected through bibliometric analysis of Google Scholar data, alongside review of major textbooks, university syllabi, and professional resources from HubSpot, McKinsey, Forrester, and Google Digital Garage. The 15 models are classified into three functional categories — audit, planning, and strategy — and analyzed for their core functions, empirical application contexts, and adaptation potential under AI-driven digital analytics conditions. The paper further draws on primary research conducted among Georgian companies and consumers (n=275), providing an emerging-economy perspective on model adoption rates and limitations. Findings reveal that while classical models such as AIDA, 4Ps, and STP remain foundational, AI-era tools demand their integration with data-driven frameworks such as RACE, TAM, and the See-Think-Do-Care model. The paper concludes by proposing an updated classification matrix that links each model to specific AI analytics capabilities, offering both academic and practical value for marketers navigating the digital transformation landscape.

Keywords: digital marketing models, AI in marketing, digital analytics, RACE planning, AIDA, TAM, marketing model classification, Georgian business, marketing effectiveness

1. Introduction

The digital marketing landscape has undergone a paradigm shift in the past decade. Where traditional marketing frameworks once served as stable anchors for strategic planning, the emergence of artificial intelligence, machine learning, big data analytics, and an ever-expanding array of digital channels has fundamentally altered the operating environment for marketers. The question is no longer simply which model to apply, but rather which models remain relevant, which need updating, and how they interact with AI-powered analytics platforms.

Marketing models serve as structured theoretical or practical frameworks that describe how marketing elements are deployed to achieve specific objectives. They encompass strategies, methods, and instruments that help organizations identify consumer needs, achieve market positioning, and attain competitive advantage (Rajer, 2023). Yet as the digital environment grows

more complex, the gap between classical model assumptions and real-world AI-era conditions has widened considerably.

This paper addresses that gap through a systematic comparative analysis of 15 marketing models that have been identified as the most widely applied in both academic and professional contexts. The selection methodology is grounded in bibliometric evidence: each model's citation frequency was determined through Google Scholar analysis, supplemented by review of leading marketing textbooks (Kotler & Keller; Chaffey), university course syllabi, and practitioner resources from authoritative sources including HubSpot, SmartInsights, McKinsey, Forrester, and Google Digital Garage.

The analysis is additionally informed by primary empirical research conducted in Georgia, an emerging economy where digital marketing adoption is accelerating but where systematic academic research on model usage remains limited. Two empirical studies involving 97 companies and bloggers (Study I) and 178 consumers (Study II), conducted using structured online questionnaires and analyzed with IBM SPSS through correlation analysis, ANOVA, and linear regression, provide a contextual grounding for the theoretical discussion.

The paper is structured as follows: Section 2 presents the methodological approach. Section 3 provides the classification of the 15 models. Section 4 delivers the comparative analysis of each model's core function, strengths, and weaknesses. Section 5 examines how AI and digital analytics transform model application. Section 6 presents findings from Georgian practice. Section 7 concludes with implications and recommendations.

2. Methodology

The research employs a mixed-method approach combining secondary research (systematic literature review and bibliometric analysis) with primary empirical data. Four complementary methods were used to establish the relevance and selection of the 15 models:

1. **Bibliometric frequency analysis:** Google Scholar search counts for each model were retrieved and used as a primary indicator of academic citation volume and scholarly penetration.
2. **Textbook prevalence review:** Frequently assigned marketing textbooks (Kotler & Keller; Chaffey et al.) were reviewed to confirm which models form part of established marketing education curricula.
3. **Practitioner recognition:** Professional blogs, white papers, and guides from HubSpot, SmartInsights, McKinsey, Forrester, and Google Digital Garage were reviewed to assess real-world usage.
4. **Google Trends analysis:** Search trend data confirmed the relative popularity and recency of interest in each model across time periods (see Appendix 1 of the parent dissertation).

Primary data was collected through structured online questionnaires administered to 97 companies and bloggers (Study I, correlational design using Pearson correlation and multivariate regression) and 178 individual consumers (Study II, using SPSS-analyzed ANOVA, linear regression, and Durbin-Watson coefficient for model stability). Respondents were purposively selected from active digital marketing practitioners in Georgia.

The 15 selected models were then classified into three functional categories — Audit, Planning, and Strategy — and analyzed comparatively across dimensions including origin, core mechanism, empirical strengths, limitations, and AI-era adaptability.

3. Classification of the 15 Marketing Models

Table 1 presents all 15 selected models with their citation frequencies, functional categories, and primary application domains.

Table 1. Top 15 Marketing Models: Selection and Classification

#	Model Name	Category	Primary Application	Google Scholar Citations
1	Technology Acceptance Model (TAM)	Audit	Planning & Strategy	4,720,000
2	RACE Planning Model	Planning	Digital Campaign Planning	4,620,000
3	Ten C's of Marketing (10C)	Audit	Digital Market Audit	4,440,000
4	SMART Goals	Planning	Goal Setting & KPIs	3,640,000
5	The Honeycomb Model	Strategy	Social Media Strategy	742,000
6	Forrester's 5Is	Audit	Engagement Measurement	323,000
7	See-Think-Do-Care (STDC)	Planning	Content Strategy	—
8	4Ps (Product, Price, Place, Promotion)	Strategy	Marketing Mix	43,500
9	AIDA Model	Audit	Communication & Ads	39,900
10	4Cs (Marketing Communications)	Strategy	Communication Strategy	20,000
11	STP Model	Strategy	Segmentation & Positioning	18,700
12	Hofacker's 5 Stages	Planning	Web UX & Information Processing	17,800
13	6Cs of Customer Motivation	Planning	E-commerce Motivation	16,300
14	Lauterborn's 4Cs	Audit	Consumer-Centric Audit	4,040
15	McKinsey's Consumer Decision Journey	Strategy	Decision-Making Analysis	—

Source: Author's compilation based on Google Scholar bibliometric analysis and practitioner resource review.

The 15 models were further classified into three functional groupings based on their primary analytical purpose, as shown in Table 2. This three-way classification reflects a logical division between tools used to assess the current state of a digital marketing system (Audit), tools used to design future action (Planning), and tools that inform broader market positioning and competitive strategy (Strategy).

Table 2. Three-Category Classification of the 15 Marketing Models

Audit Models	Planning Models	Strategy Models
Forrester's 5Is	6Cs of Customer Motivation	4Cs (Marketing Communications)
Lauterborn's 4Cs	Hofacker's 5 Stages	McKinsey's Consumer Decision Journey
Ten C's of Marketing (10C)	RACE Planning	The Honeycomb Model
AIDA Model	Technology Acceptance Model (TAM)	4Ps Model
	SMART Goals	STP Model
	See-Think-Do-Care	

Source: Author's original classification.

It is important to note that several models operate across multiple categories depending on their application context. AIDA, for instance, was classified primarily under Audit due to its diagnostic function in communication effectiveness assessment, but it is equally applied in

planning advertising content sequences. Similarly, the TAM model can serve both as a planning tool for technology roll-outs and as an evaluative framework for adoption outcome monitoring.

4. Comparative Analysis of the 15 Models

4.1 Audit Models

Forrester's 5Is (Involvement, Interaction, Intimacy, Influence, Individual) was developed by Forrester Research in 2007 as a response to the growing inadequacy of the traditional marketing funnel. Rather than tracing a linear path to purchase, the 5Is framework measures the depth and quality of brand engagement across five dimensions. As Forrester's Sean Corcoran later emphasized, achieving the 5Is does not automatically guarantee campaign success — the effectiveness of the model depends on the alignment of engagement metrics with the company's specific strategic goals. Empirical application using the Starbucks case demonstrates how the model identifies loyalty program participation (Involvement), social media dialogue (Interaction), personalized naming on cups (Intimacy), lifestyle influence (Influence), and order customization (Individual) as distinct measurable outcomes (Hanlon, 2025).

Lauterborn's 4Cs (Consumer wants and needs, Cost to satisfy, Convenience to buy, Communication) was proposed in 1990 as a consumer-centric alternative to the manufacturer-centric 4Ps. Its core argument — that marketing must start from what the customer actually wants rather than from what the company produces — was prescient. In the Netflix case, the model maps customer desire for flexible, on-demand, ad-free content (Consumer), the total cost perception relative to cable or DVD alternatives (Cost), multi-device accessibility (Convenience), and two-way personalized messaging (Communication). The 4Cs remain highly applicable in digital contexts, particularly for UX design and customer journey optimization (Hanlon, 2019).

The Ten C's of Marketing (10C) was developed by Richard Gay and colleagues at the Chartered Institute of Marketing in 2007. It places the Customer at the center and analyzes ten digital market dimensions including Corporate Culture, Competition, Convenience, Communication, Consistency, Creative Content, Customization, Coordination, and Control. The model is particularly valuable as a diagnostic audit tool because it simultaneously examines internal marketing processes and external competitive positioning. The Apple case illustrates how each C can be operationalized: Apple's minimalist branding addresses Consistency, the App Store ecosystem represents Coordination, and web analytics dashboards embody Control. Unlike more abstract frameworks, the 10C provides a practical checklist orientation for digital managers (Smart Insights, n.d.).

The AIDA Model (Attention, Interest, Desire, Action), one of the oldest marketing communication frameworks, traces consumer response through four sequential stages. Despite its age, AIDA remains among the most cited models in marketing education and practice, particularly in advertising copy design, social media campaign structuring, and email marketing sequences. Its strength lies in its clarity and versatility across B2C and B2B contexts. However, AIDA's primary weakness is its linearity — real consumer journeys, especially in digital environments, are rarely sequential. Extended variants such as AIDAS (adding Satisfaction), AIDCAS (adding Conviction), and AISDALSLove (adding Share and Love for social media contexts) have been proposed to address these limitations (Chakrabarty & Pandey, 2025). The Coca-Cola example demonstrates classic AIDA execution: emotionally evocative global advertising generates Attention; brand narrative creates Interest; social occasion association produces Desire; and retail availability triggers Action.

4.2 Planning Models

The 6Cs of Customer Motivation (Content, Customization, Community, Convenience, Cost Reduction, Choice) was developed by Dave Chaffey in 2004 as a framework for online value proposition design. It is particularly well-suited to e-commerce planning, where motivating customers to choose a digital platform over alternatives requires addressing each of the six drivers.

The Duolingo case illustrates the model's application in a gamified digital service context, where Content (language lessons), Choice (language selection), Control (self-paced learning), Collaboration (leaderboards), Constructing meaning (practical contexts), and Consequences (certificates) all operate as simultaneous motivational levers.

Hofacker's 5 Stages (Exposure, Attention, Comprehension, Yielding/Acceptance, Retention) was proposed by Charles Hofacker in 2000 to explain how website visitors process information. Although considered dated by some practitioners, the model retains analytical relevance for UX design and web content strategy. Its five stages map directly to digital user behavior: whether a visitor has sufficient dwell time on the page (Exposure), whether visual design elements capture focus (Attention), whether the content is correctly interpreted (Comprehension), whether the user takes the desired action (Yielding), and whether they return to the site (Retention). The Nike example demonstrates effective application: iconic slogans create Attention; clear brand meaning enables Comprehension; emotional resonance supports Yielding; and memorable brand associations ensure Retention (Smart Insights, n.d.).

The RACE Planning Model (Reach, Act, Convert, Engage) is a cyclically oriented digital marketing planning framework that integrates campaign design with performance measurement through KPIs. RACE's particular strength lies in its dual function: it provides a planning sequence (how to structure a digital marketing campaign from awareness through retention) and a performance monitoring framework (what to measure at each stage). The model is explicitly designed for commercial revenue growth and accommodates both short-term campaign cycles and long-term relationship management. It is complementary to the See-Think-Do-Care model in content strategy applications (Smart Insights, n.d.).

The Technology Acceptance Model (TAM) was developed by Fred Davis in 1989 at the University of Michigan to predict user adoption of computer systems. TAM operates through two core constructs: Perceived Usefulness (will this technology improve my performance?) and Perceived Ease of Use (is this technology easy to use?). In digital marketing contexts, TAM has been applied extensively to predict consumer adoption of e-commerce platforms, mobile payment systems, AI chatbots, and digital banking services. Its grounding in Ajzen and Fishbein's Theory of Reasoned Action gives it a psychologically robust theoretical foundation. TAM citations in Google Scholar exceed 4.7 million, making it the single most academically referenced model in this study's selection (Ma & Liu, 2011; Schorr, 2023).

SMART Goals (Specific, Measurable, Achievable, Relevant, Time-bound) functions as the operational goal-setting backbone for digital marketing planning. While not a marketing model in the classical sense, SMART Goals occupy a critical role in connecting strategic models to measurable KPIs. In digital marketing practice, SMART Goals translate broad campaign intentions into quantifiable targets: rather than 'increase social media presence,' a SMART goal would specify 'increase Instagram follower count by 15% within Q3 through three weekly posts and two paid campaigns.' SMART Goals were the fourth most cited model in this study's bibliometric analysis, reflecting their universal application across organizational contexts.

The See-Think-Do-Care (STDC) Model was developed specifically for the digital marketing environment to address the non-linear nature of modern consumer journeys. Unlike AIDA, STDC acknowledges that consumers exist in different mental states simultaneously — some are only aware (See), others are actively researching (Think), some are ready to purchase (Do), and existing customers need ongoing nurturing (Care). Each stage requires distinct content strategies, channel choices, and measurement metrics. STDC has been widely adopted by content marketing teams and is particularly associated with Google's content strategy methodology (Smart Insights, n.d.).

4.3 Strategy Models

The 4Cs for Marketing Communications (Clarity, Credibility, Consistency, Competitiveness) provides a framework for evaluating the quality of marketing communication strategies. Unlike

Lauterborn's 4Cs (which focus on consumer needs), this 4Cs model targets the internal quality of brand messaging. Clarity ensures messages are unambiguous; Credibility ensures they are believable; Consistency ensures they are unified across channels; and Competitiveness ensures they outperform rivals' communications. The Apple strategy table in the parent dissertation demonstrates all four: crystal-clear minimal design (Clarity), innovative product quality (Credibility), unified global branding (Consistency), and a superior ecosystem that competitors have been unable to replicate (Competitiveness).

McKinsey's Consumer Decision Journey (CDJ) challenged the traditional purchase funnel by proposing a circular, loyalty-loop-driven model of consumer decision-making. Rather than a linear progression toward purchase, CDJ identifies an Initial Consideration Set, Active Evaluation phase, Moment of Purchase, and Post-Purchase Experience that feeds into a Loyalty Loop for returning customers. In digital contexts, McKinsey's CDJ has proven particularly valuable for understanding how online reviews, comparison sites, influencer endorsements, and social proof intervene at each stage. The model has informed major shifts in how companies allocate budgets between awareness advertising and decision-stage content (Egol et al., 2014).

The Honeycomb Model (Identity, Conversations, Sharing, Presence, Relationships, Reputation, Groups) was designed specifically for social media marketing strategy, making it one of the more contemporary models in this selection. Its seven building blocks correspond to distinct social media functionalities that brands can activate or evaluate. The model is particularly useful for assessing which social media capabilities an organization is prioritizing versus neglecting, and for guiding platform-specific strategy design. Unlike models developed for pre-social media environments, the Honeycomb was built from research on how users actually engage with social platforms (Kietzmann et al., 2011).

The 4Ps Model (Product, Price, Place, Promotion), formalized by McCarthy in the 1960s and popularized by Kotler, remains the foundational strategic framework in marketing education. Despite repeated calls to extend or replace it — through 7Ps for services, 4Cs for consumer orientation, or IMC 2.0 for digital communication (Jackson & Ahuja, 2016) — the 4Ps persist because they provide a clear, operable structure for strategic decision-making that can be adapted to digital contexts. In e-commerce, Product encompasses digital features and UX design; Price includes dynamic pricing and subscription models; Place refers to digital distribution channels and logistics; and Promotion encompasses SEO, PPC, social media advertising, and content marketing.

The STP Model (Segmentation, Targeting, Positioning) is the dominant strategic framework for market orientation decisions. Segmentation divides the market into groups sharing common characteristics; Targeting selects the most attractive segments; Positioning defines how the brand's offering will be perceived relative to competitors within the target segment. In digital marketing, STP has evolved significantly: AI enables behavioral, psychographic, and contextual micro-segmentation at scale that was impossible with traditional demographic approaches. Real-time data streams allow continuous re-targeting, and A/B testing informs dynamic positioning adjustments. The STP model's enduring relevance rests on its logical architecture, which translates naturally into programmatic advertising workflows (Kotler & Armstrong, 2017).

5. AI-Era Transformation of Marketing Model Application

The advent of AI-powered digital analytics has not rendered traditional marketing models obsolete — rather, it has fundamentally changed the conditions under which they operate, the speed at which they can be applied, and the granularity of insight they can deliver. AI in marketing encompasses machine learning (ML) for pattern recognition and predictive modeling, natural language processing (NLP) for sentiment analysis and content generation, computer vision for visual search and ad creative optimization, and autonomous recommendation systems (Haleem et al., 2022; Ngai & Wu, 2022).

Three transformational dimensions define how AI reshapes marketing model application:

Real-time dynamism: Models that were designed for periodic strategic review cycles can now operate continuously. RACE planning cycles, traditionally quarterly or annual, can be executed in real time through AI dashboards that monitor KPIs, trigger automated optimizations, and generate performance reports without human intervention.

Hyper-personalization: Models based on segment-level assumptions (STP, 4Ps) can be adapted to individual-level precision. Amazon's anticipatory shipping model, which uses predictive analytics to pre-position products before customers have searched for them, represents the frontier of AI-enabled individual-level STP application (Lee, 2016).

Predictive capability: Historical data enables AI systems to forecast consumer behavior before it occurs. Predictive models can identify customers at risk of churn (enabling RACE Engage interventions), predict which AIDA stage a given customer is in based on behavioral signals, and optimize pricing algorithms within the 4Ps framework (Nanne et al., 2020; GhorbanTanhaei et al., 2024).

Table 3 presents the AI-era transformation matrix for the ten most AI-relevant models in this study's selection.

Table 3. AI-Era Transformation of Marketing Model Application

Model	Traditional Function	AI-Era Transformation
AIDA	Sequential funnel; static consumer journey	AI enables dynamic, non-linear path tracking; real-time attention capture via personalized ads; desire amplified through recommendation engines
STP	Manual demographic segmentation	AI-driven micro-segmentation using behavioral, psychographic and contextual big data; predictive targeting
4Ps	Company-centric management	Product: AI-generated co-creation; Price: dynamic pricing algorithms; Place: omnichannel AI routing; Promotion: programmatic advertising
RACE Planning	Periodic campaign cycles	Real-time optimization across Reach, Act, Convert, Engage; AI dashboards replace manual KPI reviews
TAM	Adoption prediction of new tech	Predicts AI tool adoption (chatbots, voice search) by employees and customers; used in martech evaluation
10C Model	Comprehensive digital audit framework	AI automates audit of all 10 Cs; sentiment analysis for Corporate Culture; AI chatbots for Communication
Forrester's 5Is	Engagement measurement	AI quantifies all 5Is continuously; Intimacy deepened via NLP-powered personalization; Influence tracked through social listening
6Cs Motivation	Consumer motivation mapping	AI personalizes each C in real time; content recommendations (Content), dynamic pricing (Cost), AI-driven choice architecture (Choice)
RACE + STDC	Content planning stages	AI generates stage-specific content; See: programmatic display; Think: search intent AI; Do: cart abandonment AI; Care: automated CRM sequences
McKinsey CDJ	Non-linear consumer journey	AI maps individual journey variants; predicts loyalty loop entry/exit; enables intervention at micro-moments

Source: Author's compilation.

A notable insight from this analysis is that the most AI-compatible models share a common architectural property: they are process-oriented rather than state-oriented. Models like RACE, STDC, and McKinsey's CDJ describe dynamic stages of consumer engagement that align naturally with real-time AI monitoring. In contrast, static mix models like 4Ps require more deliberate reimagination — their elements must be reinterpreted as algorithmic variables rather than fixed strategic choices.

It is equally important to acknowledge the limitations of AI integration. Algorithmic optimization risks over-fitting to short-term metrics, potentially undermining the Credibility (4Cs model) and Intimacy (Forrester's 5Is) dimensions that are fundamental to long-term brand equity. Järvinen (2016) warns that excessive focus on short-term conversion metrics can damage brand-building investments. The ethical dimension of AI personalization — particularly regarding data privacy (GDPR) and algorithmic transparency — also requires sustained attention from practitioners applying TAM and 6Cs frameworks.

6. Marketing Model Adoption in Georgian Companies: Empirical Evidence

Study IV of the parent dissertation involved a qualitative survey of Georgian companies across multiple sectors to determine which marketing models are applied in practice and how. The findings reveal a significant gap between the academic recognition of sophisticated models and their practical penetration in the Georgian business environment.

Table 4. Marketing Model Usage Among Georgian Companies (Study IV)

Model	Usage Rate	Primary Use Context
4Ps / 4Cs	78%	Foundational planning for product launch and pricing decisions
SMART Goals	71%	KPI setting for digital campaigns
STP Model	65%	Market segmentation and customer targeting
AIDA	58%	Social media advertising copy and campaign structure
RACE Planning	34%	Integrated digital campaign management
TAM	28%	Evaluating customer readiness for new digital services
10C Model	19%	Digital market auditing (primarily large enterprises)
Honeycomb / Forrester's 5Is	11%	Social media engagement analysis
McKinsey CDJ	8%	Customer journey mapping (multinational subsidiaries)

Source: Author's primary research, Study IV.

Several patterns emerge from these findings. First, classical models with high global academic citation counts (4Ps, AIDA, STP, SMART Goals) also demonstrate the highest practical adoption rates in Georgia, confirming that academic prominence correlates with practitioner familiarity. Second, sophisticated planning models — RACE, TAM, and the 10C — show considerably lower adoption, suggesting that the Georgian digital marketing ecosystem has not yet widely incorporated systematic digital planning frameworks into its operational practice.

Third, and most significantly, the data reveals a methodological gap: Georgian companies are implementing digital marketing tactics (social media advertising, SEO, PPC campaigns) without the analytical frameworks that would enable them to evaluate and optimize those tactics systematically. This finding is consistent with the research of Järvinen (2016), who identified the challenge of connecting digital marketing activities to long-term business outcomes as a fundamental problem even in more mature digital markets.

The primary research also confirmed, through Studies I and II (correlation and regression analyses), that digital marketing elements significantly influence sales growth (H_1 confirmed), and that price, information quality, brand trust, and online shopping experience each significantly

affect consumer purchase decisions in the Georgian online context (H_1 through H_4 confirmed). These findings establish the empirical foundation for recommending the broader adoption of structured marketing models — particularly planning-oriented frameworks — among Georgian practitioners.

7. Conclusions and Recommendations

This paper has presented a systematic comparative analysis of 15 marketing models, their classification into audit, planning, and strategy categories, their AI-era transformation potential, and their adoption patterns in the Georgian business context. Several key conclusions emerge:

5. **No single model is sufficient.** The most effective digital marketing operations combine classical models (AIDA, 4Ps, STP) for strategic orientation with contemporary planning frameworks (RACE, STDC) for execution and AI-compatible audit tools (Forrester's 5Is, TAM, 10C) for ongoing measurement.
6. **AI amplifies model value but does not replace model logic.** Machine learning and predictive analytics enhance the speed, precision, and individualization with which marketing model frameworks can be applied, but the underlying strategic logic of each model remains the essential architecture.
7. **Georgian practice reveals a structured knowledge gap.** The concentration of model usage around foundational frameworks (4Ps, AIDA, STP) while advanced planning and measurement models (RACE, TAM, 10C) remain largely unadopted indicates that Georgian digital marketing practitioners would benefit significantly from structured training in evidence-based model application.
8. **Empirical research confirms model relevance.** The primary studies conducted in Georgia confirm that the variables addressed by established marketing models — price, information quality, brand trust, digital tool adoption — are significant predictors of both digital marketing effectiveness and consumer purchase behavior in this market context.
9. **A new integrated model is warranted.** The limitations identified across all 15 models — linearity in AIDA, static segmentation in STP, tactical fragmentation in practice — motivate the development of the AASR Integrated Digital Marketing Model (Reach, Act, Situation Analysis, Remarketing) introduced in the parent dissertation, which is designed specifically to enable marketers to plan, monitor, and update digital marketing processes as a unified, adaptive cycle.

For researchers, this analysis provides a validated classification framework for studying marketing model effectiveness in AI-enabled environments. For practitioners — particularly in Georgia and other emerging digital economies — it provides a structured roadmap for moving beyond tactical digital execution toward evidence-based strategic marketing management.

Future research should investigate longitudinal adoption patterns of advanced digital marketing frameworks in emerging economies, examine the specific AI tools that most effectively augment each of the 15 models analyzed here, and test the effectiveness of integrated models such as AASR against the established frameworks in controlled organizational settings.

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Федеративное обучение, как инструмент противодействия мошенничеству в банковском секторе.

Обзор подходов

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Аннотация

В статье рассматриваются возможности применения технологии **Federated Learning (FL)** для повышения эффективности выявления банковского мошенничества, основанного на методах социальной инженерии, таких как телефонное мошенничество, фишинговые атаки и схемы с использованием поддельных сотрудников банков или государственных органов. Особое внимание уделено проблеме ограниченного обмена данными между банками, обусловленного требованиями законодательства о защите персональной информации. Федеративное обучение позволяет нескольким банкам совместно обучать модели машинного обучения без передачи исходных клиентских данных, что открывает новые возможности для повышения качества обнаружения мошеннических операций.

Исследование основано на анализе научных публикаций, опубликованных в 2016–2025 годах. Результаты показывают, что Federated Learning обладает значительным потенциалом для решения проблемы недостатка данных о мошеннических операциях, однако существующие исследования имеют ряд существенных ограничений. Во-первых, большинство разработанных моделей ориентировано на выявление мошенничества с банковскими картами и компрометацией учетных записей, тогда как мошенничество, основанное на социальной инженерии, остается недостаточно изученным. Во-вторых, вопросы обеспечения конфиденциальности в процессе совместного обучения моделей требуют дальнейшего развития. В-третьих, объяснимость принимаемых моделью решений чаще рассматривается как дополнительный элемент системы, а не как обязательный компонент архитектуры. Наконец, практически отсутствуют исследования, посвященные организационным и управленческим механизмам межбанковского сотрудничества при использовании федеративного обучения.

Для устранения выявленных ограничений предложена концептуальная модель **HybridFL-XAI**, объединяющая федеративное обучение и методы объяснимого искусственного интеллекта. Предлагаемая архитектура может служить основой для разработки межбанковских антифрод-систем нового поколения, обеспечивающих эффективное обнаружение мошенничества при соблюдении требований к конфиденциальности данных, прозрачности алгоритмических решений и взаимодействию участников.

Ключевые слова: федеративное обучение, социальная инженерия, банковское мошенничество, поведенческая аналитика, антифрод-системы, конфиденциальность данных, объяснимый ИИ.

1. Введение

За последние годы характер банковского мошенничества существенно изменился. Если раньше злоумышленники в основном пытались получить доступ к финансовым средствам с помощью технических методов — скимминга банковских карт, взлома программного обеспечения или перехвата данных, то сегодня всё чаще они воздействуют не на банковскую систему, а на самого клиента. Используя методы социальной инженерии, такие как фишинг, вишинг, смишинг или претекстинг, мошенники убеждают человека самостоятельно выполнить перевод денежных средств или раскрыть конфиденциальную информацию.

Такой подход создаёт серьёзные сложности для существующих антифрод-систем. С точки зрения банка подобная операция выглядит полностью легитимной: клиент использует своё устройство, проходит аутентификацию, вводит корректные реквизиты и собственноручно подтверждает перевод. В результате традиционные методы обнаружения мошенничества, основанные на правилах, сигнатурах или известных признаках компрометации, оказываются малоэффективными.

В этих условиях всё большее значение приобретает анализ поведения клиента. Важно оценивать не только параметры самой транзакции, но и изменения в действиях пользователя до её совершения: нетипичное поведение в цифровом канале, необычную последовательность действий, отклонения от привычного сценария использования банковских сервисов и другие поведенческие признаки, которые могут свидетельствовать о воздействии социальной инженерии.

Однако построение таких моделей связано с недостатком обучающих данных. Случаи мошенничества составляют крайне небольшую долю общего объёма банковских операций. По оценке Банка международных расчётов (BIS, 2022), на мошеннические операции приходится менее 0,1 % всех транзакций. Поэтому данных одного банка зачастую недостаточно для обучения устойчивых моделей, особенно если речь идёт о сравнительно новых сценариях мошенничества, основанных на социальной инженерии.

Обмениваться данными о клиентах банки не могут ни по закону, ни по соображениям конкуренции. В этом случае может использоваться федеративное обучение, идею которой предложил McMahān с соавторами в 2017 году. Суть технологии заключается в том, что несколько организаций совместно обучают одну модель, но каждая использует только на своих данных, а на общий сервер уходят не записи о клиентах, а обновления весов модели. Решение элегантно, но насколько оно подходит именно для борьбы с социальной инженерией в банках в литературе разобрано лишь фрагментарно, отдельными случаями, без общей картины.

Цель этой статьи собрать эту картину: обобщить, что уже сделано в применении федеративного обучения к антифроду, показать, какие вопросы пока остаются без ответа, и предложить рабочую схему, которая может задать направление для дальнейших практических разработок.

2. Как проводился обзор

2.1. Где и что искали

Поиск публикаций велся в базах Scopus, Web of Science и Google Scholar по запросам вида «federated learning» в сочетании с «fraud detection», «social engineering», «banking», «privacy-preserving machine learning», «behavioral analytics» и близким формулировкам. Временной период — с 2016 года, когда вышла основополагающая статья McMahān с соавторами, по март 2025 года.

2.2. Что включали, а что нет

В обзор попадали только рецензируемые статьи, материалы конференций и официальные технические отчёты на английском или русском языке при условии, что они по существу посвящены федеративному обучению и/или обнаружению финансового

мошенничества. Нерецензируемые материалы, поверхностные упоминания и дублирующие публикации одного и того же исследования отсеивались.

2.3. Как отбирали

Первоначальный поиск дал 312 публикаций. После удаления повторов осталось 274. Проверка по названию и аннотации отсеяла ещё 198 нерелевантных работ. Полный текст прочитан у 76 оставшихся публикаций, из которых по совокупности критериев в итоговый обзор вошли 32 рецензируемые работы. К ним добавлены 8 нормативных документов (директивы EBA, GDPR, стандарты ISO) и 3 технических отчёта регуляторов. Всего 43 источника.

3. Что такое федеративное обучение

3.1. Идея и базовый алгоритм

В основе федеративного обучения лежит простой принцип: данные остаются внутри организации, где они были собраны. Каждый банк самостоятельно обучает модель на своих данных и передает на центральный сервер только обновленные параметры модели. Сами клиентские данные при этом не передаются. Полученные обновления объединяются с помощью алгоритма **FedAvg**, который учитывает вклад каждого участника в зависимости от объема использованных данных (McMahan et al., 2017). Затем обновленная глобальная модель возвращается банкам, где снова проходит обучение. Такой обмен повторяется до тех пор, пока модель не достигнет необходимой точности.

В одном из наиболее полных обзоров по федеративному обучению Kaïrouz и соавт. (2021) отмечают несколько ключевых проблем, которые пока ограничивают широкое применение этой технологии. Во-первых, модель должна корректно работать с данными, существенно отличающимися у разных участников. Во-вторых, существенное значение имеют затраты на регулярный обмен обновлениями модели между участниками обучения. В-третьих, сохраняется риск восстановления исходной информации по передаваемым параметрам модели, что требует применения дополнительных механизмов защиты. Все эти вопросы имеют практическое значение и для банковского сектора, хотя степень их влияния зависит от конкретного сценария использования федеративного обучения.

Yang и соавт. (2019) предложили классификацию основных вариантов организации федеративного обучения. Первый вариант предполагает, что участники располагают одинаковым набором признаков, но работают с разными группами клиентов (горизонтальное федеративное обучение). Во втором случае совпадают клиенты, тогда как используемые признаки различаются (вертикальное федеративное обучение). Третий вариант сочетает элементы обеих схем и применяется при частичном пересечении как клиентов, так и признаков. Для банковского антифрода наиболее реалистичным представляется горизонтальный подход: банки обслуживают разные клиентские базы, но используют схожие характеристики транзакций и поведенческие признаки при оценке риска мошенничества.

3.2. Проблема: у всех банков данные разные

Одной из основных проблем при использовании федеративного обучения является неоднородность данных разных участников. В банковской практике клиентская база, структура транзакций и распространённость мошеннических схем могут существенно различаться не только между отдельными банками, но и между странами. В научной литературе такая ситуация обозначается термином **non-IID** (неоднородное распределение данных). Это означает, что модель должна обучаться на данных, которые имеют разную структуру и статистические характеристики.

Для задач антифрода данная проблема особенно актуальна. Например, мошеннические схемы, характерные для Казахстана, Великобритании или стран Африки, могут существенно различаться как по способам реализации, так и по частоте возникновения. В результате

единая модель не всегда одинаково хорошо работает для всех участников федеративного обучения.

Zhao и соавт. (2018) показали, что при высокой неоднородности данных эффективность базового алгоритма **FedAvg** заметно снижается. В отдельных экспериментах качество модели оказалось почти вдвое ниже по сравнению с централизованным обучением. Для уменьшения влияния этой проблемы были предложены модифицированные алгоритмы, такие как **FedProx**, **SCAFFOLD** и **FedNova**. Каждый из них по-разному учитывает различия между локальными моделями и помогает повысить устойчивость обучения. Однако универсального решения пока не существует: выбор алгоритма зависит от того, насколько сильно отличаются данные участников и какова специфика решаемой задачи.

3.3. Как защищают данные

Хотя при федеративном обучении исходные данные клиентов не передаются между участниками, это не означает полной защиты информации. Исследование Geiping и соавт. (2020) показало, что в отдельных случаях по обновлённым параметрам модели можно частично восстановить данные, использованные при локальном обучении. Такая угроза известна как атака инверсии градиента (gradient inversion attack).

Для снижения подобных рисков предложено несколько подходов. Один из наиболее распространённых — дифференциальная приватность (Abadi et al., 2016), при которой к передаваемым обновлениям модели добавляется контролируемый шум, затрудняющий восстановление исходных данных. Другой подход — защищённая агрегация (Secure Aggregation), предложенная Bonawitz и соавт. (2017). В этом случае центральный сервер получает только агрегированный результат обновлений всех участников и не имеет доступа к параметрам отдельных локальных моделей.

Вместе с тем оба решения имеют свои ограничения. Использование дифференциальной приватности может снижать точность модели из-за добавления шума, тогда как защищённая агрегация требует дополнительных вычислительных и коммуникационных ресурсов. Поэтому поиск оптимального соотношения между уровнем защиты данных и качеством обучения остаётся одной из наиболее актуальных задач федеративного обучения, особенно для антифрод-систем, где количество мошеннических операций невелико и каждый обучающий пример имеет высокую ценность.

4. Социальная инженерия: почему её так трудно поймать

4.1. Чем она отличается от обычного мошенничества

Социальная инженерия — это атака не на систему, а на решение человека. Мошенник не взламывает аутентификацию, он убеждает клиента пройти её самостоятельно и перевести деньги. Mouton с соавторами (2016) описали основные схемы: фишинг (письмо с поддельным содержанием), вишинг (звонок от «сотрудника банка» или «службы безопасности»), смишинг (ссылка в SMS), претекстинг (правдоподобный ложный повод, например, «ваш счёт заблокирован»). Всех их объединяет психологическое давление, создающее ощущение срочности и снижающее критичность восприятия у жертвы.

Для систем обнаружения — это настоящая проблема. Операция технически безупречна, так как используются правильное устройство, верный пароль, привычный IP-адрес. Правилам и сигнатурным фильтрам, настроенным на технические признаки взлома, здесь буквально не за что зацепиться.

4.2. На что всё-таки можно смотреть

Несмотря на то что операции, выполненные под воздействием социальной инженерии, внешне выглядят легитимными, они нередко сопровождаются косвенными поведенческими признаками. Utaogor и соавт. (2025) отмечают, что к таким признакам могут относиться проведение операции в необычное для клиента время, резкое изменение привычной суммы перевода или появление нового получателя, отсутствие характерной последовательности

действий перед совершением платежа, а также нетипичное поведение пользователя в мобильном приложении. Например, длительная задержка на экране подтверждения операции может свидетельствовать о том, что клиент получает инструкции от мошенника, а не совершает перевод самостоятельно по привычному сценарию.

По отдельности подобные признаки не являются достаточным основанием для вывода о мошенничестве. Однако их совместный анализ позволяет существенно повысить точность оценки риска. Наибольший эффект достигается в том случае, когда модель может учитывать аналогичные поведенческие паттерны, наблюдаемые у клиентов разных банков. Именно здесь возникает проблема недостаточности данных одного банка для формирования полной картины подобных мошеннических сценариев, тогда как прямой обмен клиентской информацией ограничен законодательством о защите персональных данных.

4.3. Ложные тревоги тоже цена вопроса

Одной из ключевых проблем традиционных антифрод-систем, основанных на правилах и заранее заданных сценариях, остаётся высокий уровень ложноположительных срабатываний. Ошибочная блокировка легитимной операции приводит не только к дополнительной нагрузке на подразделения проверки и расследования, но и напрямую влияет на качество клиентского опыта. Частые необоснованные ограничения могут снижать доверие клиентов к банку и повышать вероятность их перехода к другим финансовым организациям.

Nilou и соавт. (2025) отмечают, что снижение количества ложных срабатываний при сохранении высокой способности обнаруживать реальные случаи мошенничества возможно прежде всего за счёт расширения контекста анализа. Это предполагает использование более широкого набора транзакционных и поведенческих признаков, а также накопление данных о разнообразных мошеннических сценариях. Однако отдельный банк, располагающий только собственной клиентской базой, имеет ограниченные возможности для формирования такой масштабной базы знаний, что усиливает актуальность методов совместного обучения моделей без передачи исходных данных.

5. Почему обычные антифрод-системы упрутся в потолок и при чём тут федеративное обучение

Централизованные антифрод-системы сталкиваются с двумя принципиальными ограничениями. Первое связано с особенностями самих данных. Доля мошеннических операций в общем объёме банковских транзакций крайне мала, что приводит к сильному дисбалансу классов при обучении моделей. В результате алгоритм может демонстрировать высокую точность за счёт правильного распознавания большинства легитимных операций, но при этом недостаточно эффективно выявлять редкие мошеннические случаи.

Второе ограничение имеет институциональный характер. Несмотря на то что обмен данными между банками мог бы значительно повысить качество обнаружения мошенничества, передача информации о транзакциях и клиентах ограничена требованиями банковской тайны и законодательства о защите персональных данных. Таким образом, возникает противоречие: для построения более точных моделей банкам необходим доступ к более широкому массиву данных, однако прямое объединение клиентской информации невозможно по правовым причинам.

Федеративное обучение позволяет одновременно решить две ключевые проблемы централизованных антифрод-систем. С одной стороны, исходные данные клиентов остаются внутри банка и не передаются внешним участникам, поскольку в процессе обучения используются только обновления параметров модели. С другой стороны, объединение опыта нескольких участников позволяет формировать более устойчивую модель, способную учитывать широкий спектр мошеннических сценариев, которые могут быть незаметны при анализе данных одного банка.

Такой подход соответствует принципу **privacy by design**, согласно которому требования к защите данных должны закладываться на этапе проектирования системы, а не добавляться после её создания в виде дополнительных ограничений. В случае федеративного обучения конфиденциальность является частью самой архитектуры взаимодействия между участниками, что делает данный подход особенно привлекательным для финансового сектора (Luca, 2025; Sambasivam, 2025). При этом следует учитывать, что указанные работы имеют статус предварительных материалов и используются только для отражения исследовательского направления, а не как подтверждённые эмпирические результаты.

Вместе с тем федеративное обучение не устраняет все существующие проблемы. Его практическая реализация связана с рядом ограничений: необходимостью координации между участниками, дополнительными вычислительными и коммуникационными затратами, а также рисками атак на сам процесс обучения. Одной из наиболее серьёзных угроз являются атаки отравления модели (*model poisoning attacks*), при которых участник может намеренно передавать искажённые обновления, снижая качество общей модели.

Кроме технических вопросов, значительную роль играют организационные аспекты. Создание устойчивого механизма межбанковского взаимодействия требует решения вопросов распределения ответственности, управления общей инфраструктурой, контроля качества данных и определения правил участия. При этом существующая литература преимущественно сосредоточена на алгоритмических аспектах федеративного обучения, тогда как вопросы организационной модели межбанковского сотрудничества остаются изученными недостаточно.

6. Какие архитектурные решения уже предлагались

6.1. Три базовые схемы

В литературе встречаются три основных способа организовать федеративную антифрод-систему. Схема «звезда», самая распространённая, когда центральный сервер собирает обновления от всех участников и рассылает обновлённую модель обратно. Именно её реализует алгоритм FedAvg (McMahan et al., 2017). Иерархическая схема добавляет промежуточные узлы-агрегаторы, например, по географии или продуктовой линейке, что снижает нагрузку на коммуникацию при большом числе банков. Одноранговая схема вообще обходится без центрального сервера, убирая единую точку отказа, но ценой более сложного протокола согласования. Для банков выбор между этими схемами вопрос не только технический, но и организационный: кто контролирует центральный узел и на каких условиях.

6.2. Гибридная архитектура HybridFL

Особый интерес представляет архитектура **HybridFL**, предложенная Khan и соавт. (2025), которая сочетает горизонтальное и вертикальное федеративное обучение. Такая схема позволяет одновременно использовать данные нескольких банков и объединять различные типы признаков без передачи исходной информации между участниками.

Для задач выявления мошенничества, основанного на социальной инженерии, подобная архитектура имеет ряд преимуществ. При переводе денежных средств банк располагает информацией как об отправителе, так и о получателе платежа, однако характер этих данных существенно различается. Со стороны отправителя признаки мошенничества чаще проявляются в изменении привычного поведения клиента: необычном времени операции, отклонении от типичных сценариев использования банковских сервисов или резкой смене финансовых привычек. Со стороны получателя, напротив, внимание привлекают такие признаки, как отсутствие истории взаимодействия, связь с другими подозрительными счетами или участие в цепочках переводов.

Рассмотрение этих двух групп признаков по отдельности позволяет сохранить их информативность и более точно оценивать риск мошенничества. Если же объединять все

характеристики в единый набор без учёта их происхождения, различия между поведением отправителя и особенностями получателя могут сглаживаться, что снижает способность модели выявлять схемы социальной инженерии.

6.3. Какие модели используются

Выбор архитектуры модели в системах федеративного обучения определяется прежде всего типом анализируемых данных и особенностями решаемой задачи. Если необходимо учитывать последовательность транзакций и изменения в поведении клиента во времени, наиболее эффективными считаются рекуррентные нейронные сети, такие как LSTM и GRU. Они способны выявлять отклонения от привычных моделей поведения пользователя и обнаруживать аномалии, которые не видны при анализе отдельных операций (Novikova et al., 2023).

В случаях, когда мошенничество связано с сетью взаимосвязанных счетов, устройств или получателей платежей, более подходящим инструментом являются графовые нейронные сети (Graph Neural Networks, GNN). Они позволяют учитывать структуру связей между объектами и выявлять признаки организованных мошеннических схем. При использовании федеративного обучения каждый банк анализирует собственную часть графа, а совместное обучение делает модель более информативной, не требуя передачи данных о клиентах другим участникам.

Для анализа поведенческих характеристик пользователей всё больший интерес представляют модели на основе архитектуры Transformer. Они способны эффективно работать с большими объёмами последовательных данных и выявлять сложные закономерности в поведении клиентов. Однако их применение в банковской практике пока ограничивается высокими требованиями к вычислительным ресурсам, что может затруднять использование таких моделей небольшими финансовыми организациями.

Таким образом, универсальной архитектуры для федеративного антифрода не существует. Выбор модели определяется особенностями данных, доступными вычислительными ресурсами и требованиями к скорости обработки, точности и масштабируемости системы. Именно поэтому на практике предпочтение всё чаще отдаётся архитектурам, которые позволяют найти баланс между качеством обнаружения мошенничества и возможностями конкретной банковской инфраструктуры.

6.4. Атаки на модель и защита от них

Одной из наиболее серьёзных угроз для федеративного обучения являются **атаки отравления модели** (*model poisoning attacks*). В этом случае один или несколько участников намеренно передают искажённые обновления модели, стремясь ухудшить качество её работы или сформировать скрытую уязвимость, которая впоследствии позволит обходить механизмы обнаружения мошенничества.

Для противодействия таким атакам предложен ряд специальных методов. Так, Jeong и соавт. (2022) разработали алгоритм **FedCC**, который анализирует представления, формируемые предпоследним слоем нейронной сети. Если обновления одного из участников существенно отличаются от большинства, они образуют отдельную группу и могут быть исключены из процесса агрегирования. Аналогичную задачу решают и другие алгоритмы, включая **Krum**, **Bulyan** и **FLTrust**, однако каждый из них основан на собственном механизме оценки надёжности обновлений и имеет определённые ограничения, связанные с допустимой долей недобросовестных участников и особенностями распределения данных.

Несмотря на активное развитие методов защиты, вопрос их применения в банковском антифроде остаётся недостаточно изученным. Большинство существующих исследований проводилось на стандартных экспериментальных наборах данных, тогда как эффективность этих алгоритмов в условиях реальных банковских систем, где мошеннические операции

составляют лишь небольшую часть общего потока транзакций, пока не получила достаточного эмпирического подтверждения. Это направление остаётся одной из актуальных задач дальнейших исследований.

7. Объяснимость решений (XAI) в федеративных системах

Объяснимость моделей машинного обучения сегодня является не только технической характеристикой, но и важным регуляторным требованием. В случаях, когда автоматизированная система принимает решение, способное существенно повлиять на интересы клиента, банк должен иметь возможность обосновать причины такого решения. Это особенно актуально для антифрод-систем, поскольку блокировка платежа или отказ в проведении операции непосредственно затрагивают права клиента. Как отмечают Goodman и Flaxman (2017), применение алгоритмов искусственного интеллекта должно сопровождаться возможностью интерпретации результатов их работы, что приобретает особое значение в условиях ужесточения требований к прозрачности автоматизированных решений.

В федеративном обучении задача объяснимости становится более сложной. Общая модель формируется на основе данных нескольких участников, однако особенности клиентской базы, структуры операций и мошеннических сценариев могут существенно различаться между банками. Поэтому объяснение, полученное для глобальной модели, не всегда корректно отражает причины принятия решения в условиях конкретной кредитной организации.

Для решения этой проблемы Aljunaid и соавт. (2025) предлагают выполнять интерпретацию модели локально, до передачи обновлений на центральный сервер. В качестве инструмента используется метод **SHAP**, который позволяет определить вклад отдельных признаков в решение модели с учётом данных конкретного банка. Аналогичный подход возможен и при использовании метода **LIME**, однако его эффективность в условиях высокой неоднородности данных между участниками федеративного обучения пока изучена недостаточно.

Проведённый анализ литературы показывает, что вопросы федеративного обучения и объяснимости моделей чаще всего рассматриваются независимо друг от друга. В большинстве исследований методы интерпретации применяются уже после построения модели и не являются частью её архитектуры. Между тем именно интеграция механизмов объяснимости на этапе проектирования системы представляется одним из наиболее перспективных направлений развития федеративных антифрод-решений и остаётся недостаточно исследованной областью.

Показательно, что казахстанский регулятор тоже движется в этом направлении. Так, в апреле текущего года постановлением Правления АРРФР № 86 впервые было закрепило определение антифрод-системы банка, а управление модельными рисками, связанными с использованием ИИ, обозначено агентством в числе надзорных приоритетов на 2026 год. Вместе с тем конкретных технических требований к объяснимости решений, сопоставимых, например, с SR 11-7 ФРС США или NIST AI RMF, в казахстанской практике пока не сформулировано, и разработка такого стандарта представляется одним из ближайших и наиболее востребованных шагов регулятора.

8. Какие вопросы пока остаются без ответа

Анализ современных публикаций показывает, что, несмотря на активное развитие федеративного обучения, ряд вопросов остаётся недостаточно исследованным, особенно применительно к банковскому мошенничеству, основанному на социальной инженерии.

Прежде всего обращает на себя внимание направленность большинства существующих исследований. Разрабатываемые архитектуры федеративного обучения ориентированы главным образом на выявление технических видов мошенничества — компрометации

банковских карт, несанкционированного доступа к учётным записям и иных атак, связанных с нарушением информационной безопасности. Между тем мошенничество, основанное на социальной инженерии, развивается по иной логике. В подобных случаях инициатором перевода выступает сам клиент, поэтому традиционный анализ параметров транзакции оказывается недостаточным. Возрастает роль поведенческой биометрии, анализа цифрового поведения пользователя, последовательности его действий в мобильном приложении и контекста совершаемой операции. Однако именно применение таких признаков в архитектурах федеративного обучения пока освещено в научной литературе фрагментарно.

Не менее важной остаётся проблема обеспечения конфиденциальности при совместном обучении моделей несколькими банками. Большинство существующих исследований рассматривает угрозы, возникающие во взаимодействии между отдельным пользователем и сервером, тогда как особенности межбанковской среды анализируются значительно реже. При этом потенциальным источником риска могут быть не только внешние злоумышленники, но и сами участники федеративного обучения. Даже при соблюдении протокола отдельные банки теоретически способны извлекать дополнительную информацию, анализируя получаемые обновления модели. Вопросы оценки подобных рисков и разработки механизмов их предотвращения пока не получили достаточной методологической проработки.

Отдельного внимания заслуживает интеграция федеративного обучения с методами объяснимого искусственного интеллекта. В настоящее время эти направления развиваются преимущественно независимо друг от друга. В большинстве исследований инструменты интерпретации используются уже после обучения модели и рассматриваются как дополнительный компонент системы. Вместе с тем для банковского сектора всё более актуальным становится иной подход, при котором требования к объяснимости учитываются ещё на этапе проектирования модели. Несмотря на растущие требования регуляторов к прозрачности алгоритмических решений, исследований, реализующих такой подход, пока немного.

Наконец, явно недостаточное внимание уделяется организационной стороне межбанковского взаимодействия. Практическое внедрение федеративного обучения требует решения вопросов, выходящих далеко за рамки машинного обучения. К ним относятся распределение ответственности между участниками, управление общей инфраструктурой, финансирование совместного обучения, обеспечение качества локальных моделей и определение правил участия банков с различным уровнем цифровой зрелости. Кроме того, снижение эффективности общей модели может быть обусловлено не только недобросовестными действиями участников, но и объективными различиями в структуре и качестве исходных данных. Эти аспекты пока остаются значительно менее изученными по сравнению с алгоритмическими вопросами и требуют комплексного рассмотрения с организационной, правовой и управленческой точек зрения.

Этот пробел ощущается и в казахстанской практике. С 2025 года при Антифрод-центре Национального Банка РК запускается пилотный проект сессионного антифрода, однако публично доступные материалы не раскрывают, как именно распределяется ответственность между банками-участниками и кто выступает оператором совместного обучения модели. Иными словами, тот самый организационный уровень, пробел в котором отмечен выше, на практике решается скорее ситуативно, чем по формализованной методологии.

Таким образом, анализ литературы позволяет сделать вывод, что дальнейшее развитие федеративного обучения для банковского антифрода связано не столько с совершенствованием отдельных алгоритмов, сколько с решением комплекса

взаимосвязанных задач. К ним относятся адаптация моделей к сценариям социальной инженерии, обеспечение конфиденциальности в условиях межбанковского взаимодействия, интеграция механизмов объяснимости непосредственно в архитектуру модели и разработка организационных принципов совместного обучения банков. Именно эти направления формируют исследовательский пробел, на устранение которого ориентировано настоящее диссертационное исследование.

9. Концептуальная схема HybridFL-XAI

Проведённый анализ литературы позволяет предложить концептуальную архитектуру **HybridFL-XAI**, объединяющую федеративное обучение, поведенческую аналитику и методы объяснимого искусственного интеллекта. Предлагаемая архитектура не рассматривается как готовое технологическое решение. Её назначение состоит в формировании концептуальной основы для дальнейшей разработки и практической апробации межбанковских антифрод-систем, ориентированных на выявление мошенничества, основанного на методах социальной инженерии.

Первый уровень архитектуры связан с подготовкой данных внутри каждого банка. На этом этапе формируются две группы признаков. Первая включает традиционные транзакционные характеристики: сумму операции, канал проведения платежа, время выполнения, валюту, страну получателя и другие параметры транзакции. Вторая группа отражает поведенческие особенности клиента — отклонения от его привычного финансового поведения, изменения географии операций, времени их совершения, характера взаимодействия с мобильным приложением и иных элементов цифрового профиля. При этом признаки отправителя и получателя рассматриваются раздельно, поскольку именно различие в их поведенческих характеристиках позволяет выявлять сценарии, типичные для социальной инженерии.

Второй уровень представляет собой процесс федеративного обучения. Каждая кредитная организация обучает модель исключительно на собственных данных, не передавая их за пределы своей инфраструктуры. Во внешнюю среду направляются только обновления параметров модели, дополнительно защищённые механизмами дифференциальной приватности. Их объединение осуществляется с использованием алгоритмов, устойчивых к недобросовестным или ошибочным обновлениям со стороны отдельных участников, например FedCC либо других Byzantine-robust методов. При увеличении числа банков целесообразно применение иерархической схемы агрегации, позволяющей снизить нагрузку на коммуникационные каналы и повысить масштабируемость системы.

Третий уровень ориентирован на обеспечение объяснимости принимаемых решений. В предлагаемой архитектуре интерпретация результатов осуществляется непосредственно внутри каждого банка до передачи обновлений модели. В качестве базового инструмента рассматривается метод SHAP, позволяющий определить вклад отдельных признаков в итоговую оценку риска. Такой подход обеспечивает согласованность объяснений с локальными данными банка, повышает прозрачность автоматизированных решений и облегчает их последующую проверку как внутренними подразделениями, так и регулятором.

Четвёртый уровень охватывает организационные механизмы функционирования межбанковского объединения. Он включает вопросы распределения затрат между участниками, оценки вклада каждого банка в обучение общей модели, а также процедуры разрешения возможных конфликтных ситуаций. Реализация этих функций может основываться как на технологических инструментах, например, смарт-контрактах, так и на многосторонних соглашениях, определяющих правила совместной работы. Именно организационный уровень сегодня представляется наименее разработанным в научной

литературе, несмотря на его определяющее значение для практического внедрения федеративного обучения в банковском секторе.

Отметим, что необходимая институциональная площадка для практической апробации предложенной архитектуры в Казахстане уже фактически существует. Действующий Антифрод-центр при Национальном Банке РК, объединяющий более 200 участников рынка, потенциально мог бы выполнять роль центрального (либо, при переходе к иерархической схеме, одного из агрегирующих) узла для пилотного внедрения HybridFL-XAI, хотя на сегодняшний день его функциональность ограничена обменом сигналами о подозрительных операциях, а не совместным обучением моделей.

Следует подчеркнуть, что предложенная архитектура носит концептуальный характер и не претендует на роль законченного программного решения. Её основная задача заключается в систематизации существующих научных подходов и формировании целостной модели, которая может служить основой для последующих эмпирических исследований и разработки практических инструментов управления риском мошенничества в условиях межбанковского взаимодействия.

10. Ограничения этого обзора

Несмотря на полученные результаты, проведённое исследование имеет ряд ограничений, которые необходимо учитывать при интерпретации выводов.

Прежде всего, ограничения связаны с используемой базой источников. Обзор литературы выполнен на основе публикаций, представленных в базах данных Scopus, Web of Science и Google Scholar. Несмотря на широкий охват этих ресурсов, нельзя исключить, что отдельные релевантные исследования, в том числе опубликованные в национальных или специализированных научных изданиях, не были включены в анализ.

Следующее ограничение обусловлено высокой скоростью развития исследований в области федеративного обучения. Значительная часть работ последних лет ещё находится на стадии препринтов или рабочих версий и не прошла процедуру научного рецензирования. По этой причине отдельные материалы, в частности работы Luca (2025) и Sambasivam (2025), рассматриваются исключительно, как отражение современных исследовательских направлений и не используются в качестве эмпирически подтверждённых доказательств.

Следует также учитывать, что предложенная архитектура HybridFL-XAI носит концептуальный характер. В настоящем исследовании она рассматривается, как теоретическая модель, сформированная на основе анализа существующих научных подходов. Оценка её практической эффективности требует последующей апробации на реальных банковских данных, а также решения ряда методических и инженерных задач, которые могут потребовать дальнейшего развития отдельных элементов предложенной архитектуры.

Наконец, за рамками настоящего исследования остаются правовые аспекты организации межбанковского федеративного обучения. Возможности обмена моделью, требования к защите данных, распределение ответственности между участниками и условия создания подобных консорциумов определяются национальным законодательством и существенно различаются в разных странах. Комплексный анализ этих вопросов требует самостоятельного исследования в области банковского и информационного права.

Заключение

Федеративное обучение не следует рассматривать, как универсальное средство решения всех проблем банковского мошенничества. Однако данный подход предлагает один из наиболее перспективных способов преодоления ключевого противоречия современного антифрода: необходимости использования больших объёмов данных при одновременном ограничении возможностей их прямого обмена между организациями.

Проведённый анализ литературы показывает, что основные технологические компоненты для построения таких систем уже сформированы. Методы федеративной агрегации, включая FedAvg, FedProx и SCAFFOLD, подходы к защите конфиденциальности на основе дифференциальной приватности и защищённой агрегации, а также механизмы повышения устойчивости к недобросовестным обновлениям модели получили значительное развитие в научных исследованиях. Вместе с тем их применение в банковском антифроде пока остаётся ограниченным, особенно в отношении мошенничества, основанного на социальной инженерии. Такие сценарии требуют анализа не только параметров транзакции, но и особенностей поведения клиента, контекста операции и последовательности действий пользователя. Кроме того, вопросы объяснимости принимаемых решений пока недостаточно интегрированы в архитектуру федеративных моделей.

Выявленные в ходе исследования направления дальнейшего развития имеют различную природу. Ограничения, связанные с адаптацией моделей к специфике банковских данных и повышением уровня защиты приватности, преимущественно относятся к области алгоритмических и инженерных решений. В то же время проблема встроенной объяснимости требует изменения самого подхода к проектированию моделей, при котором прозрачность решений должна учитываться уже на этапе формирования архитектуры. Ещё более сложной является организационная составляющая межбанковского сотрудничества, включающая вопросы распределения ответственности, управления общей инфраструктурой и формирования правил взаимодействия между участниками.

Предложенная архитектура HybridFL-XAI объединяет указанные направления в единую концептуальную схему. При этом её цель заключается не в окончательном решении всех выявленных проблем, а в формировании основы для дальнейших исследований и практической разработки систем управления риском мошенничества, способных учитывать, как технологические ограничения, так и требования банковского регулирования.

На следующем шаге наиболее актуальны три задачи: проверить схему на синтетических банковских данных с реалистичным перекосом в сторону легитимных операций; разработать метрики приватности для объединения из нескольких банков; и создать открытые тестовые наборы данных, которые позволят сравнивать федеративные антифрод-системы по обнаружению социальной инженерии на равных условиях.

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Service Quality, Visitor Satisfaction and Sustainable Management Challenges in the “Tetra” Cave (Imereti, Georgia)

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Abstract

The article discusses the tourist potential of the natural monument — the “Tetra” Cave — and its specific physical-geographical, speleotherapy and historical-archaeological characteristics. The paper pays special attention to the innovative enogastronomic concept of the facility, which involves wine tasting and tasting in the cave.

Within the framework of the mixed research design (Mixed Methods), 570 visitors were interviewed using the principle of probabilistic, random sampling. Based on empirical data, the socio-demographic profile of the respondents, travel motivation and service quality components (speed of service, guide professionalism, tourist infrastructure and ecological safety) were analyzed according to the Likert scale.

The study revealed a high level of visitor satisfaction and loyalty (77%), however, at the same time, it identified systemic challenges in the areas of infrastructure arrangement, ecological management and safety information briefing. At the end of the article, based on the obtained statistical analysis, practical recommendations are formulated for sustainable management of the cave and optimization of service quality.

Keywords: Speleotourism, "Tetra" Cave, Visitor Satisfaction, Service Quality, Sustainable Management, Enogastronomy.

Introduction

In the modern global tourism market, natural monuments and protected areas are the most important basis for the development of sustainable ecotourism. A cave, as a specific geological formation, is the best example of how a sensitive natural resource can be transformed into an attractive, high-value tourist product. Speleotourism organically combines cognitive and adventure components, offering the visitor a unique emotional and practical experience. In addition, underground spaces contribute to the popularization of regional cultural heritage and history, as they are often associated with myths, legends or important historical events.

Georgia is distinguished by the abundance of caves of karst and volcanic origin and their high recreational potential. The development of the Prometheus Cave, the Sataplia Reserve and the recently introduced “Tetra” Cave with an innovative concept on the market is a clear proof of this. The Martvili, Navenakhve, Nozodelavo and Askhi cave complexes, which are in the active research and development phase, also have great potential in the direction of ecotourism and educational tourism. Georgian caves create a specific tourism product, which contributes to the international recognition of the country, the economic strengthening of regions and the protection of natural resources under sustainable management (National Tourism Administration, 2019).

The protection of natural monuments and their rational use are of paramount importance for the sustainability of tourism. The example of caves clearly shows how a natural heritage site can have

equal ecological, cultural, educational and economic value. Regulated tourist flows, reasonable arrangement of infrastructure, compliance with safety standards and minimization of negative impact on the environment are necessary conditions for caves to maintain their original, unique appearance (UNESCO Guidelines, 2022).

In recent years, the growing popularity of natural caves has significantly increased the demand for high-quality, safe and sustainable tourism services. Against this background, in-depth research on visitor satisfaction is gaining particular relevance, which is recognized as one of the main components of modern tourism management. The study of satisfaction is especially important in such a sensitive environment as a cave. Such research can be used to empirically assess the extent to which existing services meet tourists' expectations, how safe, comfortable and informative their visit is, and where systemic shortcomings in the service are evident. The data obtained allow identifying weaknesses and needs, which is necessary in the process of improving infrastructure, raising the qualifications of guides and staff, and refining safety and environmental standards (Cigna & Forti, 2013).

Systematic satisfaction research is an important management tool, as decisions based on real data increase the competitiveness of the facility, contribute to the effective management of tourist flows, and ensure the protection of natural resources (Middleton & Clarke, 2001). Research on visitor satisfaction with services, in general, is a prerequisite for continuous improvement of service quality and ensuring sustainable management (Kotler et al., 2017). Accordingly, such an analysis conducted in caves combines service quality monitoring, environmental responsibility, and the principles of sustainable development (UNWTO, 2019).

The relevance of this work is determined by the fact that in modern tourism, customer satisfaction is the main indicator of the success and sustainable development of a tourist facility. Visitor evaluations directly affect both the image of the facility and the dynamics of tourist flows. In addition, "Tetra" is a unique natural monument and a key resource for regional tourism development, which is why studying its service quality and visitor satisfaction provides valuable data both to management and to parties involved in the local tourism planning and development process.

Research Objectives and Tasks

The research objective is to conduct a comprehensive assessment of the quality of tourist services and visitor satisfaction of the natural monument — the Tetra Cave, identify existing challenges and weaknesses, and develop recommendations for sustainable management of the facility based on the data obtained.

To achieve the set goal, the following tasks were defined:

1. Study and analysis of the unique geological, medicinal (speleotherapy) and historical-archaeological characteristics of the Tetra Cave;
2. Identification of the specifics of the innovative enogastronomic concept (wine pairing/tasting) in the cave, its strengths and weaknesses;
3. Assessment of service quality according to specific parameters (speed of service, guide professionalism, tourist infrastructure, ecological safety, variety of services);
4. Evaluation of the effectiveness of visitor safety and conduct instructions and the quality of the information provided;
5. Identification of weak points of service and strategic directions for management improvement.

Research methodology

To solve the tasks set in the paper, a mixed research design (Mixed Methods Research) was used, which implies a combination of both qualitative and quantitative research methods and data triangulation:

- Qualitative (desk) research (Desk Research): includes an analysis of scientific literature, normative acts and statistical data. Official data of the Agency for Protected Areas of Georgia and the National Tourism Administration were studied.
- Quantitative research: A face-to-face survey of visitors was conducted using a specially developed questionnaire. To ensure the representativeness of the study, the sample size was determined using the principle of probabilistic, simple random sampling, taking into account a 95% confidence level and a 4% margin of error, which amounted to 570 respondents.
- Data analysis: The primary data obtained as a result of the quantitative survey were processed using statistical methods, their analysis was carried out, and the results were visualized in the form of appropriate graphical representations.

Physical-geographical, historical and functional characteristics of the cave "Tetra"

Georgia is distinguished by the high intensity and diversity of karst landforms, which significantly determines the speleotourism potential of the country. Within the southern slope of the Caucasus, the karst belt occupies an area of approximately 300 km, where from 1300 to 1500 caves and shafts are currently registered. Karst manifestations mainly coincide with the distribution area of the Upper Jurassic and Lower Cretaceous limestone massifs, which mostly covers the territory of Western Georgia (Nodia, 2017).

To the northeast of the resort of Tskaltubo, at an altitude of 100 meters above sea level, in the territory of the village of Khomuli, the cave "Tetra" of karst origin is located, which was formed in Lower Cretaceous limestones. Morphologically, it is of the corridor-hall type; its maximum height is 8–10 meters, width — 25–30 meters, length — 150 meters, and the total volume reaches 3,500 cubic meters. The cave is rich in specific white calcite formations — stalactites, stalagmites, and stalagnates, from which its name comes. The object has a unique historical-archaeological significance: scientific study of up to 15,000 artifacts found in the cave confirms that the mentioned space was used by primitive man for habitation twice — in the Upper Paleolithic (35–30 thousand years ago) and Eneolithic (7 thousand years ago) periods (Kalandadze, 2020).

The cave was discovered in 1954, and since 1974 the Tskaltubo branch of the Scientific Research Institute of Balneology and Physiotherapy has begun its comprehensive study. Experimental and clinical studies have confirmed the healing (speleotherapy) properties of the cave, which are determined by the stability of its microclimate parameters:

- Air temperature: constantly fluctuates within 13.8°C - 14.0°C;
- Humidity: absolute humidity is 15.4–16.0, and relative humidity is high (70–80%);
- Additional healing factors: high air ionization, the content of calcium, manganese and hydrocarbon aerosols, and the bacterial purity of the environment.

The influence of the cave microclimate was initially studied on experimental models (animals) that had previously undergone stressful nervous effects. Today, the natural environment of "Tetra" is used for the treatment and rehabilitation of pathologies such as: hypertensive and hypotonic diseases, atherosclerotic cardiosclerosis, bronchial asthma in adults and children, chronic bronchitis, pneumonia, neuroses and neurasthenia.

Innovative enogastronomic concept and specifics of functioning

Maintaining competitiveness in the modern tourist market requires going beyond traditional frameworks and creating innovative, complex products. In this regard, a new service has been added to the unique historical and healing characteristics of the Tetra cave - wine pairing and tasting. This approach organically combines elements of ecological, gastronomic and adventure tourism, which creates specific management challenges.

The cool air of the cave, constant temperature regime and natural acoustics add a different dimension to the wine tasting process. Visitors are given the opportunity to taste wines made by winemakers of the Imereti region in an authentic environment, both by the qvevri and classical methods. The tasting program is accompanied by an assortment of local natural products (various

types of cheese, churchkhela, honey, dried fruits and Toni bread), which fully demonstrates the gastronomic potential of Imeretian cuisine.

The analysis of this concept shows both its strengths and objective threats:

- Strengths and advantages: Wine tasting in a cave is an exclusive and innovative experience, which is radically different from traditional cellar tours and arouses high interest among both local and international visitors. The authentic microclimate and cave forms enhance the emotional involvement of the guest and increase the quality of perception of cultural and natural heritage.
- Weaknesses and challenges: Organizing a gastronomic tour in an underground space is associated with the difficulties of managing a sensitive ecosystem. The natural structure of the cave requires a strict ecological approach - engineering infrastructure (lighting, ventilation) must be energy-efficient and have low heat transfer, so as not to disturb the microclimatic balance.
- Risks of managing tourist flows: the simultaneous entry of large tourist groups into a small space may lead to a violation of the stability of temperature and humidity, which will pose a threat to both the geological formations of the cave and the safety of visitors. There is also a risk of losing cultural authenticity in the event of excessive commercialization of the object.

Accordingly, the main goal of the management of the Tetra cave is to maintain a balance between the protection of the natural environment and its rational exploitation. This requires a complex approach:

1. Technical regulations: use of low-power cold lighting systems and arrangement of auxiliary ventilation in such a way as not to damage the visual appearance of the object.

2. Organizational monitoring: limiting the number of visitor groups and their entry into the cave at strictly defined time intervals;

Arrangement of pedestrian paths and seating areas without damaging the natural surface of the cave.

3. Raising eco-awareness: Providing mandatory information briefings for each visitor, which prohibits mechanical contact with the stalactites and ensures compliance with environmental regulations.

Results and analysis of empirical research on visitor satisfaction

Socio-demographic and geographical profile of respondents

According to official data from the Agency of Protected Areas of Georgia, the Tetra Cave is visited by an average of 9,000 visitors annually. 570 respondents were interviewed from the general population ($N=570$, 95% confidence level, 4% margin of error).

- Gender structure: male — 56%, female — 44%.
- Geographic distribution: Asia — 33%, Europe — 28%, domestic tourism (local) — 16%, Saudi Arabia — 14%, North America — 9%.
- Employment status: pensioners (29.1%), qualified specialists (15.1%), housewives (13.9%), self-employed (13.3%), students (11.9%), unemployed (8.2%), military (6.5%), working class (1.9%).
- Economic profile (monthly income): 3500+ GEL — 40.0%, 2500–3500 GEL — 29.6%, 1000–1499 GEL — 15.4%, 500–900 GEL — 9.5%, <500 GEL — 5.4%.

A cross-sectional analysis of the data revealed an interesting trend: the largest group of visitors is pensioners (29.1%), while 69.6% of visitors have an income exceeding 2,500 GEL. This indicates that foreign pensioners with high purchasing power (mainly from Europe and Asia) predominate in international flows.

Such a segment is extremely sensitive to physical comfort and safety. The lighting in the cave, the slope of the paths, railings, benches and air humidity/temperature directly affect their satisfaction. It is worth noting the weak positioning of domestic tourism: the low share of local visitors (16%) indicates that Tetra is still not perceived as a domestic family or weekend destination. Awareness in the local market is low, or the pricing policy/product positioning is primarily oriented towards foreign tourists.

Information channels, motivation and dynamics of expectations

- Information channels: digital media/social networks (34%), television (24%), recommendation from friends/relatives (16%), tourism information centers - TIC (8%), other (19%).
- Motivation for the visit: cognitive excursion (33%), speleo-health therapy (28%), wine tasting (26%), complex goal (13%).
- Justification of expectations: fully justified (44%), partially justified (43%), not justified (13%), not justified at all (0%).

Information and motivational analysis:

1. Efficiency of channels and low role of TIC:

The leadership of online channels (34%) is natural, although the low rate of tourism information centers (TIC) (8%) is noteworthy. This indicates a weak partnership with state and regional tourism structures — the promotion of the facility on site (e.g., in Kutaisi or Tskaltubo information centers) is carried out in a passive mode.

2. High demand for unique offers (USP):

The cave is not just a “sight”. 54% of visitors come for specific services (health therapy + wine tasting). This gives “Tetra” a sharp competitive advantage over other caves in the region (e.g., Prometheus, Sataplia).

3. Risk of “partially justified” expectations (43%):

Almost half of the group states that expectations were only partially justified. This means that marketing communication (advertising, photos, promises) creates higher expectations than they actually received at the facility, or some specific service at the site (e.g., therapeutic zone or infrastructure) is partially functioning properly.

Table. Evaluation of service quality components (Likert scale)

Service component	Positive (good / very good)	Neutral (average)	Negative (bad / very bad)
Guide service	82% (47% Very good)	18%	0%
Wine and service assortment	66% - 80%	-	-
Speed of service	55%	33%	12%
Speleo-guide services	33%	24%	-
Tourist infrastructure	56%	34%	11%
Ecological safety	-	32%	19%
Overall total score	77%	-	7%

As we can see from the table, tour guide services are the absolute favorite of the survey (82% positive, 0% negative). This indicates that the communication and language skills of the staff are at a high level, which is especially important for the high-income international segment.

Compared to general guides, the low rating of speleo-guides (only 33% “good”) indicates that visitors lack in-depth, specific scientific/medical information on the therapeutic properties of the cave.

The high share of negative ratings on ecological safety (19%) and in combination with infrastructural dissatisfaction (11%) give a serious alarm signal. Visitors notice either signs of degradation of the cave's natural environment (improper lighting, violation of the micro-climate), or wear and tear of the infrastructure (wet spots, paths, safety chains).

Safety and future behavioral intention (NPS indicators)

Almost every second visitor (44%) believes that the briefing was superficial, and 43% had difficulty assessing its usefulness at all. This is a serious operational risk for the specific environment of caves. The briefing is formal in nature and does not really reach the visitor.

Despite the infrastructural and security shortcomings, the 88% recommendation index (Word-of-Mouth) indicates that the natural exclusivity of the cave, the wine concept and the hospitality of the guides outweigh the technical shortcomings.

Only 50% are ready to visit again (34% are neutral). This is standard for cognitive tourism ("I saw it once and that's enough"), but it is low for a speleo-therapeutic facility, where the business model should be built on repeat/course visits.

Conclusions and Recommendations

Conclusions

1. High purchasing power of the target audience: The majority of cave visitors (approximately 70%) belong to the high-income segment (2500 GEL and above). Geographically, the Asian and European regions are leading, which indicates the high international attractiveness of the facility.
2. Positive perception of service quality: The overall level of visitor satisfaction is high (77%). The professionalism of the guides is particularly notable. The innovative enogastronomic product (wine tasting/matching) is also successful, which was appreciated by 66% of respondents.
3. Infrastructural and ecological shortcomings: The study revealed weak points of service in the tourist infrastructure. In addition, 19% of visitors are skeptical about the cave's ecological protection mechanisms.
4. Information imbalance in the safety section: 44% of respondents believe that safety rules are superficially introduced, and 43% have difficulty assessing the effectiveness of the briefing.
5. High level of loyalty: Indicators of future behavioral intentions are optimistic — 50% of respondents are ready to visit again, and 88% will recommend the cave to their social circle.

Recommendations

- Modernization of safety information management:
 - o Introduction of a mandatory, short video briefing before the start of the tour, which visually demonstrates the rules of conduct and environmental restrictions in the cave.
 - o Placement of multilingual information booklets and electronic boards at the entrance and inner perimeter of the facility.
- Improving tourist infrastructure:
 - o Installation/monitoring of pedestrian paths, railings and energy-efficient, low-heat LED lighting systems.
 - o Maximum integration of adapted infrastructure for people with disabilities and families with children.
- Sustainable ecological management and flow regulation:
 - o Accurate determination of the cave's ecological carrying capacity and strict control of tourist flows (improvement of the advance booking system).
 - o Functional separation or time-shifting of speleotherapy and enogastronomic zones.
- Improving personnel qualifications:
 - o Conducting specialized training courses for speleo-guides in speleotherapy, geology and first aid.
- Marketing strategy optimization:
 - o Strengthening digital marketing on social media and international platforms (TripAdvisor, Google Maps).
 - o Developing loyalty programs and seasonal offers to motivate neutral visitors.

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Financial Management and the Essence of Crisis Processes at an Enterprise

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Abstract: The article examines the features of financial management, the causes of crisis processes at an enterprise, and methods for improving financial stability.

Keywords: financial management, crisis processes, crisis management, financial stability, enterprise.

Financial management represents a system of methods and tools aimed at the formation, allocation, and effective use of an enterprise's financial resources. Its main objective is to ensure financial stability, solvency, and improve the efficiency of capital utilization [1]. Under modern conditions, financial management is considered an element of the overall enterprise management system that ensures the coordination of current and strategic financial decisions, as well as maintaining a balance between profitability and risk. Particular importance is given to the ability of an enterprise's financial system to adapt to changing external environmental conditions, including market fluctuations, inflationary processes, and changes in financing conditions (Figure 1) [2].

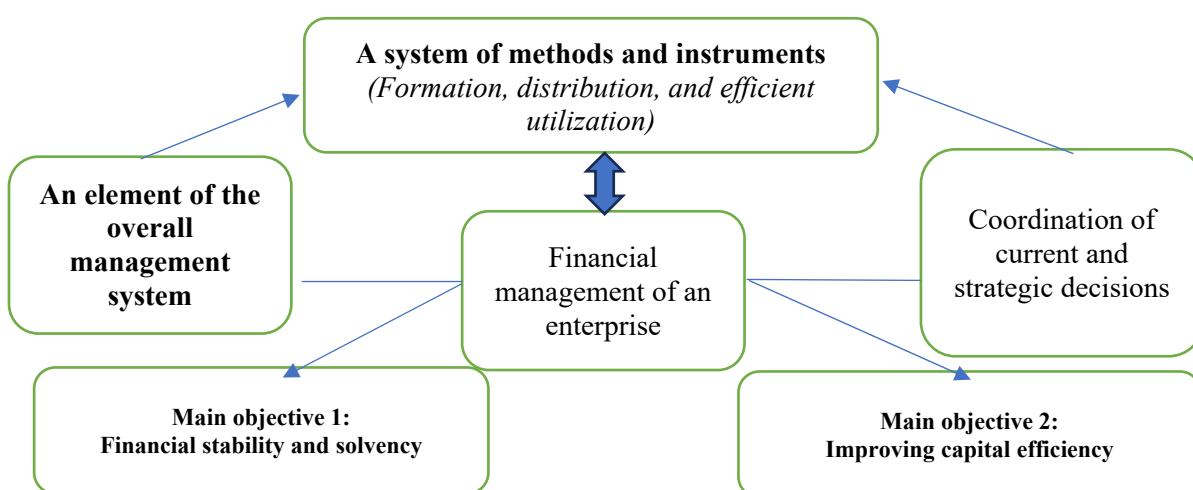


Figure 1 – System and Objectives of Financial Management

Note – developed by the author based on the data from source [2].

According to Figure 1, financial management includes a set of interrelated functions: planning, organization of cash flows, analysis of financial condition, control over the

implementation of financial decisions, and financial risk management. Effective implementation of these functions ensures the stability of capital turnover and maintaining the required level of enterprise liquidity [3].

An important element of financial management is the formation of a rational capital structure that provides an optimal ratio between own and borrowed sources of financing. Violation of this ratio results in increased financial risks and reduced enterprise sustainability, especially in an unstable economic environment [4].

For a clearer understanding of the continuity of capital management processes, the interrelationship of all key stages is presented in the diagram below (Figure 2).

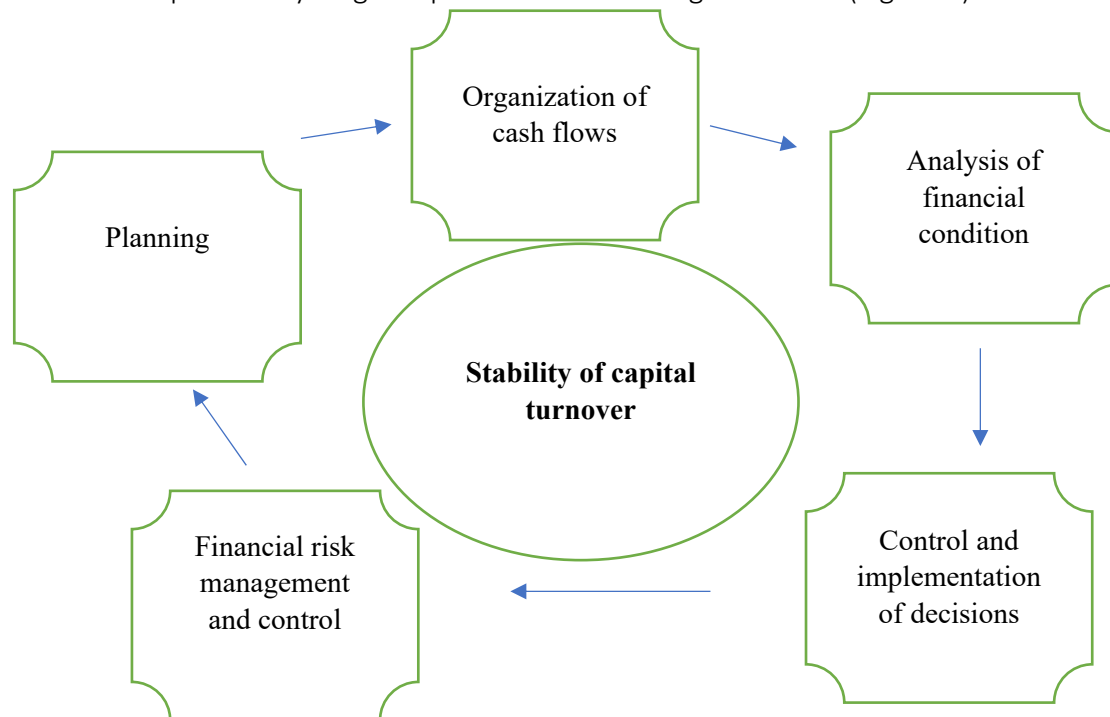


Figure 2 – Cycle of Interrelated Functions

Note – developed by the author based on the data from source [4].

According to Figure 2, a financial crisis at the enterprise level is characterized by a disruption of financial balance, manifested in a decrease in liquidity, an increase in liabilities, and deterioration of the capital structure. Crisis processes usually develop gradually and result from the accumulation of internal imbalances within the financial management system.

The main causes of crisis phenomena include a decrease in revenues, inefficient cost management, growth of fixed obligations, as well as an imbalance between the growth rates of assets and liabilities. Limited access to external sources of financing has a significant impact, increasing the enterprise's dependence on internal cash flows. This increases the pressure on the enterprise's liquidity.

The crisis is also reflected in the deterioration of key financial indicators: a decline in current liquidity, a decrease in return on assets, and an increase in the share of borrowed capital. If these trends persist, the risk of financial insolvency and loss of solvency increases.

A financial crisis is a phased process that develops from a hidden stage (a decrease in the efficiency of resource utilization) to an explicit stage (insolvency and the risk of bankruptcy). Therefore, early diagnosis of crisis processes and timely management decision-making are of particular importance (Figure 3).

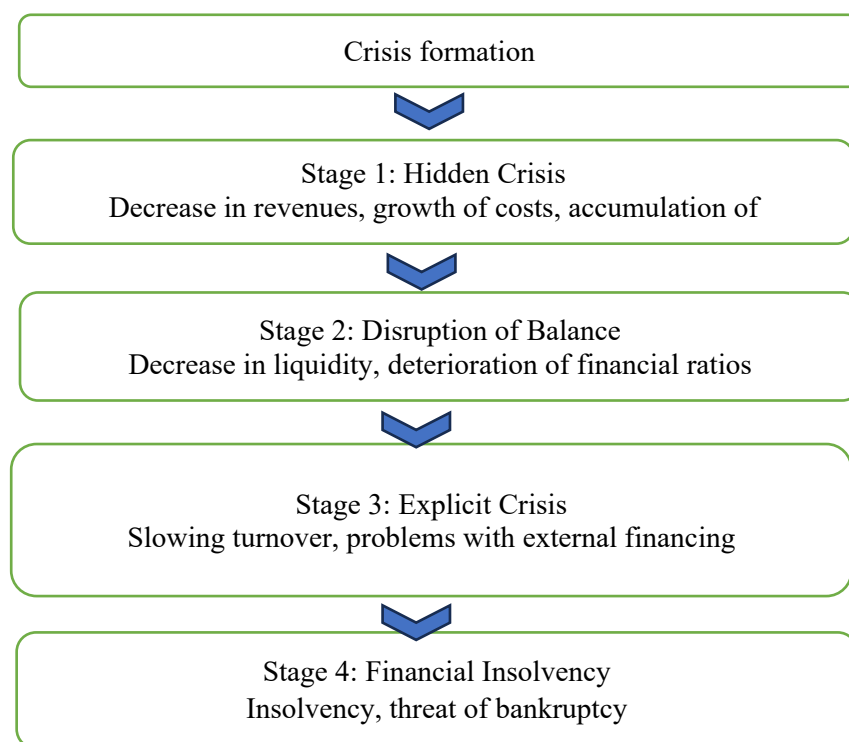


Figure 3 – Dynamics of Financial Crisis

Note – developed by the author based on the data from source [5].

As shown in Figure 3, the development of a financial crisis at an enterprise has a cumulative nature and occurs consistently under the destructive influence of both external and internal factors. The synergistic effect of their combined impact initiates a chain of negative changes, where each subsequent stage deepens the existing imbalances. As the financial system deteriorates and the crisis transitions from a hidden form to an explicit one, there is a rapid deterioration of key indicators of liquidity, solvency, and financial stability. The enterprise gradually loses net working capital, faces chronic cash flow gaps, and experiences a critical increase in debt burden, which ultimately maximizes the risk of financial insolvency (bankruptcy) of the organization [4].

Under conditions of deteriorating financial condition of an enterprise, the risk of insolvency and financial failure increases. With further intensification of crisis processes, the organization may face the inability to fulfill its obligations to creditors, employees, and the state in a timely manner. In the Republic of Kazakhstan, procedures for restoring solvency, rehabilitation, and bankruptcy of legal entities are regulated by the Law of the Republic of Kazakhstan “On Rehabilitation and Bankruptcy” dated March 7, 2014, No. 176-V ZRK. This regulatory act establishes legal mechanisms for preventing bankruptcy, restoring the financial stability of organizations, and protecting the interests of creditors, which emphasizes the importance of timely diagnosis of crisis phenomena and implementation of anti-crisis financial management measures.

Thus, effective financial management contributes to the timely identification of crisis trends, reduction of financial risks, and maintenance of sustainable enterprise development.

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Factors of Financial Crisis Emergence at an Enterprise

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Abstract: The article is devoted to the study of the factors contributing to the emergence of financial crises at an enterprise. The internal and external causes of crisis phenomena, their impact on the financial stability of an organization, as well as the main directions for preventing and overcoming crisis situations are examined.

Keywords: financial crisis, crisis factors, financial stability, anti-crisis management, enterprise.

A financial crisis at an enterprise is formed under the influence of a combination of external and internal environmental factors, which collectively lead to a disruption of financial balance, a decrease in the sustainability of business activities, and a deterioration in the enterprise's ability to ensure the continuity of operational processes. These factors usually occur simultaneously and reinforce their mutual negative impact. A characteristic feature of crisis processes is their gradual and cumulative accumulation, in which negative changes in individual elements of the financial system — capital structure, liquidity, asset turnover, and profitability — intensify the overall financial instability of an enterprise. As a result, a systemic deterioration of the financial condition is formed, which may progress from a hidden stage to explicit signs of a crisis (Figure 1) [1].

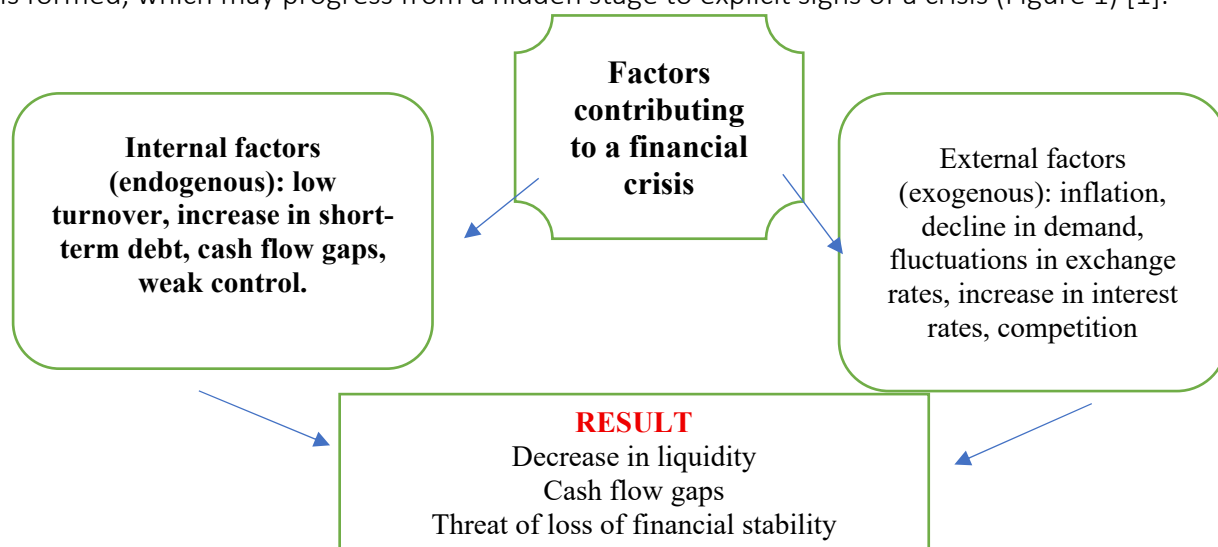


Figure 1 – Classification of Financial Crisis Factors

Note – developed by the author based on the data from source [1].

According to Figure 1, external factors include macroeconomic conditions of enterprise functioning, which form the overall environment of its activities and have a direct impact on the results of financial and economic performance.

First of all, these factors include inflationary processes, which lead to an increase in prices for raw materials, supplies, energy resources, and other production inputs. Accelerating inflation contributes to higher production costs and a decrease in the real purchasing power of consumers, which negatively affects sales volumes and the financial results of enterprises.

Exchange rate fluctuations also have a significant impact on the financial condition of enterprises. For organizations using imported raw materials, equipment, or components, the depreciation of the national currency leads to increased costs and deterioration of financial indicators. At the same time, uncertainty increases in planning future cash flows and investment activities.

Government economic policy also has a significant impact, including changes in tax legislation, the introduction of additional mandatory payments, changes in customs tariffs, and requirements for conducting business activities [2]. Increased tax burdens lead to a reduction in the company's net profit and limit opportunities for expanded capital reproduction. Under conditions of financing shortages, organizations are forced to rely mainly on internal sources, which reduces investment activity and development rates. This situation is particularly evident during periods of economic instability when credit institutions reduce the volume of financing for the real sector of the economy [3].

Internal causes of financial crises are determined by the characteristics of management and the organization of financial and economic activities. An inefficient asset structure is of significant importance, where a large share of resources is invested in low-liquid assets, reducing the solvency and financial flexibility of the enterprise.

The condition of working capital is an important factor. A slowdown in inventory turnover, an increase in accounts receivable, and inefficient use of cash resources lead to liquidity shortages and the need to attract additional financing [4].

The capital structure also plays an important role: high dependence on borrowed funds increases financial risks and strengthens the burden of liabilities. Under deteriorating market conditions, this may lead to a decrease in financial stability. Insufficient efficiency of financial planning and control also has a negative impact. Errors in budgeting, inaccurate cash flow forecasts, and weak internal control increase the risk of cash flow gaps and deterioration of solvency.

Another significant factor is inefficient cost management and accounts receivable management, which leads to reduced profitability and slower capital turnover. Overall, the quality of management decisions, the level of management competence, and the ability to adapt to changes in the external environment determine the sustainability of an enterprise and its competitiveness [5].

To obtain an objective assessment of an organization's financial condition, it is necessary to conduct a consistent diagnosis of key areas of its activities. The main stages of a comprehensive analysis of the financial condition of an enterprise are presented in Figure 2.

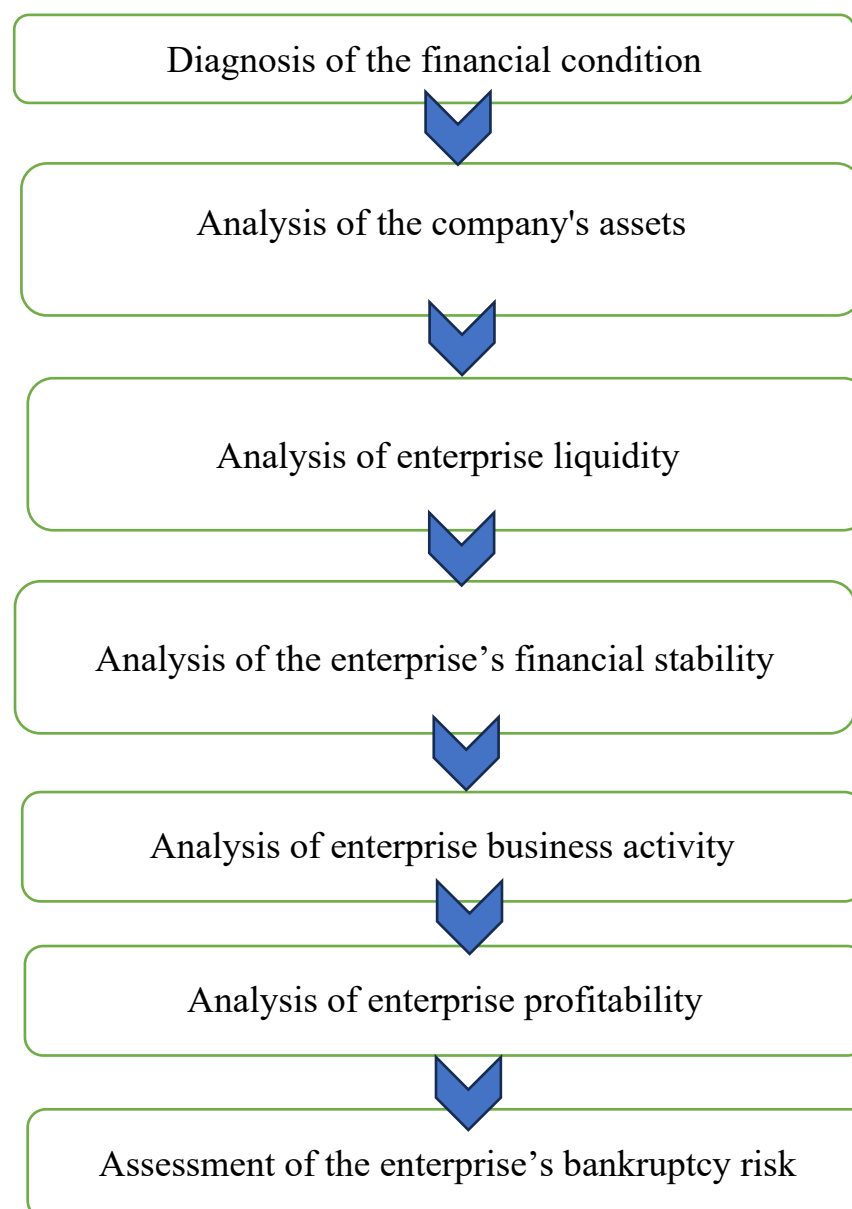


Figure 2 – Stages of Diagnosing the Financial Condition of an Enterprise

Note – developed by the author based on the data from source [5].

As shown in Figure 2, the diagnosis of the financial condition of an enterprise represents a consistent process of studying the main aspects of its financial and economic activities. Initially, an analysis of the enterprise's assets and asset structure is conducted, followed by an assessment of liquidity and financial stability indicators. The next stage involves the analysis of business activity and profitability, which makes it possible to determine the efficiency of resource utilization. The final stage is the assessment of bankruptcy risk and financial insolvency, the results of which serve as a basis for developing measures aimed at financial recovery and improving the sustainability of the enterprise. Thus, a comprehensive approach to diagnostics provides a thorough assessment of the organization's financial condition and allows timely identification of existing problems and development opportunities.

An important stage in studying the financial condition of an organization is conducting a comprehensive diagnostic assessment, which makes it possible to identify the strengths and weaknesses of the enterprise's financial and economic activities. The sequence of the main stages of financial condition diagnostics is presented in Figure 3 [6].

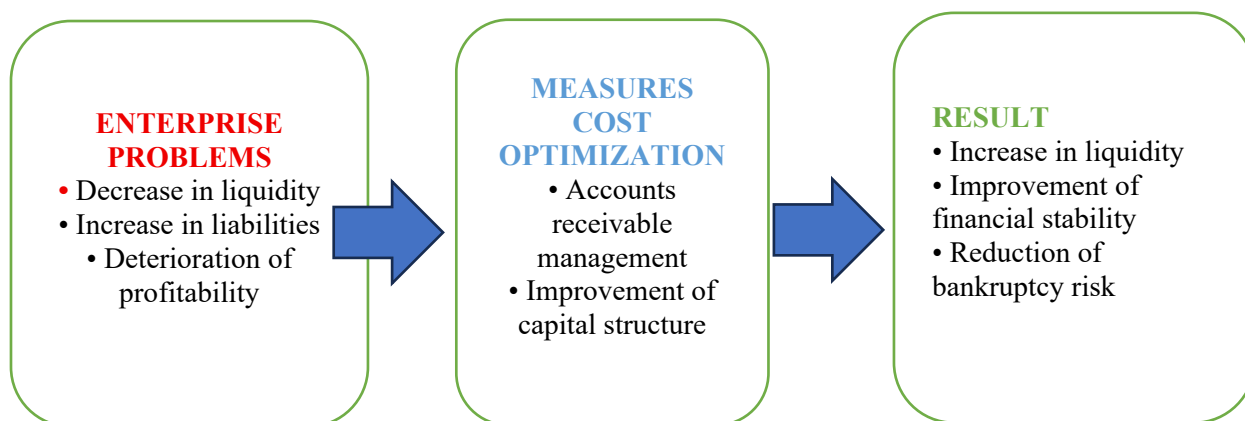


Figure 3 – Conceptual Model of Enterprise Financial Recovery

Note – developed by the author based on the data from source [6].

The data presented in Figure 3 indicate that the diagnosis of an enterprise's financial condition is comprehensive in nature and includes several interconnected stages. At the initial stage, an analysis of the organization's assets and asset structure is carried out, which makes it possible to determine the characteristics of the formation of the enterprise's resource base.

Further, an assessment of liquidity and financial stability is conducted, characterizing the enterprise's ability to fulfill its obligations on time and maintain the required level of financial independence. The analysis of business activity and profitability makes it possible to evaluate the efficiency of resource utilization and the effectiveness of economic activities.

The final stage involves assessing the risk of financial insolvency, the results of which serve as a basis for making management decisions and developing measures for the financial recovery of the enterprise. Therefore, comprehensive diagnostics ensures an overall evaluation of the organization's financial condition and facilitates the timely detection of potential risks to its sustainable development.

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Methodological Tools for Studying the Financial Condition of an Enterprise

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Abstract: The article is devoted to the study of methodological tools for assessing the financial condition of an enterprise. Modern methods of analysis, indicators of financial stability, and approaches to diagnosing the efficiency of an organization's activities are considered.

Keywords: methodological tools, financial analysis, stability assessment, performance indicators.

The methodological tools for studying the financial condition of an enterprise include a set of analytical methods aimed at a comprehensive assessment of liquidity, financial stability, profitability, and the level of financial risk of an enterprise.

The following methods are applied:

- horizontal and vertical analysis of financial statements, which makes it possible to identify structural and dynamic changes in indicators;
 - ratio analysis, including the calculation of liquidity, financial stability, profitability, and business activity indicators;
 - comparative analysis, ensuring the comparison of actual and standard values of financial indicators;
 - methods for diagnosing financial insolvency, including integrated risk assessment models (IFR);
 - calculation of forecast indicators of operational efficiency (EBIT and NOPAT).
- The current liquidity ratio is determined as:

$$K_{tl}=OA/KO \quad (1)$$

where:

OA – current assets of the enterprise;

KO – current liabilities.

The financial stability ratio is calculated according to the following formula:

$$K_{fn}=SC/BC \quad (2)$$

where:

SC – equity capital; BC – balance sheet total.

Return on Assets (ROA) is determined as follows:

$$ROA = NP / \text{Assets}$$

where:

NP – net profit of the enterprise; Assets – total assets of the enterprise.

Integrated Financial Risk Model (IFR):

$$IFR = 0,5L + 0,3F + 0,2R \quad (3)$$

where:

L – liquidity indicator;

F – financial stability indicator;

R – profitability indicator.

Operating Profit (EBIT):

EBIT = operating profit before interest and taxes

Net Operating Profit After Tax (NOPAT):

$$NOPAT = EBIT \times (1 - T) \quad (4)$$

where:

EBIT – operating profit;

T – tax rate.

$$DFL = (1 - t) \times (ROA - r) \times D/E \quad (5)$$

DFL (Financial Leverage Effect) – an indicator that reflects the impact of borrowed capital on the return on equity, expressed as a percentage.

t – income tax rate;

ROA – return on assets (economic return based on EBIT), %

r – interest rate on borrowed capital, %;

D – debt capital;

E – equity capital. [1]

The comprehensive application of the presented methods makes it possible to provide a systematic assessment of the financial condition of an enterprise, identify structural imbalances, and create a foundation for developing anti-crisis measures. The use of ratio analysis in combination with the integrated IFR model and forecast indicators of EBIT and NOPAT ensures a comprehensive approach to diagnosing the financial condition of an enterprise [2].

The financial statements of an enterprise are prepared in accordance with International Financial Reporting Standards (IFRS), which provide unified principles for the recognition, measurement, and presentation of business transactions. The application of IFRS improves the transparency of financial information, ensures comparability of indicators, and enhances the quality of analytical conclusions when assessing the financial condition of an enterprise. Depending on the category of a business entity in the Republic of Kazakhstan, the national financial reporting system (NFRS) may also be applied; however, this study uses an approach based on IFRS principles as the most universal and comparable methodological framework [3].

This article has examined the theoretical and methodological foundations of enterprise financial management under crisis conditions. It was established that financial management represents a system of tools and methods aimed at ensuring stability, solvency, and efficient utilization of an enterprise's financial resources.

The analysis showed that a financial crisis in an enterprise develops under the influence of a combination of external and internal factors, including macroeconomic instability, a decline in effective demand, an inefficient capital structure, an increase in short-term liabilities, and insufficient turnover of current assets. These factors lead to deterioration of liquidity, a decrease in financial stability, and an increase in financial risks [4].

Thus, the results of this study provide a methodological foundation for further practical analysis of the enterprise's financial condition and the development of a set of anti-crisis measures aimed at restoring financial stability and improving operational efficiency.

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SCORING SYSTEM FOR LOAN DECISION IN BANKING SYSTEM FOR SME

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Abstract

The surrounding economic reality, the provision of loans, has made risk management a complex decision-making problem, increasingly making credit scoring issues an important tool for the development of all participants in this process. The analysis shows that the most significant impact on the financial result of the bank is the introduction of an improved credit scoring system, which is possible through the digitalization of customer interaction with a credit institution. The review covers ways to improve the banking credit scoring system. The paper examines research and peer review results. The solutions of both the traditional credit scoring approach and the advanced approach based on artificial intelligence and machine learning are studied.

Key words: credit scoring, banking system, risk management, artificial intelligence, machine learning.

Introduction

In the context of the formation of a new development model for Kazakhstan, one of the main priorities is the creation of an open and self-sufficient market economy, where one of the main drivers should be the development of SMEs (Ashimbayev, 2023). According to the Government of the Republic of Kazakhstan, systemic measures are being implemented to improve the business environment, reducing the administrative burden and providing support to small and medium-sized businesses (Kuantyrov, 2023). It should be noted that at present, state support is largely focused on small businesses and the opening of new businesses (Ashimbayev, 2023).

According to Stat.gov.kz (2026), in the country as of April 2025, the share of individual entrepreneurs in the total number of operating SMEs was 70.3%, small business legal entities - 17.2%, peasant or farming enterprises - 12.3%, and medium-sized business legal entities - 0.2% (Stat.gov.kz, 2026).

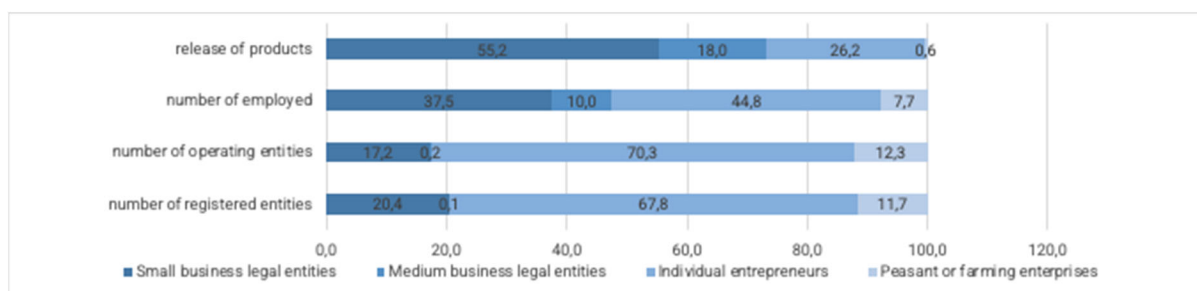


Figure 1. Monitoring of small and medium-sized businesses in the Republic of Kazakhstan (as of April 1, 2025) (Stat.gov.kz, 2026).

Compared to 2023 and 2024 figures, according to Gov.kz (2024), as of January 1, 2024, the number of active small and medium-sized businesses increased by 6.6% and amounted to 99,190 units. Including: small and medium-sized legal entities - 19.3 thousand units, individual entrepreneurs - 69.8 thousand units, peasant farms - 10.1 thousand units. The share of active SMEs in the total number of registered entities was 90.5%. The volume of products manufactured

by SMEs for January-September 2023 amounted to 1.9 trillion tenge. As of October 1, 2023, the number of people employed in SMEs amounted to 237,138, representing 43.3% of the region's total employed population. The growth of these figures for 2025 is significant.

However, the picture is not so rosy, and the recent increase in the number of small businesses is largely a result of business fragmentation, according to Ashimbayev (2024). According to his data, the overwhelming majority of small businesses operate in low-productivity sectors, with trade remaining the dominant activity, accounting for approximately 35% of all small businesses. Meanwhile, trade is an important sector of the economy, so it is necessary to ensure the growth of SMEs, particularly in the manufacturing sector.

Despite the indicators according to Gov.kz (2024) of 6.6% increase in the number of operating small and medium-sized businesses, almost 30% of medium-sized businesses showed losses in the first half of 2023 (Inform.kz, 2023). In order to ensure the solution of problems of economic diversification, it is necessary to carefully analyze the effectiveness, it is necessary to reconfigure business support measures. It is necessary to strengthen both the tools stimulating the consolidation and scaling of effectively operating enterprises. First of all, it is important to pay attention to the development of the most promising and productive sectors (Ashimbayev, 2023).

In this regard, according to Gov.kz (2024), in 2023, within the framework of the National Project for the Development of Entrepreneurship for 2021-2025, 957 projects were financed in the amount of loans of 44 billion tenge, including 535 projects subsidized in the amount of 37.6 billion tenge, 392 projects guaranteed in the amount of 6.3 billion tenge, 30 grants issued in the amount of 141.2 million tenge. In addition, in 2023, the Regional Program "Kasipker" was launched (on a parity basis with Damu 50/50). In 2023, 41 projects were financed for 1.3 billion tenge. As a result, 52 new jobs were created. Also in 2024, the implementation of the Unified Comprehensive Support for SMEs was launched, the purpose of which is to ensure the effective use of state support and the development of competitive, import-substituting enterprises in various sectors of the economy. The Unified SME support program is implemented in 6 areas (Gov.kz, 2024):

- microentrepreneurship;
- small and medium entrepreneurship;
- small, medium and large entrepreneurship in the manufacturing industry and services;
- entrepreneurship in single-industry and small towns, rural settlements;
- social entrepreneurship;
- stock exchange (KASE, AIFC)

The evolution of the above indicators is currently progressing rapidly. For example, in 2026, state financial and non-financial assistance to businesses in Kazakhstan expected will be provided within the framework of the new Unified Comprehensive Small Business Support Program "Isker Aimak" (implemented on January 25, 2026), which replaces previous disparate entrepreneurship development programs. Below are the Table 1 for key statistical and financial data on SME support in Kazakhstan for 2026 (Damu Foundation, 2026; Adilet.zan.kz, 2026; Stat.gov.kz, 2026):

Table 1. SME Support and Development Program in Kazakhstan

Description	Key parameter	Conditions in 2026
Current state of the sector	• Active SME entities • Share of employed population • Regions with leading activity	• ~1.97 million units • 46.6% of the economically active population • The cities of Almaty and Astana
Financial terms of lending (program "Іскер аймақ")	• Maximum project limit • Final rate for business • Rate subsidy period • Damu Fund guarantee coverage	• Up to 200 million tenge • ~8.8% (40% of the nominal rate is subsidized) • Up to 3 years • Up to 85% of the loan amount if there is insufficient collateral
Instruments and priorities of state support	• Main types of assistance • Priority niches and industries	• Financial (subsidies, guarantees), non-financial (training, services), infrastructure (premises, land) • Processing of agricultural raw materials, food industry, furniture and building materials production in rural areas and single-industry towns

Table 1. Programs for support and development of SMEs in Kazakhstan for 2026 (Damu Foundation, 2026; Adilet.zan.kz, 2026; Stat.gov.kz, 2026)

The above data indicate that the development of small and medium-sized businesses requires additional resources, a significant place among which belongs to bank loans. As the most widespread type of banking services, consumer credit undoubtedly has a great impact on the state of the entire banking system, the development of small and medium-sized businesses. The development of the global economy convincingly proves the crucial role of small and medium-sized enterprises in the structure of the national economy and ensuring economic growth (Maramygin et al., 2021). Such enterprises, as a rule, demonstrate a tendency to grow, contributing to the creation of new jobs and stimulating the development of competition, thus performing socially useful functions. At the same time, small businesses are most sensitive to fluctuations in consumer demand and changes in market conditions, but the flexibility and mobility of their adaptation to changing environmental conditions ensures their viability (Zavyalova, 2022).

In this regard, research on consumer bank credit is actively studied and has become widespread. In scientific literature, leading economists and analysts use the term "consumer credit". From a general theoretical standpoint, many scientists characterize consumer credit as a loan provided to the population. One of the most common definitions of consumer lending is the sale of consumer goods by retail enterprises with deferred payment or the provision of loans by banks for the purchase of consumer goods, as well as for the payment of personal expenses. In other words, consumer credit is a form of credit provided to individuals and enterprises for the purchase of consumer goods, durable goods, payment for banking services on deferred payment terms (Orlova, 2015).

Due to the relevance of the bank lending system, this paper studies a type of consumer credit - a retail loan, which is issued through retail chains or bank branches. In other words, quick loans, unsecured, unfunded or non-targeted loans. At the same time, the main component of increasing the efficiency of the retail lending system is the efficiency of risk assessment of this type of service. One of such tools for making a lending decision is credit scoring as a system that primarily regulates the activities of commercial banks, based on data from software developers.

Analysed data indicate that a scoring system for a loan decision in the banking system and issues of developing methods and algorithms for intelligent decision support based on risk assessment in the lending system, taking into account aspects of subjective credit behavior are relevant.

Problem Statement

Bank loans currently form the basis of active operations of a commercial bank, generate the main income and, at the same time, are the main cause of risk, which, if improperly managed, can lead to bankruptcy of banks. The problem of making decisions on loan applications in banking practice is considered exclusively as a problem of assessing the creditworthiness of potential borrowers. This approach does not take into account the risk of disruption of the payment balance of the creditor bank due to the issuance of a loan, which reduces the effectiveness of credit investments - the bank's credit operations, which subsequently leads to lost profits or losses. Therefore, when making decisions on granting a loan, it is necessary to take into account both the creditworthiness of the potential borrower and the impact of the fact of issuing a loan on the state of prospective liquidity of the creditor bank itself (Nationalbank.kz, 2025; Nationalbank.kz, 2026).

Existing methods for assessing the creditworthiness of borrowers, which boil down to calculating financial ratios, themselves have a number of shortcomings (Zavyalova, 2022; Maramygin et al., 2021). Their "empirical" nature, insufficient theoretical and methodological elaboration, and weak use of mathematical apparatus are noteworthy. The main emphasis in the implementation of these methods is on the subjective opinion of experts (Zavyalova, 2022; Maramygin et al., 2021).

A comprehensive accounting of the credit risk of borrowers, the liquidity risk of the creditor bank, the dynamics of changes in the main influencing factors and the consequences of decisions made will improve the efficiency of the creditor bank (World Bank Group, 2019). This approach can reduce the costs of maintaining the required level of liquidity, increase its profitability and sustainability. Therefore, the conducted analysis of a scientifically based methodology and tools to support decision-making on issuing loans by specialists of credit departments of banking institutions, which make it possible to assess the impact of decisions made to provide loans on the dynamics of the prospective liquidity of the creditor bank itself, seems relevant. Such methods and software packages to support decision-making on the terms of issuing loans by a banking institution are developed on the basis of a comprehensive accounting of the credit risk of borrowers, the liquidity risk of the creditor bank, the dynamics of changes in influencing factors and the consequences of decisions made.

Features of the process of providing a loan by a bank

The process of providing a loan by a bank consists in the fact that the bank providing the loan is exposed to many risks, the most dangerous of which are credit risk and the risk of its own liquidity, consisting of a lack of cash for the lending bank itself to fulfill current and future obligations to its clients.

The main quantitative indicators of credit risk are the probability of default of the borrower, characterizing the inability of the borrower to service his debts and fulfill obligations at a particular point in time, as well as expected and unexpected, unplanned losses, characterizing the scale of the creditor's losses in the event of the borrower's default. The final indicator of the credit risk assessment is the limit - the maximum volume - of lending to a specific borrower, which allows limiting the volume of possible losses of the creditor.

There are various models and methods for quantitative assessment of credit risk. Among them are: exogenous and regression models of default, discriminant analysis, principal component analysis, hierarchical classification models, probit/logit analysis, neural networks, fuzzy sets, etc.

In addition, the approach using mathematical apparatus to assess credit risk instead of generally accepted indicators of the borrower's financial condition will reduce the influence of subjectivity and increase the validity of decisions made on the advisability and terms of lending to a particular borrower (Zavyalova, 2022; Maramygin et al., 2021).

Credit scoring plays a central role in the financial system of Kazakhstan, providing an effective and objective assessment of the solvency and reliability of potential borrowers. It is a comprehensive software system that analyzes various aspects of a person's financial behavior and history, including their income, credit history, marital status, age, and many other factors. This approach allows credit institutions to minimize the risks associated with issuing loans and makes the lending process more accessible and transparent for clients. Scoring affects not only the possibility of obtaining a loan, but also the terms of its provision, including interest rates and repayment terms. Thus, scoring becomes a key element in maintaining the health and sustainability of the country's financial system (KMF, 2023).

For completeness, it is necessary to emphasize that scoring in the banking system is an assessment system used by banks and financial institutions to determine the reliability and solvency of potential borrowers. The scoring system analyzes many factors, on the basis of which an overall score is formed, which helps lenders decide whether to grant a loan and on what terms. Thus, scoring is a banking tool designed to reduce risks and provide loans to more responsible clients (KMF, 2023).

Credit scoring works as an automated assessment system designed to analyze the financial reliability and solvency of potential borrowers. It is based on algorithms that process large amounts of data: credit history, information from the borrower's questionnaire, income, professional status, marital status and much more. Based on this analysis, the scoring system assigns points to the borrower. The higher the score, the more likely it is that the borrower will receive a loan and on more favorable terms. This allows banks to effectively manage the risks associated with lending, providing more informed and faster decisions on issuing loans (Korobova, 2012; KMF, 2023).

There are many scoring systems, and each credit institution can focus on different assessment criteria. However, there are three main types of credit scoring in Kazakhstan (Adilet.zan.kz, 2026; Kmf.kz, 2023; Fingramota.kz, 2022; Gov.kz, 2026):

- Borrower survey: answers to various questions are assessed, which affect the final score.
- Behavioral scoring: a type of scoring aimed at identifying financial fraudsters and malicious defaulters by analyzing the financial behavior of a potential borrower.
- Collection scoring: used to collect debts through phone calls, SMS notifications and personal meetings with the debtor.

These three types of scoring in Kazakhstan represent different approaches to assessing the creditworthiness and reliability of borrowers. Together, these approaches form a comprehensive assessment system that allows financial institutions to minimize risks and provide more efficient lending. Credit scoring data is taken from a variety of sources to provide an accurate and comprehensive assessment of the borrower's solvency. Key sources include:

- Credit history: information about previous and current consumer microloans and credits, their amounts, terms and payments.
- Borrower questionnaire: personal data specified when applying for a loan, including place of residence, age, marital status and income.
- Bank data: information about the movement of funds on debit and credit cards, revealing information about the financial behavior of the borrower.
- Public records: information about debts on utility bills, fines and other financial obligations.

Thus comprehensive approach allows lenders to obtain a complete picture of the borrower's financial status and behavior, minimizing risks and increasing the accuracy of assessing their creditworthiness.

Credit Scoring Measurement

Increasing the accuracy of assessing the borrower's creditworthiness becomes the cornerstone for the development of financial institutions - the stability of the banking system. On the other hand, consumer credit acts as a factor in reducing staff turnover at enterprises, this is due to the fact that employees of the enterprise remain at their workplace as long as possible in order to be solvent. Such a factor, of course, has a positive effect on the economy of any country. In such a consideration of the essence and role of consumer credit in the economy, it can be perceived that consumer credit is a significant factor in raising the national welfare (Korobova, 2012).

However, it should be noted that consumer credit, creating a high market situation and production growth, can contribute to the production itself going beyond the solvent demand of the population, thereby exacerbating the economic crisis in the country. How to find a balance? What tools for improving the measurement of credit scoring will be able to maintain the harmony of such challenges associated with consumer lending? Meanwhile, credit risk is the most significant risk in terms of impact for any bank and financial institution. Accurately assessing credit risk impacts an organization's balance sheet and income statement because credit risk strategy determines pricing and can even influence seemingly unrelated areas such as marketing and decision making (Markov, Seleznyova and Lapshin, 2022).

Recent peer review researchers propose different approaches. For example, in a study conducted by Ahelegbey and Giudici (2023), which is devoted to improving the way of credit scoring measurement, an approach is proposed through factor clustering. To improve the measurement, it is proposed to apply it to small and medium enterprises (SMEs) involved in P2P lending. This approach explores the concept of familiarity. The concept of familiarity is based on the idea of how familiar similar situations are in terms of functionality or latent characteristics. Latent factors are defined as observable data. Their approach uses singular value decomposition of the object to extract the factors underlying the observed indicators of SME financial performance. They then clustered the factors using a standard k-means algorithm. This allowed the researchers to segment the heterogeneous population into clusters with more homogeneous characteristics. The obtained results of Ahelegbey and Giudici (2023) show that clusters with relatively fewer SMEs produce a more parsimonious and interpretable credit scoring model with better default prediction performance.

And in another study, Kamimura, Pinto and Nagano (2023) propose a methodology for optimization applied to credit scoring models through technical procedures based on bibliographic and exploratory analysis. The study of these researchers consisted of 46 publications, including 10 literature reviews and 36 proposals for credit scoring models using Scopus, ScienceDirect and Web of Science databases. The results obtained showed that credit scoring models are usually formulated using financial analysis, machine learning, statistical methods, operational research and data mining algorithms. The main databases used by the researchers were banks and the University of California, Irvine. According to the analysis of the researchers' data, financial institutions use 48 types of methods used in credit scoring models, the main ones being: logistic regression (13%), naive Bayes algorithm (10%) and artificial neural networks (7%). Kamimura, Pinto and Nagano (2023) conclude that advances in credit scoring research will require new hybrid approaches that can integrate big data and deep learning algorithms in credit scoring models. These algorithms should have practical questions addressed to improve the level of adaptability and performance required for such credit scoring models.

In a similar review, the peer review (Markov, Seleznyova and Lapshin, 2022) examined 150 of the most relevant credit scoring-related articles published between January 2016 and June 2021 to identify trends in credit scoring using a fixed set of questions.

The results obtained by the researchers allow for comparison with previous periods and highlight some of the latest best practices. In particular, various statistical and machine learning methods can be used at different stages of credit scoring. In addition, they examined papers that propose new approaches to feature selection, model testing, and quality assessment. They also noted that the publicly available data available to researchers has increased significantly. For example, Kaggle and other platforms provide tools for organizing credit scoring competitions and exchanging statistical information; P2P lending platforms (Lending Club, We.com, among the most well-known) show high potential for analyzing large volumes of real data. Also, a large dataset provided by Fannie Mae allows testing credit scoring methods when applied to mortgage data (Markov, Seleznyova and Lapshin, 2022). As a conclusion of their study, Markov, Seleznyova and Lapshin (2022) recommend using multiple publicly available datasets to test credit scoring models at the same time. In doing so, the researchers recommend:

- It is reasonable to use multiple publicly available datasets to validate the model used.
- Consider the potential impact of rejected loans on the modeling results. All authors in their analysis conclude that including rejection inference in the model improves its performance. Since rejected application data is not always available to researchers, however, the Lending Club public dataset provides information on both accepted and rejected loan applications.
- There is a persistent problem of imbalance between good and bad loans in credit scoring, so it may be reasonable to adjust the credit scoring model accordingly. The researchers suggested looking at the Synthetic Method of Minority Oversampling (SMOTE) as it seems to be one of the most prominent approaches to address this issue.
- Data preprocessing, missing value imputation, and feature selection techniques are becoming more common to achieve better performance of simple model architectures. Adopt a more vigilant approach to model testing: Use multiple misclassification criteria and thoughtful validation to conduct a more vigilant test of the proposed model. Additionally, using untimed samples for testing and measuring the financial impact of the model and the cost of errors can be particularly beneficial to the business.
- Logistic regressions, support vector machines (SVMs), and classifier and regression trees (CARTs) have become the most widely used base models, often producing average results compared to other models developed. Neural networks are also gaining popularity as a base model for other more sophisticated credit scoring methods.
- Ensemble (i.e. bagging, boosting, and stacking) models are often presented as a better alternative to base models, especially if we exclude the “Other” model category due to our concerns about overfitting and survivorship bias.

It was noted above that many experts in the field of credit scoring have proposed various solutions that should have an approach based on a comprehensive solution that defines the credit system as a system that ensures the functioning of credit in society, implements its functions and essence. In this regard, it will be relevant to study the role of artificial intelligence and machine learning in credit scoring.

The Role of Artificial Intelligence and Machine Learning in Credit Scoring

AI-powered credit scoring or artificial intelligence-powered credit scoring is a modern approach to assessing the creditworthiness of a borrower. Unlike traditional credit scoring, which relies on static variables and historical data, AI-powered credit scoring uses machine learning algorithms to analyze a wide range of data points, including non-traditional data, to predict a

borrower's likelihood of repaying a loan. The significance of AI-powered credit scoring is a more comprehensive and dynamic assessment of credit risk, providing lenders with a more accurate and detailed understanding of a borrower's financial behavior (Datrics.ai, 2024).

It is important to note that AI-powered credit scoring revolutionizes the traditional credit scoring process by using advanced machine learning algorithms to analyze a vast array of data points that go far beyond what traditional scoring systems take into account. While traditional scoring is a mathematical model based on statistical methods and calculations for a large amount of information, AI-based scoring provides more sensitive, personalized credit rating assessments based on a number of additional factors in real time. This allows more people with potential income to gain access to financial services.

This approach allows for a more dynamic, comprehensive and accurate assessment of the borrower's creditworthiness. For example, according to Datrics.ai, (2024) AI-based credit scoring is the most promising and relevant solution. Credit scoring assesses how well a bank client can pay and whether a borrower is willing to repay the debt. AI-based credit assessment decisions are formed based on data such as:

- Total Income
- Credit History
- Transaction Analysis
- Work Experience
- User Behavior Analytics

However, the data collection steps for AI-based credit scoring are as follows:

Data collection and analysis - AI systems can process and analyze a wide range of data sources, including banking transactions, bill payments, social media activity, and even mobile phone usage patterns. This extensive data collection allows for a more holistic view of an individual's financial behavior.

Machine learning models - are trained on large data sets to identify patterns and correlations that may indicate a borrower's likelihood of repaying a loan. By analyzing thousands of data points, machine learning algorithms can identify subtle connections between seemingly unrelated factors and an individual's financial strength.

Predictive analytics - Once a machine learning model is trained, it can be used for predictive analytics. When a new loan application is received, the AI system evaluates the applicant's data against the patterns learned during training. It then generates a score that predicts the applicant's creditworthiness. This score is based on a complex analysis of a variety of factors, including some that may not be obvious even to financial experts.

Continuous learning – One of the key benefits of AI-powered credit scoring is its ability to learn and adapt over time. As the system processes more applications and receives feedback on its predictions, such as whether borrowers will actually repay their loans, it can refine its models to improve accuracy. This continuous learning process ensures that the AI system stays abreast of changing financial behavior and market conditions.

As it can be seen, artificial intelligence is playing a transformative role in credit scoring. Traditional credit scoring models often fail to account for the complexity and variability of individual financial behavior. On the other hand, AI can process massive amounts of data, identify patterns, and make predictions with a high degree of accuracy. This allows for more personalized and fair credit scoring. AI-powered credit scoring can also expand lending opportunities to underserved populations, such as those with poor credit histories or first-time credit seekers, by considering alternative data in the scoring process.

AI credit scoring, while revolutionary, is not without its challenges and shortcomings. The main criticisms center on the opacity of machine learning models (often referred to as the "black box" problem) and the potential for biased decisions (Datrics.ai, 2024).

Since credit scoring is the basis for financial institutions to make credit decisions, and big data technology has penetrated into the financial field, the development of science and technology is one of the leading solutions. One such solution was proposed by researchers in their field in three approaches based on machine learning by Wu and Pan (2021):

- The first stage is the application of credit scoring on personal credit data, the experimental dataset is cleaned, the discrete data is encoded with a single HOT, and the data is standardized. In order to obtain reliable output, the pdC-RF algorithm was applied to optimize the correlation of data features and reduce the 145-dimensional data to 22-dimensional data due to the high dimensionality of personal credit data.
- Next, based on the data from the first stage, WOE encoding was performed on the dataset, which was applied to the random forest, support vector machine, and logistic regression models, and the performance was compared. In this step, it was found that logistic regression is more suitable for the personal credit scoring model based on the Lending Club dataset.
- Finally, in the third stage, based on the logistic regression model with the best parameters, the user samples are scored and the final scorecard is output.

The contribution of the researchers Wu and Pan (2021) is to provide scientific and reasonable credit assessment to the general public in the new situation. These researchers established a series of complete credit assessment systems, including formula derivation, model construction and simulation analysis of the personal credit assessment model according to the advanced big data mining technology. In the research process, firstly, the discrete variables are encoded to solve the problem that discrete variables and continuous variables cannot be treated uniformly. Then, aiming at the problem that high-dimensional data is easy to overfit, the data is reduced in dimension. Then, the data after dimensionality reduction is divided into data partitions, and continuous variables and discrete variables are classified into partitions through variable discretization, and the WOE codes of each district are obtained. Then, the WOE datasets are trained according to the three models, respectively. After comparing the performance, the researchers found that logistic regression is more suitable for the personal credit assessment model based on Lending Club datasets. They also noted that based on the logistic regression model with the best parameters, user samples are evaluated and the final scorecard is derived (Wu and Pan, 2021).

There is no single answer in the literature on which method is the most effective means of credit scoring: different authors seem to have different, if not opposite, opinions on this issue. However, as the review showed, credit scoring is of great importance for both individuals and SMEs seeking loans from banking and fintech companies. With the increasing trend of using a modern credit scoring model, there is a need for a more advanced solution that can also take into account peer trust factors. This paper focused on understanding the existing set of credit scoring systems taking into account all the available modern solutions. The problem of creditworthiness assessment should be further studied, the accuracy and structure of the credit scoring system remains extremely relevant in the banking system today.

Conclusion

Bank loans currently represent the basis of active operations of a commercial bank, bring in the main income and at the same time are the main cause of risk, and if improperly managed, can lead to bankruptcy of banks.

The problem of making decisions on credit applications in banking practice is considered exclusively as a problem of assessing the creditworthiness of potential borrowers. This approach does not allow taking into account the risk of disruption of the payment balance of the creditor bank due to the issuance of a loan, which reduces the effectiveness of the bank's credit investments and leads to a loss of profit or losses. Therefore, when making decisions on granting a loan, it is necessary to take into account both the creditworthiness of the potential borrower and the impact of the fact of issuing a loan on the state of the prospective liquidity of the creditor bank itself

The existing methods of assessing the creditworthiness of borrowers, which are reduced to calculating financial ratios, themselves have a number of shortcomings. Their "empirical" nature, insufficient theoretical and methodological elaboration, and weak use of mathematical apparatus are noteworthy. The main emphasis in the implementation of these methods is on the subjective opinion of experts (Zavyalova, 2022; Maramygin et al., 2021).

The purpose of the theoretical review was to study the decision-making process on issuing loans by a banking institution to both individuals and legal entities, small and medium businesses. According to the traditional approach, most experts propose a comprehensive accounting of the credit risk of borrowers, the liquidity risk of the lending bank, where the dynamics of changes in the main influencing factors and the consequences of decisions made will improve the efficiency of the lending bank, reduce the costs of maintaining the required level of liquidity, and increase its profitability and sustainability. Experts of the traditional approach consider it reasonable to use several publicly available data sets to test the model used, as well as specially developed credit scoring models (Gov.kz, 2026; Adilet.zan.kz, 2026; Kmf.kz, 2023; Fingramota.kz, 2022; Korobova, 2012).

On the other hand, the development of technology allows for an advanced path of credit scoring based on artificial intelligence and machine learning. It was noted that AI systems can process and analyze a wide range of data sources, including banking transactions, bill payments, social media activity, and even mobile phone usage patterns. This extensive data collection allows for a more holistic view of a person's financial behavior. However, AI credit scoring, although revolutionary, is not without its problems and shortcomings. The main criticism concerns the opacity of machine learning models. This approach is called the "black box" problem (Datrics.ai, 2024).

Overall, the conducted review allows us to assert the relevance of the studied problem of developing a scientifically based methodology and tools to support decision-making on issuing loans by specialists of credit departments of banking institutions, allowing to assess the impact of decisions made on providing loans on the dynamics of the prospective liquidity of the lending bank itself. New research, solutions, methods and software packages to support decision-making on the terms of issuing loans by a banking institution would have practical significance, especially based on the use of AI and ML. It should be noted that the surrounding economic reality, the provision of loans, has made risk management a complex decision-making problem, increasingly making credit scoring issues an important tool for the development of all participants in this process. It turned out that the most significant impact on the financial result of the bank is the introduction of an improved credit scoring system, which is possible through the digitalization of client interaction with a credit institution. Analysis of the proposed scoring systems allows us to establish that the improvement of the lending system for small and medium-sized businesses has been well studied. However, at the same time, there is a need for further improvement of the lending system, taking into account the latest achievements of science and technology, which should positively affect the entire lending system for small and medium businesses in the Republic of Kazakhstan, which will allow the growth of the well-being of all participants in the economic process.

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TRUST–INTERACTION–PURCHASE PATHWAYS IN LIVE E-COMMERCE: EMPIRICAL EVIDENCE FROM ‘YU HUI TONG XING’

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Abstract

Live-streaming commerce converts social attention into transactions as trust reduces uncertainty, interaction supplies diagnostic and emotional cues, and purchasing feeds back into trust. This study examines that pathway in the Douyin account ‘Yu Hui Tong Xing’ (与辉同行), launched on 9 January 2024. It uses only public, auditable observations from the live room, established business media, and third-party monitoring platforms. Trust is proxied by follower accumulation and audience continuity; interaction by viewers, concurrent audience, chat messages, likes, and stream frequency; and purchase by units and reported gross merchandise value (GMV). Across launch, day 15, day 50, and year one, the account recorded 53.574 million launch viewers, 1.177 million average concurrent viewers, 114,000 messages, over one million units, and at least RMB150 million GMV. Cumulative GMV exceeded RMB627 million by day 15, approached RMB1.3 billion by day 50, and surpassed RMB9.3 billion across about 621 first-year streams. Overall, the findings support a descriptive, mechanism-consistent—not causal—trust–interaction–purchase pathway for this highly visible empirical case.

Keywords: live-streaming commerce; trust; interaction; purchase behavior; social commerce; Douyin; Yu Hui Tong Xing

1. Introduction

Live-streaming commerce compresses product discovery, evaluation, social interaction, and checkout into one interface. Its commercial promise is not explained by visibility alone. Consumers buy products they cannot physically inspect, from sellers they may never meet, while prices, comments, and audience counts change in real time. The central managerial problem is therefore a pathway problem: how does trust become interaction, and when does interaction become purchase?

2. Literature Review and Analytical Framework

2.1 Trust as uncertainty reduction and relational capital

Online purchase decisions are constrained by information asymmetry: consumers cannot fully verify product quality, seller motives, or post-purchase performance before checkout. In live commerce, vicarious trials, real-time explanations, and value congruence can work as signals that reduce product uncertainty and cultivate trust [1]. Trust also has a relational dimension. Guo et al. [2] show that trust in broadcasters, products, and community members supports engagement through swift guanxi, while Zhang et al. [4] place trust at the center of customer retention in a socio-technical system. Social capital research adds that professionalism and parasocial relations can affect purchase intention through trust, whereas a streamer's negative public events can

erode that mechanism [6]. Accordingly, follower migration is not treated here as proof of trust, but as a cautious behavioral proxy for willingness to continue a relationship with a new account.

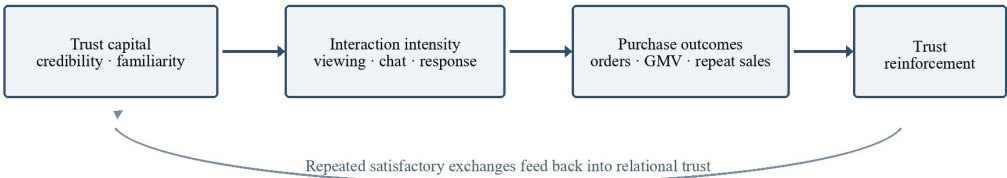
2.2 Interaction as information, presence, and social proof

Interaction is more than a decorative engagement feature. Synchronous demonstrations and question handling can increase information diagnosticity, while visible comments and audience reactions produce social presence and conformity cues. Mixed-method evidence indicates that live streams help consumers acquire need-specific information and additional service, even though repetitive information can reduce efficiency for experienced viewers [5]. Emotional contagion research further suggests that streamer affect and audience-generated messages jointly shape emotional trust and purchase intention [3]. Recent work differentiates interactions that obtain product information, reveal the purchase dynamics of others, and deliver monetary incentives; these pathways work through social presence and conformity rather than through a single undifferentiated ‘engagement’ construct [9]. Therefore, this study separates reach (cumulative viewers), synchronous depth (average concurrent viewers and chat), and repetition (number of streams and content activity).

2.3 Purchase outcomes and the feedback loop

Purchase intention is necessary but not equivalent to realized sales. Consumption-value evidence shows that functional, social, emotional, conditional, and self-gratification values influence intention, with streamer popularity strengthening several effects [10]. Influencer trust and attachment can also raise purchase intention [8], and source credibility, congruence, and parasocial relationships matter in Chinese live-shopping contexts [7]. At the behavioral level, however, orders and GMV are the clearest observable outcomes. When consumers repeatedly receive satisfactory value, realized transactions may reinforce trust and produce continued viewing; failed products, exaggerated claims, or poor service may reverse the cycle. The framework therefore includes a feedback arrow rather than a one-way funnel.

Figure 1. Trust–interaction–purchase pathway used in the case analysis



The framework generates three case propositions. P1: transferable credibility should be visible in rapid follower accumulation and immediate large-scale viewing. P2: interaction intensity should coexist with—not merely precede—purchase outcomes, indicating that attention is being processed through informational and social mechanisms. P3: if the pathway extends beyond a launch event, repeated streams and cumulative GMV should continue to grow after the initial publicity shock. These propositions are evaluated descriptively; they are not framed as causal hypotheses because the public data lack an untreated comparison group and user-level exposure histories.

3. Data and Method

3.1 Case selection and observation window

The case is the Douyin account ‘Yu Hui Tong Xing,’ launched on 9 January 2024 and associated with Dong Yuhui. The observation window runs from the first broadcast through the first anniversary. This is a revelatory rather than statistically representative case: a new account inherited recognizable human capital, but had to establish its own operating cadence, product portfolio, and organizational identity. The design focuses on temporal pattern matching across public milestones instead of generalizing a population parameter.

3.2 Public-data protocol

A metric was included only when a dated public page stated the value and its measurement context. Five pages constitute the audit trail: Sina Finance's report of launch metrics; Jiemian's day-15 summary; Newrank's day-50 monitoring report; E-commerce News' first-anniversary summary based on a third-party platform; and the official PLOS publication used to contextualize regulatory risks. Where reports differed, the study used the clearly dated value attached to the specified observation window and avoided combining incompatible denominators. 'More than' and 'approximately' qualifiers are retained. GMV is explicitly labeled as reported or estimated; it is not equated with audited revenue, cash collected, or profit.

Table 1. Construct operationalization and evidentiary limits

Construct	Public indicators	Interpretive role	Main limitation
Trust	Follower gain; continued audience attention	Behavioral willingness to follow the account	Followers may reflect curiosity or celebrity transfer
Interaction	Cumulative viewers; average concurrent viewers; chats; likes; stream count	Reach, synchronous participation, and repeated contact	Platform definitions and de-duplication are not fully disclosed
Purchase	Units sold; reported cumulative GMV; GMV per stream	Realized transaction proxy	GMV may include cancellations/returns and is not audited revenue
Continuity	Day-15, day-50, and year-one milestones	Tests persistence beyond launch publicity	Sparse milestones cannot recover daily dynamics

3.3 Derived indicators

Four transparent ratios are calculated from published values: (1) launch GMV per cumulative viewer = reported launch GMV divided by cumulative viewers; (2) launch units per cumulative viewer = units divided by cumulative viewers; (3) milestone average GMV per elapsed day = cumulative GMV divided by days since launch; and (4) year-one GMV per stream = cumulative GMV divided by reported streams. These are intensity indicators, not conversion rates. A person may enter repeatedly, a viewer may buy several items, and GMV may be revised after refunds. The calculations are reproducible from Table 2 and are reported with conservative inequality signs when the source value is a lower bound.

3.4 Analytical strategy and validity

The study uses temporal pattern matching and triangulation. Each milestone is mapped to trust, interaction, and purchase indicators, then assessed against P1–P3. Construct validity is strengthened by using multiple indicators rather than treating likes as sales or GMV as trust. Reliability is supported by an explicit URL audit trail and arithmetic that can be independently reproduced. Internal validity remains limited because media exposure, promotions, assortment, prices, and platform recommendation may jointly influence all three constructs. External validity is analytical: the case can refine mechanisms for personality-led live-commerce accounts, but it does not estimate the average effect for all streamers.

4. Empirical Evidence

4.1 Launch: transferring trust into synchronous participation

The first broadcast provides the clearest view of trust transfer. Over four hours, the live room presented 188 product links, attracted 53.574 million cumulative viewers, maintained 1.177 million average concurrent viewers, received 114,000 chat messages, sold more than one million units, and generated more than RMB100 million GMV according to a monitoring report cited by Sina Finance. The live room itself reported a higher launch figure above RMB150 million, also carried by established media; this study adopts RMB150 million only in the milestone series while

retaining the monitoring-based lower bound in sensitivity language. The discrepancy illustrates why public live-commerce numbers must be attributed and qualified rather than treated as audited accounts.

The attention pattern is consistent with P1. A newly created account ordinarily lacks platform history, but 'Yu Hui Tong Xing' entered with a familiar presenter, recognizable narrative style, and a mobilized audience. Rapid following and very high concurrency indicate that viewers were willing to move attention to the new account. That is compatible with transferred credibility, though it does not prove that every follower trusted every product. The 114,000 messages show synchronous participation at scale; the audience was not only exposed to a prerecorded advertisement.

4.2 The first 15 days: converting an event into a cadence

By 25 January 2024, Jiemian reported 13.599 million followers, more than RMB627 million cumulative GMV, over 11.67 million units, and 24 live sessions during the first 15 days. Its account of the launch also recorded more than 42 million views and RMB150 million GMV. Although the viewer metric differs from the 53.574 million monitoring estimate because sources may define the broadcast window and unique viewing differently, the direction is unambiguous: large reach coincided with substantial transaction volume. More importantly, 24 sessions in 15 days indicate an operating rhythm beyond a single ceremonial broadcast.

Table 2. Publicly reported milestones and pathway interpretation

Milestone	Trust / audience proxy	Interaction proxy	Purchase proxy	Pathway reading
Launch, 9 Jan 2024	Rapid audience migration; follower gain reported near 3 million	53.574m viewers; 1.177m average concurrent; 114,000 chats; 4 hours	>1m units; reported GMV >RMB100m; live-room report >RMB150m	Transferred trust immediately became dense participation and purchases
Day 15	13.599m followers	24 streams; launch likes >1.29bn; launch views >42m	Cumulative GMV >RMB627m; >11.67m units	Repeated sessions sustained the launch pathway
Day 50	Follower gain 12.77m since launch	183 short videos in prior 30 days; 67,800 average likes; 44 high-GMV streams	Cumulative estimated GMV near RMB1.3bn	Content repetition and sales persisted after novelty
First year	Account remained the leading monitored Douyin commerce creator	Approximately 621 streams	Reported GMV >RMB9.3bn, excluding showcase and group-buying	Purchasing was institutionalized across a full operating year

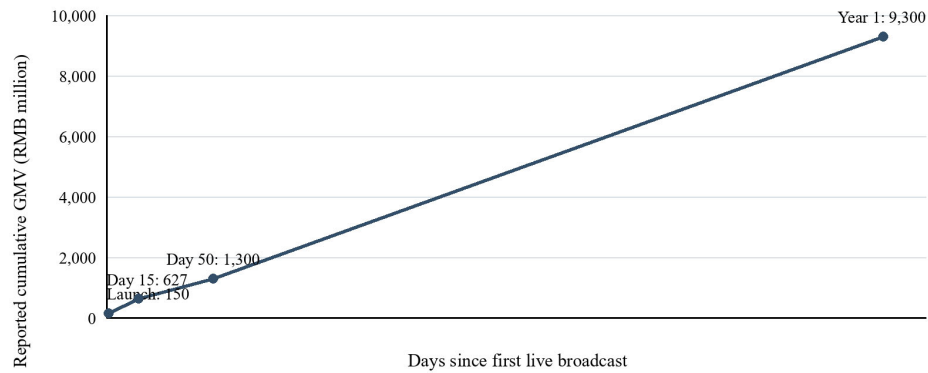
The launch and day-15 evidence supports P2 in a bounded sense. Interaction indicators and purchases co-occur at high levels, and repeated sessions extend the association. However, public totals do not identify whether particular chat exchanges caused particular orders. Product discounts, platform traffic allocation, scarcity prompts, and Dong Yuhui's celebrity visibility are alternative or complementary mechanisms. The appropriate inference is therefore mechanism consistency: interaction supplied a plausible channel through which existing trust and attention could be translated into transaction-relevant information and social proof.

4.3 Day 50 and year one: persistence after the publicity shock

The day-50 observation is important because launch-day novelty should have decayed. Newrank reported that the account had gained 12.77 million followers and approached RMB1.3 billion cumulative estimated GMV. In the preceding 30 days it published 183 short videos averaging 67,800 likes, while 44 live sessions recorded estimated GMV above RMB10 million. These activity measures show a dual content system: short video maintained discoverability and narrative contact between broadcasts, while frequent live sessions provided transactional occasions. The account was therefore building an organization around the presenter's credibility rather than depending only on one viral evening.

At the first anniversary, E-commerce News reported third-party monitoring of approximately 621 live sessions and more than RMB9.3 billion GMV, excluding product-showcase and group-buying data. It also reported an average product price of RMB61.64, suggesting that the headline total did not depend solely on a few high-priced items. The scale should still be read as monitored GMV, not audited company revenue. Nevertheless, a full year of repeated broadcasts and a multi-billion-yuan cumulative transaction estimate is consistent with P3: the pathway persisted after account launch, organizational separation, and a reduction in the founder's personal broadcast frequency.

Figure 2. Reported cumulative GMV milestones



Note: Values are media-reported lower bounds or third-party estimates, not audited revenue. The launch value uses the live-room report of >RMB150m; day 15 uses >RMB627m; day 50 ≈RMB1.3bn; year one >RMB9.3bn.

4.4 Reproducible intensity indicators

Indicator	Calculation	Result	Interpretation
Launch GMV per cumulative viewer	RMB150m / 53.574m	>RMB2.80	Spend intensity per reported viewing occasion; not conversion
Launch units per cumulative viewer	>1.0m / 53.574m	>1.87%	Items per reported viewing occasion; repeat entries/buyers unknown
Day-15 average cumulative GMV per elapsed day	>RMB627m / 15	>RMB41.8m/day	Launch-weighted early commercial velocity
Day-50 average cumulative GMV per elapsed day	≈RMB1.3bn / 50	≈RMB26.0m/day	Lower than launch phase but still persistent
Year-one GMV per stream	>RMB9.3bn / 621	>RMB15.0m/stream	Sustained commercial yield across repeated sessions
Year-one average GMV per elapsed day	>RMB9.3bn / 365	>RMB25.5m/day	Long-run average similar to day-50 cumulative velocity

The derived results sharpen the persistence claim. Average cumulative GMV per elapsed day falls from the launch-weighted first 15 days to about RMB26 million by day 50, as expected when an exceptional opening normalizes. Yet the first-year average remains above RMB25 million per day and the average monitored GMV exceeds RMB15 million per stream. The near alignment of the day-50 and year-one daily averages suggests stabilization rather than collapse. This is consistent with conversion of personal trust into a repeatable channel capability, although it cannot isolate the contribution of trust from assortment, price, traffic allocation, or supply-chain execution.

5. Discussion

5.1 What the case adds to trust research

The case distinguishes transferable trust from institutionalized trust. At launch, the account benefited from trust attached to a recognizable individual: expertise, communication style, and perceived value congruence could travel faster than organizational routines. This mechanism fits uncertainty-reduction research [1] and social-capital evidence showing that professionalism and parasocial relations influence purchase through trust [6]. But year-one persistence cannot be explained by transfer alone. Repeated product selection, service encounters, and the performance of additional hosts had to preserve enough credibility for consumers to return. Trust therefore shifted from being predominantly person-centered to being partly embedded in an account, a team, and a recurring content format.

5.2 Interaction as a conversion infrastructure

The launch metrics show that reach and interaction depth must be analyzed separately. More than 53 million cumulative views describe exposure, whereas 1.177 million average concurrency and 114,000 messages describe simultaneous participation. Concurrency creates a visible crowd; chat allows questions, reactions, and purchase cues to circulate; the host's responses can reduce ambiguity; and the integrated product links shorten the path to checkout. These functions align with research on information exchange and customer service in live commerce [5] and with evidence that product-information, purchase-dynamics, and incentive interactions operate through social presence and conformity [9].

However, more interaction is not automatically better. A dense comment stream may become unreadable, popular questions may crowd out niche concerns, and repetitive sales scripts

may lower efficiency. The useful managerial construct is therefore resolved interaction: the share of meaningful uncertainty or service needs that the live room can address, not the raw number of comments. Public data cannot measure resolved interaction directly. Future platform studies should link time-stamped questions and host responses to product-page visits, orders, cancellations, and returns while protecting privacy.

5.3 From intention to observed purchasing

Most cited studies explain purchase intention, a psychologically important but incomplete outcome [1,3,7,8,10]. This case uses units and GMV, bringing the analysis closer to realized behavior. The comparison also reveals why GMV must be handled carefully. It may include unpaid orders, later refunds, and multiple items per buyer, and a platform's proprietary estimation method may change. Consequently, the article uses inequalities and approximation signs, avoids reporting profit, and does not label items-per-view as a conversion rate. The methodological contribution is modest but important: public sales evidence becomes academically useful when provenance, denominators, and uncertainty are visible.

5.4 The reinforcing loop and its failure modes

The first-year persistence supports a reinforcing loop: credibility attracts attention; interaction creates information and social presence; purchase creates experience; satisfactory experience can support repurchase, word-of-mouth, and renewed trust. Yet the loop is reversible. Product-quality failures, exaggerated claims, opaque sponsorship, inconsistent after-sales service, or negative public events can rapidly weaken relational capital [6]. Policy research also warns that live-commerce growth is accompanied by governance problems involving claims, pricing, and platform responsibility. For a personality-led account, reputational and operational risks are tightly coupled: a single failure can damage both the presenter's identity and the institutional account.

The evidence therefore favors a conditional pathway rather than a deterministic funnel. Trust increases willingness to attend and accept information, interaction can reduce uncertainty and intensify emotion, and purchase becomes more likely when product value, price, and service also meet expectations. Each arrow depends on moderators. Popularity may amplify several consumption-value effects [10]; congruence and source credibility shape parasocial influence [7]; and the relative importance of moral reputation, expertise, popularity, and responsiveness differs between individual and enterprise streamers [11]. 'Yu Hui Tong Xing' combines both types, making governance of the transition especially consequential.

6. Implications, Limitations, and Conclusion

6.1 Theoretical implications

First, the case links constructs often studied in isolation into a temporally ordered pathway. Trust is not simply another antecedent of purchase intention; it is an audience-mobilization resource that affects who enters the live room and how messages are interpreted. Interaction is not only an experiential stimulus; it is the conversion infrastructure between relational capital and transaction. Purchase is not merely an endpoint; accumulated experience can update future trust. This feedback structure extends static intention models without contradicting their micro-level findings.

6.2 Managerial implications

Managers should design the pathway as a system. At the trust stage, selection standards, sponsorship disclosure, consistent claims, and visible accountability matter more than short-term traffic. At the interaction stage, hosts need structured question triage, product demonstrations, readable on-screen evidence, and clear handoffs to customer service. At the purchase stage, teams should monitor paid-order GMV, refund-adjusted GMV, repeat purchase, complaint resolution, and cohort retention rather than celebrating gross traffic alone. The goal is not maximal engagement but trustworthy, decision-relevant engagement.

Personality-led accounts should also manage succession explicitly. A founder's presence can efficiently acquire viewers, but overconcentration makes both scheduling and reputation fragile. Secondary hosts should be introduced through content formats that preserve shared standards while allowing differentiated expertise. Short videos can maintain narrative continuity between live sessions, as the day-50 evidence suggests. Finally, public reporting should separate platform counts, third-party estimates, and audited financial results; doing so protects credibility and improves managerial learning.

6.3 Limitations and future research

This study has five limitations. First, it is a single revelatory case and cannot represent the heterogeneous live-commerce population. Second, the milestone series is sparse and compiled from media and monitoring reports with partially undisclosed methods. Third, GMV is not audited revenue and may be affected by cancellations, returns, duplicate viewers, and category mix. Fourth, the design lacks a counterfactual account, so platform recommendation, promotions, price, and news exposure cannot be separated from trust and interaction. Fifth, public aggregates cannot identify mediation at the individual level.

6.4 Conclusion

Public evidence from 'Yu Hui Tong Xing' is consistent with a trust–interaction–purchase pathway that operated at launch and persisted through the first year. Recognizable credibility enabled rapid audience migration; synchronous viewing and messaging created an infrastructure for information, social presence, and emotional reinforcement; and repeated broadcasts generated sustained monitored sales rather than a one-night spike. The evidence does not prove causality, and its GMV values must remain qualified. Its strongest conclusion is therefore disciplined: live-commerce performance is most plausibly sustained when personal trust is converted into repeatable interaction routines, transaction value, and institutional credibility. Transparent measurement of that conversion is as important as the traffic itself.

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Political Studies

Energy and Transit Projects – Security Guarantee of the South Caucasus Region

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Annotation

This article examines the strategic role of energy and transit projects in the South Caucasus Region as key instruments of regional stability and sovereignty. It highlights how geopolitical shifts following Russia's invasion of Ukraine have transformed the region from a peripheral corridor into a central hub linking Europe and Asia. The study analyzes existing energy pipelines such as BTC, SCP, and the Southern Gas Corridor, as well as emerging initiatives including the Middle Corridor and renewable energy transit projects like the Black Sea Submarine Cable. By situating these infrastructures within broader security and geopolitical frameworks, the article argues that economic projects in the South Caucasus function not only as drivers of development but also as political tools reinforcing Western engagement and integration into global security architecture.

Keywords: South Caucasus, Transit corridors, Critical infrastructure, Middle Corridor, Energy security.

Introduction

The South Caucasus region, both historically and within the modern security system, has always represented a highly important geopolitical and geoeconomic crossroads. In recent years, due to ongoing geopolitical changes, its significance has greatly increased. This results from transformations in global logistics chains and supply corridors.

In 2022, Russia's invasion of Ukraine and the outbreak of full-scale war fundamentally altered traditional Eurasian logistical transit. The agenda shifted toward the search for and expansion of alternative, secure, and high-technology transit corridors to ensure the uninterrupted movement of cargo flows. All of this transformed the South Caucasus from a peripheral and secondary transit corridor into one of the main hubs on the Europe-Asia connecting route.¹

Large-scale energy and infrastructure projects passing through the South Caucasus do not carry only economic or commercial significance. They represent a fundamental pillar of the regional security architecture. This stems from the fact that the region is a site of confrontation among the interests of global actors such as the United States, the European Union, China, and Russia.

¹ Loharzhevskiy, M., & Bento, C. (2026). MSC 2026: Reconfiguring South Caucasus Security. EPIS Insight Security Policy & Defence. <https://epis-thinktank.com/publications/msc-2026-reconfiguring-south-caucasus-security> (Accessed 21.07.2026).

Likewise, we encounter regional actors such as Turkey, Iran, and various transnational corporations with their own interests. Since the South Caucasus region has become one of the alternatives to routes passing through Russia, this creates for global actors the necessity of maintaining stability in the region, which is expressed in the effort to maximally safeguard stability, sovereignty, and the inviolability of borders.

The Transit and Energy Architecture of the South Caucasus

The modern energy and transit architecture of the South Caucasus has been formed over the course of many years and today represents a multi-layered, complex, and sophisticated system. In this region we observe the collision of interests among numerous regional and global actors. Their interests are concentrated around critical infrastructure.

In considering infrastructure from this perspective, particular importance is attached to the contemporary understanding of "critical infrastructure." Critical infrastructure encompasses such physical or virtual assets and systems whose destruction or disruption would have a devastating impact on state security, the national economy, and public welfare.²

Based on contemporary geopolitical processes, the geopolitical order in the region has changed. In the post-Soviet period, the region was characterized by Russian influence. In parallel with the Russia-Ukraine war, however, we see that Russian influence in the region has significantly weakened. Clear indicators of this include the resolution of the Armenia-Azerbaijan conflict, which ultimately concluded through American mediation; the opening project of the Zangezur Corridor, called the TRIPP project (Trump Route for International Peace and Prosperity); and the reduction of Russian influence in Azerbaijan and Armenia.³

Various actors are attempting to fill this vacuum. These include the United States, the European Union, China, India, Iran, and Turkey. Since the region connects the European Union with Asia, it has become a major focus of attention in the geopolitical arena.

Energy Projects and Their Role in Integration with the West

The integration of the region into the Western strategic space was laid by such historic projects as the Baku–Tbilisi–Ceyhan (BTC) oil pipeline and the Baku–Tbilisi–Erzurum (BTE) gas pipeline, also known as the South Caucasus Pipeline (SCP). The total length of the BTC oil pipeline is 1,768 kilometers, while the length of the SCP gas pipeline amounts to 692 kilometers, of which 442 km pass through Azerbaijan and 248 km through the territory of Georgia⁴. These projects demonstrated that the South Caucasus is capable of ensuring the reliable transit of hydrocarbons to the West by bypassing Russia and significantly reducing the region's energy dependence on its northern neighbor.

An essential development of this architecture is the Southern Gas Corridor (SGC), which connects the Shah Deniz gas field directly to Southern Europe through the SCP, the Trans-Anatolian Pipeline (TANAP), and the Trans-Adriatic Pipeline (TAP). According to 2025 data, Azerbaijan and SOCAR supplied 12.5 billion cubic meters (bcm) of natural gas to European Union member states, representing a 53.8% increase compared to 2021 figures and underscoring the importance of the SGC as one of the main alternative routes for replacing Russian gas. In January 2026, TAP's

² Public Safety Canada, "Critical Infrastructure: Cross-Cutting Issues," Government of Canada 2026, <https://www.publicsafety.gc.ca/cnt/ntnl-scrtr/crtcl-nfrstrctr/cci-iec-en.aspx> (Accessed 21.07.2026).

³ Khatia Kikalishvili, Sergey Minasyan, Yunis Gurbanov, and Vakhtang Kapanadze, „Assessing Regional Security in the South Caucasus“, Bucharest: New Strategy Center, June 11, 2026. P 3-4. https://newstrategycenter.ro/wp-content/uploads/2026/06/assessing-regional-security-in-the-south-caucasus-1d5f7925_c.pdf (Accessed 21.07.2026).

⁴ Eugene Kogan, "Trilateral Military and Energy Security Co-operation: Reactions from Moscow and Washington", Expert Opinion no. 17 (Tbilisi: Georgian Foundation for Strategic and International Studies, 2014), Page – 4. <https://gfsis.org.ge/files/library/opinion-papers/17-expert-opinion-eng.pdf> (Accessed 21.07.2026).

transmission capacity was increased by 1.2 bcm per year within the framework of its first expansion stage.⁵

Nevertheless, the further expansion of the project, which under the 2022 European Union–Azerbaijan memorandum envisions the delivery of 20 bcm by 2027, faces certain infrastructural and financial barriers. Azerbaijan’s current gas production amounts to 52 bcm per year (more than 140 million cubic meters per day). However, for the continued growth of exports, President Ilham Aliyev of Azerbaijan emphasized the shortage of long-term gas purchase contracts and the necessity of investments to increase pipeline capacity specifically, expanding TAP to 20 bcm and TANAP from 16 to 31 bcm, which may also require the construction of a parallel pipeline.⁶

Transport and Logistics Corridors: The Strategic Importance of the Middle Corridor

Beyond hydrocarbons, transport and logistics corridors play a crucial role, particularly the “Middle Corridor” (also known as the Trans-Caspian International Transport Route). This multimodal transit network connects the railway and maritime terminals of China and the Central Asian countries with the European Union through the Caspian Sea, the South Caucasus, and Turkey. The development of the Middle Corridor accelerated especially in 2025–2026 with large-scale support from international financial institutions.⁷

On June 2, 2026, the Board of Directors of the World Bank approved the “Trans-Caspian Transport Corridor – Georgia Accessibility and Transport Enhancement” (TC-GATE) project valued at 372 million USD, with a total budget of 751 million USD. The project is co-financed by the Asian Development Bank (ADB, 175 million USD) and the Asian Infrastructure Investment Bank (AIIB, 182 million USD). Its objective is the modernization of Georgia’s transit infrastructure, specifically the procurement of new, energy-efficient electric locomotives for Georgian Railways (which will increase locomotive availability up to 95%, raise revenues by 20%, and reduce emissions by 2.3 million tons) and the construction of strategic road sections in Kakheti (Badiuri–Chalaubani–Bakurtiskhe and Gurjaani–Telavi). These developments will reduce travel time from eastern Georgia to the Port of Poti by 43 minutes and enhance climate resilience against landslides and floods⁸.

In parallel, to strengthen Kazakhstan’s transit network, in January 2026 the World Bank approved a guarantee of 846 million USD for the modernization project of “Kazakhstan Railways” (KTZ), with the total package amounting to 1.236 billion USD. Within this transport network, the Baku–Tbilisi–Kars (BTK) railway plays an important role, providing a fast land connection from the region to Europe.⁹

⁵ Robert Cutler, "South Caucasus Energy and Europe’s Strategic Redundancy after Hormuz," Strategy International, June 12, 2026, <https://strategyinternational.org/2026/06/12/publication270/> (Accessed 21.07.2026).

⁶ Ali Baydarol, “The EU’s Energy Diversification Framework: Can the Role of the Southern Gas Corridor Expand?” (Istanbul: Istanbul Policy Center–Sabancı University–Stiftung Mercator Initiative, April 2026), page 2-5. <https://ipc.sabanciuniv.edu/Content/Images/CKeditorImages/20260616-09063626.pdf> (Accessed 21.07.2026).

⁷ World Bank Group, "Georgia Boosts Role in Trans-Caspian Transport Corridor with World Bank Group Support," Press Release, June 2, 2026, <https://www.worldbank.org/en/news/press-release/2026/06/02/georgia-boosts-role-in-trans-caspian-transport-corridor-with-world-bank-group-support> (Accessed 21.07.2026).

⁸ Ibid.

⁹ Ministry of Finance of Georgia, "Georgia Secures \$372 Million in Financial Resources from the World Bank within the \$751 Million Trans-Caspian Transport Corridor Project," Press Release, June 2, 2026. https://www.mof.ge/en/n/events/transkasiuri_satransporto_derefnis_751 mln_ashsh_dolaris_ghirebule_bis_proektis_farglebshi_msofliu_bankma_sakartvelos_372_miloni_ashsh_dolaris_odenobis_finansuri_resu_rsi_gamouko (Accessed 21.07.2026).

In conclusion, it can be stated that the development of the Middle Corridor is not only an economic factor for the South Caucasus but also a determinant of geopolitical stability. Large-scale investments carried out with the support of international financial institutions in the transit infrastructure of Georgia and Kazakhstan strengthen the region's role as a strategic hub connecting Europe and Asia. The functioning of the Baku–Tbilisi–Kars railway and the implementation of the TC-GATE project create the foundation for the South Caucasus to become a central part of a sustainable, energy-efficient, and climate-resilient transport network.

New Prospective Projects: Green Energy Transit to Europe

Against the backdrop of the international energy agenda of decarbonization and the full implementation of the European Union's "Carbon Border Adjustment Mechanism" (CBAM) starting in 2026, the development of green energy transit infrastructure is actively beginning in the South Caucasus. The flagship project in this direction is the Black Sea Submarine Cable (BSSC), which envisions the construction of a 1,195 km high-voltage direct current (HVDC) cable (1,100 km underwater) from the Georgian city of Anaklia to the Romanian city of Constanța, with a transmission capacity of 1,000 - 1,500 megawatts.¹⁰

In February 2026, the Romanian company "Transelectrica" and "Georgian State Electrosystem" (GSE) signed a Memorandum of Understanding in Bucharest, after which the project moved into the technical preparation stage. A contract was signed between GSE and the Italian consulting company CESI regarding the planning and supervision of geophysical and geotechnical studies of the Black Sea seabed, following CESI's preliminary study which confirmed the economic and technical viability of the project.¹¹

The cable will facilitate the export of green energy from the Caspian and Central Asia, supported by Azerbaijan, Kazakhstan, and Uzbekistan through the Baku-based "Green Corridor Union LLC." In Georgia's 2026 budget, 25 million GEL was allocated for this project. It is noteworthy that Georgia experiences a structural energy deficit during the winter period (in 2025, thermal power plants provided 19–20% of domestic generation, while the electricity trade deficit amounted to 24.3 million USD). To balance this deficit and ensure grid stability, with the support of the Asian Development Bank (ADB), construction is underway in Ksani of the country's first 200-megawatt Battery Energy Storage System (BESS), scheduled for completion by 2028.¹²

It can be said that the new green energy transit projects in the South Caucasus not only strengthen regional energy security but also synchronize with the European Union's decarbonization strategy. The Black Sea Submarine Cable (BSSC) and the planned Battery Energy Storage System (BESS) in Ksani create a structural foundation that will enable the region to become a strategic conduit of green energy toward Europe. These initiatives reduce the winter energy deficit, increase grid stability, and enhance the role of the South Caucasus as a significant node of a sustainable energy architecture.

Economic Projects as Political Instruments

Transit and energy projects in the South Caucasus have already gone beyond the framework of mere economic development and have become real political instruments for safeguarding regional stability and sovereignty. Projects such as Baku–Tbilisi–Ceyhan and the Southern Gas

¹⁰ UN Global Compact Network Georgia, "Strategic Transformation of Georgia's Energy Sector," UN Global Compact Network Georgia, June 2026, <https://unglobalcompact.ge/sustainability-spotlight/en/strategic-transformation-of-georgias-energy-sector/> (Accessed 21.07.2026).

¹¹ Submarine Networks, "Romania and Georgia Advance Black Sea Submarine Cable Project with New MoU," June 17, 2024, <https://www.submarinenetworks.com/en/systems/asia-europe-africa/bssc/romania-and-georgia-advance-black-sea-submarine-cable-project-with-new-mou> (Accessed 21.07.2026).

¹² UN Global Compact Network Georgia, "Strategic Transformation of Georgia's Energy Sector," UN Global Compact Network Georgia, June 2026, <https://unglobalcompact.ge/sustainability-spotlight/en/strategic-transformation-of-georgias-energy-sector/> (Accessed 21.07.2026).

Corridor have demonstrated that the region can ensure energy security and integration with Europe while bypassing Russia. At the same time, the development of the Middle Corridor and new green energy transit initiatives strengthen the South Caucasus's role as a strategic hub where Western interests are steadily increasing. It is precisely in this context that the deepening of Western engagement should be considered, as it grants the region an even more significant position within the global security architecture.

The European Union's decision to completely cease importing Russian natural gas by 2027 compelled Western states to view the South Caucasus as an integral part of their energy and logistical security.¹³ In the context of rising risks to maritime shipping in the Strait of Hormuz (where in 2025 up to 20 million barrels of oil per day were transported under conditions of limited alternative routes), the South Caucasus corridor is regarded as a strategic reserve of critical importance for the European system.¹⁴

Western engagement goes beyond the framework of declarative support. The telephone conversation held on March 30, 2026, between U.S. Secretary of State Marco Rubio and the Prime Minister of Georgia, which addressed the security issues of the Black Sea and the South Caucasus, clearly demonstrates that transport, energy, and regional stability are part of a single geopolitical equation for Washington.¹⁵ Western protection of these corridors functions as a "Tripwire Effect" external revisionist actors are aware that military aggression directed against the countries of the South Caucasus would endanger the West's critical energy and logistical interests, thereby provoking a strong international response.

In conclusion, it can be said that the economic projects of the South Caucasus have already been transformed into political instruments that define regional stability and the region's place within the global security architecture. Energy and transit corridors have become critical strategic resources for the West, particularly against the backdrop of the European Union's reduction of dependence on Russian gas and the growing risks in the Strait of Hormuz. The involvement of the United States and the European Union demonstrates that these projects are perceived not only as economic initiatives but also as guarantees of security. Therefore, their protection functions as a deterrence mechanism that closely links the region to the strategic interests of the West.

Challenges, Risks, and Geopolitical Rivalry

Economic projects in the South Caucasus, while highly attractive, also carry significant risks for the region, as they have both supporters and opponents. The region's major neighbors, Russia and Iran, traditionally view Western-oriented transit and energy corridors with suspicion, since these diminish their monopoly and leverage. The Russian Federation actively employs its hybrid arsenal, including information manipulation and cyber operations, to maintain instability in the region. In the Black Sea, Russia resorts to the suppression and falsification of navigation systems (spoofing and jamming), which significantly complicates maritime transport safety and threatens underwater energy and digital connections.¹⁶

¹³ Ali Baydarol, „The EU's Energy Diversification Framework: Can the Role of the Southern Gas Corridor Expand?“ (Istanbul: Istanbul Policy Center–Sabanci University–Stiftung Mercator Initiative, April 2026), Page 2, <https://ipc.sabanciuniv.edu/Content/Images/CKeditorImages/20260616-09063626.pdf> (Accessed 21.07.2026).

¹⁴ Robert Cutler, "South Caucasus Energy and Europe's Strategic Redundancy after Hormuz," Strategy International, June 12, 2026, <https://strategyinternational.org/2026/06/12/publication270/> (Accessed 21.07.2026).

¹⁵ Wilfried Martens Centre for European Studies, South Caucasus: Energy Security and Geopolitical Challenges, (Brussels: Martens Centre, June 2026), <https://www.martenscentre.eu/wp-content/uploads/2026/06/South-Caucasus-Paper-FINAL.pdf> (Accessed 21.07.2026).

¹⁶ Andrzej Łukasiewicz, "Hybrid Coercion and Maritime Security in the Black Sea," Security and Defence Quarterly, 2026. <https://securityanddefence.pl/pdf-221580-142381?filename=Hybrid-coercion-and-marit.pdf> (Accessed 21.07.2026).

Iran, for its part, expresses dissatisfaction with any project that might weaken its land connection with Armenia or contribute to strengthening the positions of Turkey and Azerbaijan in the South Caucasus. The Zangezur Corridor is considered such a project. Against the backdrop of the Iran–U.S. war, it is highly likely that Iran will strongly oppose the activation of this corridor.

The evolution of such threats has compelled the states of the region to significantly strengthen their national defense capabilities and security institutions.

Georgia recognized its vulnerability as early as 1998 and established a specialized structure, the Strategic Pipelines Protection Department (SPPD), which closely cooperates with the British consulting company Bowman Risk Management in the area of personnel training.

Azerbaijan created the Special State Protection Service (SSPS), which has a budget of 10 million USD, employs more than 800 personnel, and operates a 200-hectare training base near Baku. The entire pipeline route is equipped with modern digital maps and sensors, ensuring the immediate identification of any physical or technical disruptions.¹⁷

A major challenge lies in the physical vulnerability of critical infrastructure. With active military operations and the presence of mines in the Black Sea basin, the risk of damage to underwater cables and gas pipelines is high. In addition, there is the problem of “ambiguous attribution” — in the case of underwater sabotage, it is difficult to identify the attacker and to activate mechanisms of international legal response, which increases the likelihood of asymmetric attacks.

Conclusion and Recommendations

The conducted study has shown that the energy and transit projects of the South Caucasus represent not merely economic corridors, but fundamental political guarantees for regional stability and the protection of sovereignty. The material interest of major international actors, linked to the proper functioning of these corridors, creates a security system in which the protection of the region’s countries is directly interconnected with global security.

Considering the challenges and risks present in the region, it is advisable to develop the following policy recommendations:

For the countries of the region (Georgia and Azerbaijan):

1. Strengthening security coordination: It is necessary to further deepen the existing trilateral format (Azerbaijan–Georgia–Turkey) and expand the scale of the “Eternity” exercises so that they cover not only the physical protection of pipelines but also joint mechanisms for responding to cyberattacks.
2. Modernization and climate resilience: In the development of transit infrastructure (e.g., within the TC-GATE project), special attention should be paid to preventing risks caused by climate change and to ensuring compliance with ecological standards, which will help attract Western investment.
3. Strategic diversification: Active dialogue should be conducted between Georgia and Armenia within the TRIPP project framework to avoid unhealthy competition in cargo transit and to promote the mutual integration of regional transit networks.

For international partners (United States, European Union, international financial institutions):

1. Increasing investment in cyber and physical security: The EU and the U.S. should expand direct assistance to strengthen the cybersecurity of critical infrastructure in the region, including through the permanent involvement of civilian missions and security experts.
2. Long-term commercial guarantees: The European side should ensure the signing of long-term purchase contracts to increase the financial attractiveness of the Southern Gas Corridor and the Black Sea Submarine Cable projects for private investors.

¹⁷ Eugene Kogan, *Trilateral Military and Energy Security Co-operation: Reactions from Moscow and Washington*, Expert Opinion no. 17 (Tbilisi: Georgian Foundation for Strategic and International Studies, 2014), Page 6. <https://gfsis.org.ge/files/library/opinion-papers/17-expert-opinion-eng.pdf> (Accessed 21.07.2026).

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INSTITUTIONAL MECHANISMS OF MULTILATERAL DIPLOMACY: A COMPARATIVE ANALYSIS OF THE ORGANIZATION OF TURKIC STATES, THE EURASIAN ECONOMIC UNION, THE SHANGHAI COOPERATION ORGANISATION, AND THE COMMONWEALTH OF INDEPENDENT STATES

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Abstract. This article offers a comparative institutional analysis of four multilateral organizations active in the post-Soviet and Turkic-speaking space: The Organization of Turkic States (OTS), the Eurasian Economic Union (EAEU), the Shanghai Cooperation Organisation (SCO), and the Commonwealth of Independent States (CIS). While these bodies share a common geopolitical arena and, in several cases, overlapping membership, they differ markedly in institutional depth, degree of supranational delegation, and the diplomatic functions their mechanisms perform. Drawing on the comparative regionalism literature and on integration theories — federalism, functionalism, neofunctionalism, intergovernmentalism, and constructivism — the article develops a structured comparison of summit architecture, permanent bodies, and dispute-settlement or coordination capacity. It argues that the OTS occupies an intermediate institutional position: more developed than the loosely coordinating CIS, yet more consultative and identity-driven than the economically supranational EAEU or the security-focused SCO. The findings contribute to the broader literature on comparative regionalism in Eurasia and to an understanding of how multilateral diplomacy is institutionally channeled among states that belong simultaneously to several overlapping regional frameworks.

Keywords: Organization of Turkic States; multilateral diplomacy; regional institutions; Eurasian Economic Union; Shanghai Cooperation Organisation; Commonwealth of Independent States; comparative regionalism; institutionalization; integration theory.

Introduction

The post-Soviet and wider Eurasian space is unusual among world regions for the density of overlapping multilateral organizations operating within it. Kazakhstan, Kyrgyzstan, and Uzbekistan, for instance, hold simultaneous membership or observer status across several

regional bodies that pursue distinct — and at times competing — logics of cooperation. This overlap raises an analytical puzzle central to regional studies: why do states embedded in a shared geopolitical space and, in several cases, sharing a common Turkic linguistic and cultural heritage, choose to build parallel institutions rather than consolidate cooperation within a single framework.

The question is more than academic. Each organization examined here carries distinct diplomatic instruments, membership rules, and decision procedures, and a state's choice to invest political capital in one framework over another shapes the practical channels through which its multilateral diplomacy is conducted. Understanding these differences requires moving beyond descriptive accounts of each organization in isolation and toward a systematic comparison of their institutional mechanisms — the summits, councils, secretariats, courts, and working bodies through which cooperation is actually negotiated and implemented.

This article addresses that puzzle by comparing the institutional mechanisms of multilateral diplomacy in four organizations: The Organization of Turkic States (OTS), the Eurasian Economic Union (EAEU), the Shanghai Cooperation Organisation (SCO), and the Commonwealth of Independent States (CIS). The comparison is not intended to rank these bodies by success, but to clarify how each channels multilateral diplomacy — through which bodies, with what degree of delegated authority, and toward what functional ends. The article situates the OTS, whose institutional evolution and diplomatic mechanisms form the subject of a wider dissertation project on multilateral diplomacy within the organization, within this comparative field, allowing its distinctive institutional trajectory to be seen in sharper relief against organizations that share its regional setting but differ in origin and design logic.

The remainder of the article proceeds as follows. Section 2 reviews the relevant literature on comparative regionalism and on the four organizations individually. Section 3 sets out the theoretical framework. Section 4 describes the institutional architecture of each organization in turn. Section 5 develops a structured comparison, including a summary table of institutional features. Section 6 discusses the implications of this comparison for understanding the OTS's own trajectory, and Section 7 concludes.

Literature Review

Scholarship on the OTS has grown considerably since its 2021 rebranding. Aydın and Liu (2024) examine the diverse and sometimes divergent motivations that bring member states to the organization, arguing that Turkic cooperation cannot be reduced to a single unifying rationale but instead reflects a bundle of overlapping economic, cultural, and geopolitical interests. Koçak (2023) situates the OTS within competing International Relations paradigms, noting that realist, liberal, and constructivist readings each capture a partial truth about the organization's behavior, and cautions against relying on a single theoretical lens. Dosbolov and Sönmez (2023) examine the OTS through a postcolonial framework, exploring its potential contribution to processes of decolonization in Central Asia while noting significant limitations in its capacity to do so. A recent study by Abi (2026) analyzes how Azerbaijan, Kazakhstan, and Türkiye construct and narrate the idea of a shared "Turkic world" amid regional geopolitical turbulence, underscoring the discursive and identity-based dimension of OTS cooperation alongside its functional instruments.

The EAEU has attracted a substantially larger and more mature academic literature, reflecting its longer institutional history. Dragneva and Wolczuk (2013, 2017) provide the most widely cited institutional account of the Union, characterizing it as a rules-based regime whose formal supranational design coexists with persistent member-state control over substantive outcomes. Vinokurov (2017, 2018), writing from within the Eurasian Development Bank, offers a more integration-optimistic account, emphasizing measurable gains in labor mobility and trade facilitation even as he acknowledges an implementation gap between formal commitments and

practice. Comparative treatments by Hancock and Libman (2016) situate the EAEU within the broader universe of "authoritarian regionalism," arguing that many post-Soviet regional organizations serve political functions for their member governments that diverge from their official integrationist mandates.

Literature on the SCO has often approached the organization through a security lens. Fredholm (2013) traces the SCO's institutional development and its geopolitical positioning between Russia and China, while Gatev and Diesen (2016) compare the SCO and EAEU as two distinct but increasingly interlinked vehicles of Eurasian order-building, one security-oriented and the other economic. By contrast, the CIS has received comparatively less recent scholarly attention, reflecting its declining institutional salience; where it is discussed, it is generally treated, as in Dutkiewicz and Sakwa's (2014) edited volume, as a baseline or point of departure against which the more institutionally ambitious EAEU and SCO are measured.

At a more general theoretical level, Fawcett (2012) and Hurrell (1995) remain foundational references for distinguishing regionalism from regionalization and for cataloguing the varied forms regional cooperation can take outside the European context. Söderbaum's (2016) work on comparative regionalism explicitly cautions against treating the European Union as the implicit benchmark for evaluating non-European regional organizations, a caution highly relevant to comparing the OTS, EAEU, SCO, and CIS, none of which was designed to replicate the EU model in full. This article builds on these strands of literature by bringing all four organizations into a single, structured institutional comparison, a combination that, to the author's knowledge, has not previously been undertaken with specific reference to the OTS's diplomatic mechanisms.

A smaller but growing body of work has begun to compare the OTS directly against other post-Soviet or Eurasian regional organizations rather than treating it in isolation, and this article positions itself within that emerging comparative strand. Existing comparisons have tended to be partial, contrasting the OTS with a single other body — most often the EAEU, given the overlap in Central Asian membership — rather than situating it within the fuller field of regional organizations in which its member states actually operate. By extending the comparison to include the SCO and the CIS alongside the EAEU, this article aims to capture more completely the institutional "portfolio" available to Central Asian states, and to avoid the risk, noted by Söderbaum (2016), of over-interpreting any single bilateral comparison as representative of the region's institutional logic as a whole.

Theoretical Framework

Comparative regionalism scholarship generally distinguishes cooperation mechanisms along a spectrum from purely intergovernmental coordination, where sovereignty is fully retained and decisions require unanimous consent, to supranational delegation, where member states transfer binding authority to common institutions capable of producing rules that apply directly within domestic legal orders. Classical integration theory offers several lenses for interpreting where along this spectrum a given organization sits, and the OTS literature itself has increasingly turned to these frameworks, following Aydın and Liu (2024) and Koçak (2023), to move beyond purely descriptive accounts.

Federalism treats integration as a deliberate, constitutionally anchored pooling of sovereignty into a new political entity with its own directly effective authority; among the cases considered here, none approaches this model, though the EAEU's Court and Commission represent the most federalism-adjacent instruments (Dragneva and Wolczuk, 2013). Functionalism, associated with Haas's (1958) early account of European integration, expects cooperation to emerge issue-by-issue around discrete technical or welfare-enhancing tasks, with institutional form following functional need rather than a prior political design — a logic visible in the SCO's narrowly targeted Regional Anti-Terrorist Structure. Neofunctionalism, developed

further by Haas (1964), predicts that cooperation in one sector generates spillover pressure toward cooperation, and eventually supranational delegation, in adjacent sectors; the EAEU's gradual extension from a customs union toward a common labor market and, more tentatively, a common financial market is consistent with this expectation, even as Vinokurov (2018) and others note that spillover has been partial and contested.

Intergovernmentalism, and its liberal variant associated with Moravcsik (1998), emphasizes that even where common institutions exist, substantive bargaining outcomes continue to reflect the preferences and relative power of member states, with supranational bodies serving largely to lower transaction costs rather than to displace state control. This lens fits the EAEU well, where the nominally supranational Commission's rulings have on occasion been overruled following appeal by a member state to the intergovernmental Supreme Council (Dragneva and Wolczuk, 2017). Constructivism, drawing on Acharya's (2014) work on the construction of regional order outside the West, directs attention to shared identity, norms, and discourse as independent drivers of cooperation, treating institutions partly as expressions of a collective self-understanding rather than purely as functional solutions to coordination problems. This approach is particularly well suited to the OTS, whose institutional consolidation has been explicitly framed by its members and leadership as an expression of shared Turkic identity and historical kinship (Abi, 2026), alongside — and in part preceding — its accumulation of functional economic and security competencies.

A second, complementary distinction, developed by Hurrell (1995) and Fawcett (2012), separates regionalism, understood as a state-led, top-down process of building formal regional institutions among at least three states, from regionalization, understood as a bottom-up increase in societal, economic, and cultural interaction between adjacent states that may or may not be accompanied by formal institutions. All four organizations compared here are instances of regionalism in this sense: each was created by explicit intergovernmental agreement rather than emerging organically from prior regionalization. Their differences lie not in whether they are state-led, but in the extent to which state-led design has subsequently been backed by binding delegation of authority, and in the discursive register — economic, security, or civilizational — in which that design has been justified to domestic and international audiences. Söderbaum (2016) further cautions that such comparisons should avoid treating the European Union's supranational model as the implicit standard of "successful" integration, a caution this article follows by evaluating each organization's institutional design on its own functional and political terms rather than against a Eurocentric benchmark.

A related but distinct strand of theory, neoliberal institutionalism, associated with Keohane's (1984) work on cooperation under anarchy, suggests that even shallow, non-supranational institutions can generate significant cooperative value by reducing transaction costs, providing information, and creating focal points for coordination, independent of any formal transfer of sovereign authority. This perspective is useful for interpreting organizations such as the CIS and, to a lesser extent, the OTS, whose institutional value cannot be measured solely by the presence or absence of binding supranational instruments. Under a neoliberal institutionalist reading, the OTS's summit architecture, working groups, and affiliated bodies perform a genuine coordinating function — reducing uncertainty about partners' intentions, standardizing technical cooperation in areas such as customs procedures, and providing a recognized diplomatic venue — even though they fall well short of supranational delegation. This reading complements, rather than displaces, the constructivist emphasis on identity discussed above: institutional value in the OTS case appears to derive both from the practical coordination benefits Keohane's framework predicts and from the identity-affirming function highlighted by Acharya (2014) and Abi (2026).

Methodology

This article adopts a qualitative, document-based comparative institutional method. For each organization, primary sources — founding treaties, charters, organizational structure pages, and summit declarations — were used to establish the formal architecture of decision-making, executive, and dispute-settlement bodies. These primary sources were supplemented by the secondary academic literature reviewed in Section 2 to interpret the practical operation of that architecture, since founding documents alone often understate the degree to which formally supranational bodies are, in practice, constrained by intergovernmental bargaining. The four organizations were selected because they represent the principal multilateral frameworks within which the OTS's core Central Asian and Caucasus member states — Kazakhstan, Kyrgyzstan, Azerbaijan, and Uzbekistan — conduct regional diplomacy, allowing the comparison to speak directly to the overlapping-membership dynamic discussed in Section 5.

The comparison is structured around six dimensions common to the institutionalist literature on regional organizations: the timing and legal basis of founding; the composition and standing of the supreme decision-making body; the existence and mandate of a permanent executive body; the presence or absence of a judicial or quasi-judicial dispute-settlement mechanism; the organization's primary functional domain, understood broadly as the issue area in which it has developed its most substantial institutional capacity; and the degree of supranational delegation, assessed qualitatively based on whether common bodies can produce binding decisions independent of unanimous member-state consent in practice, not merely in formal treaty language. This last distinction, following Dragneva and Wolczuk's (2017) methodological approach to the EAEU, is treated as central, since several of the organizations compared here formally provide for supranational instruments that are in practice heavily circumscribed by intergovernmental override mechanisms.

Institutional Architecture Compared ***The Organization of Turkic States***

The OTS traces its institutional origin to the Nakhchivan Agreement of 2009, which established the Cooperation Council of Turkic-Speaking States; the body was renamed the Organization of Turkic States in 2021, reflecting a deliberate shift from a language-based framework toward a fuller intergovernmental organization with a broader diplomatic mandate. Its founding members — Azerbaijan, Kazakhstan, Kyrgyzstan, and Türkiye — were joined by Uzbekistan in 2019, while Hungary, Turkmenistan, the Turkish Republic of Northern Cyprus, and the Economic Cooperation Organization hold observer status, extending the organization's diplomatic reach beyond its core Turkic-speaking membership.

Diplomacy within the OTS is channeled primarily through annual summits of heads of state, supported by a Council of Foreign Ministers, senior officials' committees, and thematic working groups covering areas such as transport, customs, culture, and education. A General Secretariat, headquartered in Istanbul, provides administrative continuity between summits, while a network of affiliated bodies extends the organization's institutional footprint beyond executive diplomacy into legislative, scholarly, and cultural domains: The International Organization of Turkic Culture (TÜRKSOY), based in Ankara; the Parliamentary Assembly of Turkic-Speaking Countries (TURKPA), based in Baku; and the International Turkic Academy, based in Astana. This affiliated-body structure gives the OTS a wider institutional footprint per unit of supranational authority than any of the other three organizations compared here, consistent with an identity-driven design in which cultural and parliamentary diplomacy substitute for binding economic or judicial instruments.

Since 2021 the organization has visibly accelerated its institutionalization. It adopted a Charter of the Turkic World at the 2024 summit, established the Turkic Investment Fund to support infrastructure and economic projects among members, created a Council of Central (National) Banks to coordinate macroeconomic policy, and formalized a flag and a regulation for permanent representatives. Subsequent summits have broadened the agenda further, adding a Digital Economy Partnership Agreement, a collective civil protection mechanism, and, most recently, expanded attention to defense, security, and infrastructure protection cooperation. Taken together, these steps mark a transition from largely symbolic summitry toward a more institutionalized, though still fundamentally intergovernmental, framework of cooperation — a trajectory consistent with the gradual, issue-by-issue institution-building that Aydın and Liu (2024) identify as characteristic of the organization.

Summit-Level Institutional Deepening, 2021–2026

The pace of OTS institution-building is most visible at the level of individual summits, and a brief chronological illustration is useful for grounding the general claims made above. The Istanbul Summit of 2021 formalized the transition from the Turkic Council to the Organization of Turkic States, adopting a new name intended to signal a more comprehensive and less narrowly linguistic mandate. The Samarkand Summit of 2022 carried this forward with the establishment of the Turkic Investment Fund, an instrument explicitly modeled on comparable development-finance vehicles in other regional organizations and intended to mobilize member-state capital for shared infrastructure and connectivity projects. The Astana Summit of 2023 continued this institutional consolidation, embedding customs facilitation and transport coordination more firmly into the organization's standing work program.

The 2024 summit marked perhaps the most consequential single step in the organization's recent institutional history, with the adoption of the Charter of the Turkic World alongside a formally adopted OTS flag and a regulation governing permanent representatives — instruments that, taken together, move the organization closer to the standing diplomatic apparatus associated with more established regional bodies, while still stopping well short of the EAEU's

supranational commission model. The same summit designated Bishkek as the Digital Capital of the Turkic World for 2025 and endorsed the Turkic Green Vision sustainable-development framework, illustrating the organization's continued willingness to add thematic institutional layers — digital economy, environmental cooperation — onto its original cultural and linguistic foundation. Summits in Azerbaijan during 2025 placed additional emphasis on military affairs, security, and infrastructure protection, a shift that several observers have read as evidence of the OTS's gradual acquisition of a genuine geopolitical, and not merely cultural, dimension. This summit-by-summit pattern illustrates concretely the incremental, issue-by-issue institutional accretion described theoretically in Section 3, and offers a preliminary empirical basis for the neofunctionalist-adjacent interpretation advanced in Section 6.

The Eurasian Economic Union

The EAEU, formally established by treaty in 2015 among Russia, Belarus, Kazakhstan, Armenia, and Kyrgyzstan, is the most institutionally developed of the four bodies compared here. Its roots extend back to earlier customs-union arrangements dating to the 1990s and 2000s, giving it a longer period of institutional gestation than the other organizations considered (Dragneva and Wolczuk, 2013). Its architecture includes the Supreme Eurasian Economic Council (heads of state), the Eurasian Intergovernmental Council (heads of government), the Eurasian Economic Commission — a permanent supranational regulatory body responsible for drafting common economic policy across roughly a dozen defined competency areas — and a Court of the Union tasked with ensuring uniform application of EAEU law.

Despite this apparatus, scholarship on the EAEU generally concludes that supranational competence remains narrow in practice. The Commission's decisions have on occasion been overruled following appeal by a member state to the Supreme Council, a pattern Dragneva and Wolczuk (2017) describe as reflecting the exercise of continued political power behind a formally rules-based structure, and consistent with liberal intergovernmentalist expectations. The Union has nonetheless achieved substantive integration in specific domains, most notably the common labor market, which Vinokurov (2017) identifies as one of the EAEU's clearest achievements, particularly for labor-exporting members such as Kyrgyzstan. The Union continues to expand its institutional remit incrementally, as illustrated by recent decisions to develop a common gas market and to coordinate court-fee policy for cross-border business disputes.

The Shanghai Cooperation Organisation

The SCO, founded in 2001 and built on the earlier Shanghai Five framework linking China, Russia, and three Central Asian states, was institutionalized through the 2002 Charter and the 2003 decision to establish two permanent bodies: a Secretariat, headquartered in Beijing, providing analytical and administrative support, and a Regional Anti-Terrorist Structure (RATS), headquartered originally in Tashkent, coordinating counter-terrorism, counter-separatism, and counter-extremism activity among members through shared databases and joint operational planning. Fredholm (2013) situates this institutional design within the broader geopolitical bargain between Russia and China that underpins the organization, in which China's economic weight and Russia's security-political influence are balanced through consensus-based decision procedures.

Decision-making authority rests with the annual Council of Heads of State, supplemented by councils of heads of government and foreign ministers, and by a rotating annual chairmanship. The SCO's diplomatic mechanisms are thus organized principally around security cooperation, with economic and cultural cooperation occupying a secondary, less institutionalized role, administered through bodies such as the SCO Business Council and an Interbank Consortium rather than through treaty-based supranational structures. Gatev and Diesen (2016) argue that the SCO and EAEU function as complementary rather than competing vehicles of Eurasian order,

with the SCO handling security and connectivity dialogue, including with China, while the EAEU manages internal economic integration among a narrower set of members. The organization's membership has expanded substantially since its founding, with India and Pakistan acceding in 2017 and additional members and dialogue partners joining subsequently, broadening its geographic and diplomatic scope well beyond its original Central Asian and Chinese core.

The Commonwealth of Independent States

The CIS, created in December 1991 as former Soviet republics negotiated their post-Soviet relationships, represents the least institutionally developed of the four organizations. It possesses no supranational powers; cooperation is coordinated through the Council of Heads of State, the Council of Heads of Government, sectoral ministerial councils (including foreign affairs, defense, and border-troop commanders), an Inter-Parliamentary Assembly, and a permanent Executive Committee headquartered in Minsk, with a branch office in Moscow. A CIS Economic Court also exists, though its jurisdiction and case volume have historically been limited relative to the EAEU's Court of the Union.

Dutkiewicz and Sakwa (2014) characterize the CIS's primary historical function as facilitating an orderly institutional "divorce" among former Soviet republics rather than driving deep integration, and its subsequent trajectory — alongside related but now largely superseded frameworks such as the Eurasian Economic Community — has generally been one of gradual contraction rather than deepening. Its more recent "CIS+" initiative, extending cooperation to partners and observers without formal accession, illustrates a continued institutional preference for flexible, low-commitment coordination over binding integration, a preference that stands in contrast to the more incremental but still expansionary institution-building visible in the OTS over the same period.

Comparative Analysis

Table 1. Comparative institutional features of the OTS, EAEU, SCO, and CIS.

Feature	OTS	EAEU	SCO	CIS
Founded	2009 (Nakhchivan Agreement); renamed 2021	2015 (treaty in force)	2001	1991
Supreme body	Summit of Heads of State	Supreme Eurasian Economic Council	Council of Heads of State	Council of Heads of State
Standing executive body	General Secretariat (Istanbul)	Eurasian Economic Commission	Secretariat (Beijing)	Executive Committee (Minsk)
Dispute settlement	None (consultative)	Court of the Union	None (consultative)	None (consultative)
Primary domain	Culture, connectivity, trade, emerging security	Economic/customs integration	Security (counter-terrorism), expanding economic	General post-Soviet coordination
Supranational delegation	Low	Moderate (contested in practice)	Low	None
Affiliated bodies	TÜRKSOY, TURKPA, Turkic Academy	n/a (single Commission structure)	RATS, Business Council, Interbank Consortium	Inter-Parliamentary Assembly, Economic Court

Read together, the four cases suggest a rough institutional gradient. The CIS anchors the low-commitment end, offering broad but shallow coordination without supranational instruments, a pattern consistent with Dutkiewicz and Sakwa's (2014) characterization of the organization as primarily a mechanism of post-Soviet disengagement. The SCO occupies an intermediate position: its two permanent bodies give it operational continuity, but its mandate remains functionally concentrated in the security domain, with only limited machinery for economic or cultural diplomacy (Fredholm, 2013). The EAEU represents the deepest formal delegation of authority among the four, possessing a standing commission and a court, even though in practice its supranational elements remain constrained by member-state veto behavior, consistent with intergovernmentalist predictions and with Dragneva and Wolczuk's (2017) empirical findings. The OTS, by contrast, combines relatively shallow formal delegation — it has neither a supranational commission nor a binding court — with an unusually broad and expanding functional agenda spanning trade facilitation, transport connectivity, investment, cultural and educational cooperation, and, increasingly, security dialogue.

This configuration reflects the OTS's distinctive diplomatic logic. Because its cohesion rests substantially on shared linguistic and cultural identity rather than on a single binding economic or security rationale, its institutional mechanisms have been designed to preserve maximum flexibility and sovereignty for member states while still allowing the organization to accumulate

functional instruments incrementally — the Turkic Investment Fund and the Council of Central Banks being recent examples. In regionalism-theory terms, and consistent with Koçak's (2023) caution against relying on a single theoretical lens, the OTS is better described as a case of identity-driven intergovernmentalism moving gradually toward functional cooperation, in a pattern with some resemblance to neofunctionalist spillover, rather than as a case of deliberate supranational integration on the EAEU model or issue-specific functionalism on the SCO model.

A further point of comparison concerns overlapping membership. Kazakhstan and Kyrgyzstan belong simultaneously to the OTS, the EAEU, the SCO, and the CIS; Uzbekistan holds full OTS membership while maintaining observer status in the EAEU and full membership in the SCO. This layered participation indicates that, for Central Asian states in particular, multilateral diplomacy is not organized around a single institutional hierarchy but around a portfolio of parallel frameworks, each mobilized for different diplomatic purposes: the EAEU for market access, the SCO for security dialogue with China and Russia, the CIS for residual post-Soviet coordination, and the OTS for cultural affinity, connectivity projects, and an emerging platform for diplomacy with Türkiye and the wider Turkic-speaking world. This portfolio logic is itself a form of diplomatic risk diversification: by distributing cooperation across several frameworks with different memberships and different great-power orientations, Central Asian states avoid excessive dependence on any single institutional patron or partner, a dynamic broadly consistent with Hancock and Libman's (2016) account of how post-Soviet states use regional organizations instrumentally alongside their formally stated integrationist purposes.

The four organizations also differ in the linguistic and administrative channels through which their diplomacy is conducted, a dimension with practical significance for how accessible each framework is to different diplomatic communities. The OTS conducts its affairs in the national languages of its members without a single privileged working language, reflecting its identity-based rather than purely functional character, though Turkish and, increasingly, English serve as *de facto* working languages at the Secretariat level. The EAEU and CIS both operate predominantly in Russian, reflecting their institutional origins in the former Soviet administrative space, while the SCO formally recognizes both Russian and Chinese as official languages, reflecting the organization's dual Russian-Chinese anchorage. These linguistic arrangements are not merely administrative details: they shape which member states' officials can engage most fluently with an organization's technical and legal output, and they signal, at a symbolic level, whose institutional and cultural traditions a given organization is understood to extend. In this respect, the OTS's comparatively pluralistic linguistic practice reinforces its self-presentation as a horizontal association of culturally related but formally equal states, in contrast to the more centered linguistic architecture of the EAEU, CIS, and SCO.

Discussion

The comparative picture developed here has several implications for the study of the OTS's institutional evolution. First, the organization's relatively cautious approach to formal delegation should not be read as institutional weakness relative to the EAEU or SCO, but as a rational design choice consistent with an identity-based regionalism in which member states value flexibility and the preservation of foreign-policy autonomy above binding commitment. This interpretation is consistent with constructivist accounts such as Acharya's (2014), which treat institutional restraint not as a deficiency to be corrected but as an expression of the kind of cooperation the members actually intend to build.

Second, the OTS's recent institutional deepening — the 2021 renaming and Charter, the Investment Fund, the Council of Central Banks, and growing attention to security and defense cooperation evident in its most recent summits — suggests a trajectory of gradual functional accretion that parallels, on a smaller scale and a slower timeline, the early institutional

development of the EAEU and SCO. Whether this trajectory eventually produces comparable supranational instruments, such as a dedicated court or a binding commission, remains an open question. A plausible expectation, drawing on the neofunctionalist logic outlined in Section 3 and on Vinokurov's (2018) observations about the EAEU's own gradual institutional maturation, is that further spillover from economic instruments such as the Investment Fund and the Council of Central Banks could generate pressure for a more formalized dispute-resolution mechanism, particularly as cross-border investment volumes increase.

Third, the comparison also has implications for how multilateral diplomacy is studied more generally in the post-Soviet space. Much of the existing literature, following Dragneva and Wolczuk (2013, 2017) and Vinokurov (2017, 2018), has concentrated disproportionately on the EAEU, given its more extensive supranational architecture and correspondingly richer paper trail of formal rulings and commission decisions. The relative institutional modesty of the OTS should not be taken to imply a correspondingly modest diplomatic significance; as Abi (2026) demonstrates, the discursive and identity-construction work performed through OTS summitry carries real political weight for its member states' foreign-policy positioning, even where it is not backed by binding legal instruments.

Fourth, the comparison carries practical implications for policymakers and diplomats operating within these frameworks. Because the OTS's institutional design deliberately preserves member-state sovereignty and avoids binding delegation, member states retain greater latitude to calibrate the intensity of their participation issue by issue than they would within the EAEU's more binding customs and regulatory framework. This flexibility may partly explain why states such as Uzbekistan, which has been notably cautious about deeper EAEU integration, have nonetheless engaged energetically with the OTS: the reputational and identity benefits of participation are available without the sovereignty costs associated with supranational delegation. At the same time, this same flexibility limits the OTS's capacity to enforce compliance with its own decisions, a trade-off inherent to identity-driven intergovernmentalism that future institutional reforms, such as a stronger dispute-settlement mechanism, would need to address directly rather than treat as a peripheral technical matter.

A limitation of the present analysis is that it compares formal institutional architecture rather than measuring actual diplomatic output — the volume, density, and implementation rate of agreements concluded within each framework. Formal architecture is a necessary but not sufficient indicator of institutional depth, and future research combining the comparative framework developed here with quantitative treaty-implementation data, of the kind Vinokurov (2018) has begun to compile for the EAEU, would offer a fuller picture of how effectively each organization's mechanisms translate summit-level commitments into binding cooperation. A further limitation is the relatively short time horizon since the OTS's 2021 rebranding, which limits the extent to which its post-2021 institutional trajectory can be projected forward with confidence.

These limitations point toward several directions for future research. A natural extension would combine the qualitative institutional comparison developed here with a systematic content analysis of OTS summit declarations, tracking the ratio of concrete, implementable commitments to purely declaratory language over time, in order to assess empirically whether the organization's institutional deepening since 2021 has been accompanied by a corresponding increase in binding, verifiable cooperation. A second extension would examine the OTS's relationship with TÜRKSOY, TURKPA, and the Turkic Academy in greater institutional detail, treating these affiliated bodies not merely as symbolic appendages but as distinct diplomatic channels with their own decision procedures and, in the case of TURKPA, their own quasi-parliamentary legitimacy claims. A third and more ambitious extension, suited to the broader dissertation project from which this article is drawn, would trace how the OTS's multilateral diplomatic mechanisms interact in practice with

member states' bilateral diplomacy, testing whether the organization functions primarily as a genuine multilateral forum or, as some critics of post-Soviet regionalism more broadly have argued of comparable bodies, primarily as a stage on which bilateral relationships — particularly between Türkiye and its Central Asian partners — are performed and legitimized.

Conclusion

This article has compared the institutional mechanisms of multilateral diplomacy across four organizations active in the Turkic-speaking and post-Soviet space. It finds that the Organization of Turkic States occupies a distinctive position along the spectrum from loose intergovernmental coordination to supranational integration: more institutionally developed and functionally diverse than the CIS, yet less formally supranational than the EAEU and less narrowly security-focused than the SCO. This intermediate and identity-anchored institutional profile reflects the OTS's dual character as both a cultural-civilizational platform, in the sense described by Abi (2026), and an increasingly functional regional organization.

Understanding this comparative position clarifies not only the OTS's own institutional trajectory but also the broader logic by which Central Asian and Turkic-speaking states distribute their multilateral diplomatic engagement across several overlapping regional frameworks rather than consolidating it within one. For the wider dissertation project on which this article draws, the comparison suggests that the OTS's institutional mechanisms are best interpreted neither as underdeveloped imitations of EAEU-style supranationalism nor as purely symbolic cultural diplomacy, but as a coherent and evolving institutional form suited to an organization whose cohesion rests on identity as much as on function — and whose future institutional development is likely to proceed incrementally, issue by issue, rather than through a single decisive act of supranational delegation.

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Philological Sciences

Teacher Perspectives on Integrating Artificial Intelligence into English Language Classrooms

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Abstract

Generative artificial intelligence tools have moved rapidly from novelty to everyday presence in language classrooms, yet teachers remain the decisive variable in whether this technology improves English language instruction or simply adds noise to it. This short article synthesizes recent research on English as a Foreign Language (EFL) teachers' perceptions of AI integration and proposes a compact study design for examining how teacher attitudes, confidence, and institutional support jointly shape classroom adoption. The review finds that teachers are generally positive toward AI in principle but express a persistent gap between enthusiasm and practical readiness, driven by uneven training, ethical uncertainty, and concerns about the erosion of their pedagogical role. A brief mixed-methods survey-and-interview design is proposed to examine these dynamics within a single language department, aimed at generating actionable guidance for professional development rather than broad generalization. The article closes with practical recommendations for institutions seeking to support teachers through this transition.

Keywords: artificial intelligence, EFL teaching, teacher perceptions, professional development, classroom integration

1. Introduction

Artificial intelligence tools, from AI-powered writing assistants to conversational chatbots, have become part of the everyday toolkit available to English language teachers and their students. Institutions have responded unevenly: some have issued guidance encouraging thoughtful use, others have restricted AI tools outright, and many have left the decision to individual teachers with little formal training. In this uneven landscape, the teacher's own perception of AI, more than any institutional policy, tends to determine what actually happens in the classroom (Karaduman, 2025). Teachers who see AI as relevant to their teaching goals and feel confident using it report more positive attitudes and more frequent classroom use, while those who lack training or feel threatened by the technology tend to avoid it or use it superficially (Karaduman, 2025).

This matters because English language teaching depends heavily on interaction, feedback, and the teacher's ability to read a learner's developing competence, all of which sit close to tasks that generative AI can now approximate. Understanding how teachers themselves are making sense of this shift is a necessary first step before institutions invest further in AI-related infrastructure or training.

2. What Recent Research Shows

2.1 Broadly positive attitudes, unevenly matched by literacy

Across several recent studies, EFL teachers report generally favorable attitudes toward AI as a concept. A mixed-methods study of English teachers found that most measured attitude factors scored above the midpoint on a five-point scale, and a large majority of teachers expressed openness to incorporating AI tools into their practice (Üretmen Karaoğlu & Doğan, 2025). Similarly, teachers in other studies have widely endorsed statements describing AI as beneficial to their teaching (Üretmen Karaoğlu & Doğan, 2025). Yet self-reported enthusiasm does not always match actual knowledge: in one study, only 60 percent of teachers answered basic AI literacy questions correctly, despite rating their own AI competence considerably higher, pointing to a mismatch between confidence and demonstrated understanding (Üretmen Karaoğlu & Doğan, 2025).

This pattern, positive attitude paired with limited technical grounding, recurs across national contexts. A study of Saudi EFL educators' training needs found a critical, strongly felt need for structured AI training, alongside recognition that AI can enhance learning and support more student-centered teaching, provided ethical considerations and human interaction remain central (Metwally & Bin-Hady, 2025). The same study identified insufficient professional training as a consistent, recurring barrier to effective AI integration, a finding that echoes similar reports from other national contexts (Metwally & Bin-Hady, 2025).

2.2 Where AI is embraced, and where it is not

Teachers do not treat all uses of AI equally. Research on generative AI and teacher self-professionalism found that EFL teachers engaged readily with AI for self-assessment and reflective practice, but engagement dropped sharply for tasks like automated student assessment, interactive lesson planning, and other activities closer to the core of classroom authority (Nazim et al., 2025). The same study identified limited technological access, gaps in AI proficiency, ethical and legal concerns, time constraints, and differing cultural attitudes as the main constraints on further integration (Nazim et al., 2025). This selective pattern suggests that teachers are not resistant to AI in general, but are cautious about handing over tasks that touch directly on judgment, fairness, and their relationship with students.

2.3 The question of teacher identity

Teacher attitudes toward AI cannot be separated from how teachers understand their own professional role. A qualitative study of EFL students in Jordan examined how AI-enhanced classrooms are reshaping perceptions of teacher identity and found that students describe AI as a double-edged pedagogical tool: useful for certain tasks, but not a replacement for the relational and interpretive judgment that teachers provide (Almashour et al., 2025). Participants in that study also described a shift in how authority and expertise are understood in the classroom, with the teacher's role reframed rather than simply reduced (Almashour et al., 2025). This reframing appears to be experienced by teachers themselves as well, and helps explain why training focused narrowly on technical AI skills, without addressing how AI reshapes the teacher's role, may fail to produce lasting changes in classroom practice.

2.4 Training as the recurring gap

Across nearly every study reviewed here, the single most consistently cited barrier to effective AI integration is insufficient structured training, not lack of teacher interest (Nazim et al., 2025; Üretmen Karaoğlu & Doğan, 2025). Teachers with greater AI readiness have been found to integrate AI more effectively into their teaching, reinforcing training and readiness, rather than baseline attitude, as the more actionable lever for institutions (Üretmen Karaoğlu & Doğan, 2025).

3. A Proposed Study Design

To move from broad attitude surveys toward classroom-relevant guidance, a compact mixed-methods study is proposed for a single English language department.

Aim: To examine how EFL teachers' AI literacy, confidence, and perceived professional identity relate to their actual classroom use of AI tools, and to identify what kind of support most effectively closes the gap between positive attitude and practical use.

Research questions:

- How do EFL teachers describe their current use of AI tools for lesson planning, feedback, and assessment?
- What do teachers identify as the main barriers preventing more extensive or more confident use?
- How does perceived AI competence relate to teachers' sense of their own professional role in the classroom?

Design: A short online survey (20–25 items, mixing Likert-scale attitude and frequency-of-use items with two open-response questions) distributed to all English language teachers in the department, followed by semi-structured interviews with a purposive subsample of 8–10 teachers selected to represent a range of self-reported AI use, from minimal to frequent.

Analysis: Descriptive statistics and group comparisons (e.g., by years of experience or prior AI training) for the survey; thematic analysis of interview transcripts, focused specifically on how teachers talk about their professional role and authority when discussing AI.

Anticipated outcome: Based on the patterns identified in the literature reviewed above, the study is likely to find generally positive attitudes toward AI in principle, a self-reported literacy level that exceeds teachers' demonstrated technical understanding, selective adoption concentrated in low-stakes tasks such as lesson preparation rather than assessment, and training gaps as the most frequently cited barrier to further use.

4. Practical Recommendations for Institutions

Based on the patterns identified above, three recommendations follow directly, even ahead of new data collection.

First, training should be structured and ongoing rather than a single onboarding session, since existing studies consistently identify one-off exposure as insufficient to build durable competence or confidence (Nazim et al., 2025). Second, training content should explicitly separate low-stakes uses of AI, such as generating warm-up activities or brainstorming lesson ideas, from high-stakes uses, such as grading or assessment, since teachers appear to evaluate these very differently and may need distinct guidance and reassurance for each. Third, professional development should address how AI reshapes teacher identity and authority, not only which buttons to click, since resistance rooted in identity concerns is unlikely to be resolved by technical training alone.

5. Limitations

This article is a literature-grounded design proposal rather than a report of new empirical findings, so its "anticipated outcomes" are working hypotheses, not results. The underlying studies cited here vary in national and institutional context, which limits how directly their findings can be generalized to any single classroom. The proposed study itself, being limited to one department, would similarly generate context-specific rather than broadly generalizable findings, though this is a deliberate trade-off in favor of actionable, locally relevant guidance.

6. Conclusion

Teachers, not institutional mandates, are the ones who determine whether AI meaningfully improves English language instruction. Current research suggests they are broadly open to the

technology but held back less by resistance than by insufficient structured training and unresolved questions about how AI reshapes their professional role. Institutions seeking to support this transition should invest in sustained, role-aware training rather than one-time technical workshops, and should expect teachers to adopt AI selectively, embracing it for lower-stakes tasks well before trusting it with the judgments closest to the heart of teaching.

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İnklüziv təhsil mühitində müəllim hazırlığı və fərdi yanaşma bacarıqlarının inkişafı

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Açar sözlər: inklüziv təhsil, müəllim hazırlığı, fərdi yanaşma, pedaqoji bacarıqlar, differensial təlim, xüsusi qayğıya ehtiyacı olan uşaqlar, təhsil bərabərliyi.

Müasir dünya təhsil sisteminin ən mühüm prioritetlərindən biri hər bir fərdin keyfiyyətli təhsil almaq hüququnun təmin edilməsidir. Bu kontekstdə inklüziv təhsil, fiziki, psixoloji, sosial və ya digər xüsusiyyətlərindən asılı olmayaraq, bütün uşaqların ümumtəhsil prosesinə inteqrasiyasını nəzərdə tutan humanitar və pedaqoji bir yanaşmadır. Təhsil mühitində inklüzivliyin uğurla tətbiq olunması birbaşa olaraq bu prosesi idarə edən mütəxəssislərdən – müəllimlərdən asılıdır.

Ənənəvi təhsil sistemləri çox vaxt "orta statistik şagird" profilinə yönəldiyi halda, inklüziv mühit müəllimdən tamamilə fərqli bir yanaşma tələb edir. Müasir sinif otaqlarında öyrənmə çətinliyi olan, istedadlı, autizm spektr pozuntusu və ya fiziki məhdudiyyəti olan uşaqlar bir arada təhsil alırlar. Bu rəngarənglik fonunda müəllim hazırlığı və onların fərdi yanaşma bacarıqlarının inkişaf etdirilməsi sadəcə bir ehtiyac deyil, həm də müasir dövrün təxirəsalınmaz tələbidir. Bu məqalədə inklüziv təhsil mühitində müəllimlərin peşəkar hazırlıq səviyyəsi, fərdi yanaşma strategiyaları və bu bacarıqların inkişaf etdirilməsi yolları elmi-pedaqoji müstəvidə təhlil olunur. Inklüziv təhsil sadəcə xüsusi ehtiyacı uşaqların sinif otağına fiziki olaraq yerləşdirilməsi deyil. Bu, məktəb mədəniyyətinin, kurikulumun və təlim metodlarının şagirdlərin müxtəlifliyinə uyğunlaşdırılması prosesidir.

Salamanka Bəyannaməsi (1994): Inklüziv təhsilin global səviyyədə qəbul edilmiş əsas manifestidir. Burada qeyd olunur ki, hər bir uşağın unikal xüsusiyyətləri, maraqları və öyrənmə ehtiyacları vardır.

- **BMT-nin Əlilliyi olan şəxslərin hüquqları haqqında Konvensiyası:** Təhsil sahəsində diskriminasiyanın qarşısını almağı dövlətlərin öhdəliyinə qoyur.
- **Azərbaycan Respublikasının Qanunvericiliyi:** "Təhsil haqqında" qanun və müvafiq dövlət proqramları ölkəmizdə inklüziv təhsilin inkişafını və bu sahədə kadr hazırlığını strateji hədəf kimi müəyyən edir.

Müəllim bu hüquqi və fəlsəfi bazanı dərk etmədən sinifdə inklüziv mühit yarada bilməz. Inklüzivlik "xeyriyyəçilik" deyil, insan hüquqlarının bərabərliyi prinsipidir.

İnklüziv təhsilin keyfiyyəti müəllimin hazırlıq səviyyəsi ilə düz mütənasibdir. Tədqiqatlar göstərir ki, bir çox müəllimlər inklüziv siniflərdə dərs keçməyə psixoloji və metodiki cəhətdən tam hazır deyillər. Müəllim hazırlığında qarşıya çıxan əsas çətinlikləri aşağıdakı qruplara ayırmaq olar:

Ali təhsil müəssisələrində tələbələrə inklüziv təhsilin nəzəri əsasları öyrədilsə də, real sinif mühitində müxtəlif diaqnozlu (məsələn, Disleksiya, DEƏH - Diqqət Əskikliyi və Hiperaktivlik Pozuntusu) uşaqlarla işləmək üçün praktiki vərdislər yetərinə aşılınmır. Bəzi müəllimlərdə xüsusi qayğıya ehtiyacı olan uşaqların ümumi təhsil proqramını mənimsəyə bilməyəcəyinə dair qeyri-rəsmi bir skeptisizm mövcuddur. Bu stereotip müəllimin şagirddən gözləntilərini aşağı salır. Inklüziv siniflərdə materialların adaptasiyası (məsələn, görmə məhdudiyyətli şagird üçün iri şriftli və ya Brayl əlifbalı mətnlər) üçün müəllimlərin kifayət qədər dəstək materialı tapmaqda çətinlik çəkməsi. Inklüziv mühitdə aşağıdakı fərdi yanaşma bacarıqları vardır :

- Fərdi Yanaşmanın Komponentləri:
- Diaqnostik Qiymətləndirmə (Şagirdin güclü və zəif tərəflərinin müəyyənləşdirilməsi)
- Differensial Təlim (Tapşırıqların çətinlik dərəcəsinə görə bölünməsi)

-Çevik Kurikulum Adaptasiyası (Tədris planının fərdə uyğunlaşdırılması)

- Emosional Dəstək (Şagirdin sinifdə özünü təhlükəsiz hiss etməsi)

Fərdi yanaşma – təlim prosesinin hər bir şagirdin fərdi inkişaf dinamikasına, idrak imkanlarına, maraq və meyllərinə uyğun qurulmasıdır. İnküziv təhsildə bu bacarıq müəllimin peşəkarlığının əsas göstəricisidir

Müəllim fərdi yanaşmanı reallaşdırmaq üçün differensial (fərqləndirilmiş) təlim metodundan istifadə etməlidir. Bu metod üç istiqamətdə tətbiq olunur:

1. **Məzmunun differensiasiyası:** Eyni mövzunun müxtəlif qavrama səviyyələrinə uyğun (məsələn, vizual, audial, kinetik materiallarla) təqdim edilməsi.
2. **Prosesin differensiasiyası:** Şagirdin tapşırığı yerinə yetirərkən istifadə etdiyi zamanın və metodların tənzimlənməsi.
3. **Nəticənin differensiasiyası:** Şagirdin öyrəndiklərini nümayiş etdirməsi üçün müxtəlif seçimlərin (inşa yazmaq, rəsm çəkmək, şifahi təqdimat etmək) verilməsi.

Müəllimlərin bu sahədəki səriştələrini artırmaq üçün həm makro (dövlət və universitetlər səviyyəsində), həm də mikro (məktəbdaxili) səviyyədə sistemli addımlar atılmalıdır. Müəllim hazırlayan ali məktəblərin kurikulumlarına "İnküziv pedaqogika" və "Fərdi təlim strategiyaları" modulları dərinlən integrasiya olunmalıdır. Tələbə-müəllimlər pedaqoji təcrübə dövründə mütləq inküziv siniflərdə müşahidələr aparmalıdırlar.

Hər bir xüsusi qayğıya ehtiyacı olan şagird üçün FTP hazırlanır. Müəllim hazırlığı proqramlarında FTP-nin yazılması, onun monitorinqi və qiymətləndirilməsi mexanizmləri müəllimlərə praktiki olaraq öyrədilməlidir. FTP-nin effektivliyi müəllimin multidisiplinar komanda (psixoloq, loqoped, sosial işçi) ilə əməkdaşlıq bacarığından asılıdır.

Bacarıq növü	İnküziv mühitdə tətbiqi	İnkişaf mexanizmi
Empatiya və Kommunikasiya	Şagirdin və valideynin emosional vəziyyətini anlamaq	Psixoloji treninqlər və keys (case) analizləri
Texnoloji Səriştə	Dəstəkləyici texnologiyalardan (ekran oxuyucular, xüsusi proqramlar) istifadə	İKT üzrə ixtisasartırma kursları
Krizis İdarəçiliyi	Sinifdə baş verə biləcək emosional böhranları (məsələn, autistik krizis) idarə etmək	Davranış analizi (ABA) seminarları

Müəllim inküziv mühitdə tək qalmamalıdır. Fərdi yanaşma bacarıqlarının inkişafında məktəbdaxili professional öyrənmə icmalarının (PLC) rolu böyükdür. Təcrübəli müəllimlərin gənc həmkarlarına mentorluq etməsi, inküziv siniflərdə "müştərek tədris" (co-teaching) modelinin tətbiq olunması (iki müəllimin eyni sinifdə eyni vaxtda işləməsi) işin səmərəliliyini artırır.

Valideynlərlə tərəfdaşlıq da bu prosesin ayrılmaz hissəsidir. Müəllim fərdi yanaşma strategiyasını ev mühiti ilə uzlaşdırmaq üçün valideynlə daimi ünsiyyətdə olmalı, şagirdin evdəki davranış və inkişaf dinamikasını izləməlidir.

Nəticə

İnküziv təhsil mühitinin formalaşması yalnız infrastrukturun yaxşılaşdırılması və qanunların qəbul edilməsi ilə bitmir. Bu prosesin mərkəzində dayanan əsas qüvvə müəllimdir. İnküziv təhsil sisteminin müvəffəqiyyəti, hər bir şagirdi unikal bir dəyər kimi qəbul edən peşəkar müəllim heyətinin mövcudluğundan asılıdır.

Bu tədqiqat göstərir ki, keyfiyyətli müəllim hazırlığı prosesi nəzəri biliklərlə yanaşı, humanist dəyərləri, psixoloji hazırlığı və İKT resurslarından istifadə bacarıqlarını da əhatə etməlidir. Müəllimlərdə fərdi yanaşma bacarıqlarının inkişaf etdirilməsi, differensial təlim metodlarının mənimsənilməsi və Fərdi Təhsil Planlarının effektiv tətbiqi sinifdəki hər bir uşağın potensialının maksimum dərəcədə üzə çıxmasına şərait yaradır. Yalnız bu halda təhsil bərabərliyi və inküziv

cəmiyyət idealları real həyatda öz əksini tapa bilər. Müəllim hazırlığına qoyulan investisiya, gələcəyin ayrı-seçkilikdən uzaq, tolerant və humanist cəmiyyətinə qoyulan investisiyadır.

Aparılan elmi təhlillər göstərir ki, müəllimin peşə nüfuzu yalnız onun peşə hazırlığı ilə deyil, həm də dövlətin təhsil siyasəti, cəmiyyətin müəllim peşəsinə münasibəti, sosial təminat səviyyəsi, peşəkar inkişaf imkanları və müəllim əməyinin obyektiv qiymətləndirilməsi ilə sıx bağlıdır.

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Pedagogical Sciences

ҚАЗАҚ ТІЛІН МЕҢГЕРУ ДЕҢГЕЙІН БАҒАЛАУДА ЖАСАНДЫ ИНТЕЛЛЕКТТІ ПАЙДАЛАНУ

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гуманитарлық ғылымдар магистрі, №20 жалпы білім беретін мектептің, қазақ тілі пәнінің мұғалімі

Қазіргі таңда білім беру саласында цифрлық технологиялар мен жасанды интеллект құралдарын тиімді пайдалану оқу үдерісін жетілдірудің маңызды бағыттарының біріне айналып отыр. Әсіресе тіл үйрету барысында білім алушының жеке ерекшеліктерін ескеру, оқу жетістігін жедел бағалау және кері байланысты уақытылы ұсыну маңызды болып саналады. Осы тұрғыдан алғанда, жасанды интеллект қазақ тілін меңгеру деңгейін бағалаудың жаңа мүмкіндіктерін қалыптастырады. Мақалада қазақ тілін меңгеру деңгейін анықтауда жасанды интеллект технологияларын қолданудың мүмкіндіктері, артықшылықтары және тиімді бағалау бағыттары қарастырылады. Сонымен қатар AI құралдары арқылы оқушының лексикалық қоры, грамматикалық сауаттылығы, оқылым, жазылым, тыңдалым және айтылым дағдыларын бағалау жолдары сипатталады.

Бүгінгі білім беру жүйесінде оқушының білімін бағалау тек қорытынды нәтиже шығарумен шектелмей, оның оқу барысындағы жетістіктерін бақылауға, қиындықтарын анықтауға және әрі қарайғы даму бағытын белгілеуге негізделуі қажет. Қазақ тілін үйрету үдерісінде де бағалау жүйесінің сапасы ерекше маңызға ие. Себебі тіл меңгеру деңгейін анықтау кезінде білім алушының тек грамматикалық ережелерді білуі ғана емес, сонымен қатар сөздік қоры, мәтінді түсінуді, өз ойын жазбаша және ауызша жеткізе білуі сияқты бірнеше тілдік дағдысы қатар ескеріледі.

Дәстүрлі бағалау әдістерінде мұғалім оқушының жұмысын тексеріп, қателерін анықтап, кері байланыс береді. Алайда сыныптағы оқушылар санының көп болуы, уақыттың шектеулігі және әр білім алушыға жеке тапсырма дайындаудың күрделілігі мұғалім жұмысына қосымша жүктеме түсіреді. Осындай жағдайда жасанды интеллект технологияларын қолдану бағалау үдерісін автоматтандыруға және оны жекелендіруге мүмкіндік береді.

Жасанды интеллект - адамның ойлау, талдау, салыстыру, болжау және шешім қабылдау сияқты әрекеттерін белгілі бір деңгейде модельдеуге қабілетті технологиялар жиынтығы. Білім беру саласында AI құралдары мәтінді талдау, жауаптарды салыстыру, қателерді анықтау, оқушының нәтижесін саралау және жеке ұсыныстар беру бағыттарында қолданылып келеді. Қазақ тілін меңгеру деңгейін бағалауда да бұл технологиялардың әлеуеті жоғары.

Қазақ тілін меңгеру деңгейін бағалауда жасанды интеллектіні қолданудың негізгі артықшылықтарының бірі- жедел кері байланыс беру мүмкіндігі.

AI негізіндегі тіл үйрену құралдары білім алушының тілдік қателерін анықтап, кері байланыс беруге және тілдік қабілеттерін бағалауға мүмкіндік береді (Woo & Choi, 2021).[1]

Мысалы, оқушы белгілі бір грамматикалық тапсырманы орындағаннан кейін, AI жүйесі оның жауабын талдап, дұрыс немесе қате екенін көрсетіп қана қоймай, қателіктің

себебін түсіндіре алады. Бұл оқушыға өз қатесін бірден түсініп, оны түзетуге мүмкіндік береді. Нәтижесінде бағалау оқыту үдерісінің ажырамас бөлігіне айналады.

Жасанды интеллект арқылы қазақ тілін меңгерудің бірнеше негізгі компонентін бағалауға болады. Біріншісі - лексикалық дағдыны бағалау. AI жүйесі оқушы қолданатын сөздердің санын, сөздік қордың әртүрлілігін және сөздерді контекске сәйкес пайдалану деңгейін талдай алады. Мысалы, оқушыға белгілі бір тақырып бойынша шағын мәтін құрастыру ұсынылады. Жүйе мәтіндегі сөздерді талдап, қай сөздердің жиі қолданылатынын, жаңа сөздердің қолданылу деңгейін және сөздердің мағыналық тұрғыдан дұрыс байланысуын анықтай алады.

Екіншісі - грамматикалық сауаттылықты бағалау. Жасанды интеллект сөйлем құрылымындағы қателерді, сөздердің дұрыс жалғануын, септік, тәуелдік, жіктік және көптік жалғауларының қолданылуын талдауға мүмкіндік береді. Сонымен қатар етістіктің шақтары мен райларын дұрыс қолдану, сөздердің сөйлемдегі орын тәртібі сияқты грамматикалық ерекшеліктерді де тексеруге болады. Мұндай бағалау оқушының нақты қандай тақырыптарды меңгеруде қиындық көріп отырғанын анықтауға көмектеседі.

Үшіншісі - жазылым дағдысын бағалау. Бұл бағытта жасанды интеллектінің мүмкіндігі айтарлықтай кең. Білім алушы белгілі бір тақырыпта эссе, пікір немесе шағын мәтін жазады. AI жүйесі мәтіннің құрылымын, логикалық байланысын, грамматикалық және орфографиялық қателерін талдай алады. Сонымен қатар мәтіннің тақырыпқа сәйкестігін және ойдың бірізділігін бағалауға көмектеседі. Дегенмен мұндай бағалау кезінде жасанды интеллект берген нәтижені мұғалімнің кәсіби сараптамасымен толықтыру маңызды.

Төртіншісі - оқылым дағдысын бағалау. Жасанды интеллект оқушыға қазақ тіліндегі мәтін ұсынып, оның мазмұнын түсіну деңгейін түрлі тапсырмалар арқылы тексере алады. Мысалы, мәтін бойынша сұрақтарға жауап беру, негізгі ойды анықтау, қажетті ақпаратты табу немесе мәтін мазмұнына сәйкес қорытынды жасау тапсырмалары беріледі. AI жүйесі оқушының жауаптарын талдап, оның мәтінді түсіну деңгейін анықтай алады.

Бесіншісі - тыңдалым және айтылым дағдыларын бағалау. Дыбысты тану технологиялары арқылы оқушының қазақ тіліндегі сөздерді дұрыс айтуы, сөйлем құрауы және ауызша жауап беруі талдануы мүмкін. Жасанды интеллект оқушының айтылымындағы кейбір фонетикалық ерекшеліктерді анықтап, дұрыс дыбыстауға қатысты ұсыныстар бере алады. Бұл әсіресе қазақ тілін екінші тіл ретінде үйреніп жүрген білім алушылар үшін пайдалы.

Жасанды интеллектіні бағалау үдерісінде қолданудың тағы бір маңызды бағыты - жеке оқу траекториясын қалыптастыру. Оқушының тест нәтижелері мен орындалған тапсырмаларын жүйелі түрде талдау арқылы AI оның әлсіз және күшті жақтарын анықтай алады. Мысалы, белгілі бір білім алушының грамматикалық тапсырмаларды жақсы орындағанымен, сөздік қорының жеткіліксіз екені байқалса, жүйе оған жаңа сөздерді меңгеруге бағытталған тапсырмаларды көбірек ұсына алады. Ал басқа оқушының грамматикалық білімі жақсы болғанымен, сөйлеу дағдысы төмен болса, оған диалогтік және коммуникативтік жаттығулар берілуі мүмкін.

Бұл тәсіл адаптивті бағалау қағидатына негізделеді. Яғни тапсырмалардың күрделілігі оқушының нақты деңгейіне қарай өзгеріп отырады. Егер білім алушы тапсырмаларды дұрыс орындаса, келесі кезеңде күрделірек сұрақтар ұсынылады. Ал қателер саны көбейген жағдайда жүйе жеңілдеу тапсырмаларға қайта оралып, қажетті тақырыпты қосымша түсіндіреді. Осылайша бағалау тек нәтиже көрсеткіші емес, оқушының әрі қарай дамуына ықпал ететін құралға айналады.

Жасанды интеллектіні бағалау үдерісінде қолдану мұғалімнің кәсіби қызметін толық алмастырмайды, керісінше, оның жұмысын қолдайтын құрал ретінде қарастырылуы қажет. AI құралдарын білім беру үдерісіне енгізу кезінде педагогикалық мақсаттармен қатар адам

факторы, этикалық талаптар және білім алушының деректер қауіпсіздігі ескерілуі тиіс (UNESCO, 2023). [2]

Себебі мұғалім бағалау үдерісінде салыстырмалы түрде талдау жасауы мүмкін, оқушының психологиялық ахуалына көңіл бөлуі мүмкін яғни жасанды интеллектінің бағалау жүйесі мұғалімді толық ауыстыра алмайды. AI автоматты түрде көптеген тапсырманы тексеріп, бастапқы талдау жасай алады, ал мұғалім алынған нәтижелерді педагогикалық тұрғыдан саралап, оқушыға нақты бағыт береді. Әсіресе шығармашылық жазылым, еркін сөйлеу және мағыналық тұрғыдан күрделі жауаптарды бағалауда адам сараптамасының маңызы жоғары болып қала береді.

Сонымен бірге жасанды интеллектіні қолдануда бірқатар мәселелерді ескеру қажет. Біріншіден, қазақ тіліндегі AI құралдарының сапасы басқа кең таралған тілдермен салыстырғанда әлі де жетілдіруді қажет етеді. Екіншіден, автоматты бағалау кезінде контекстік және мәдени ерекшеліктерді дұрыс түсінбеу қаупі бар. Үшіншіден, оқушының жеке деректерін қорғау және цифрлық қауіпсіздікті қамтамасыз ету мәселелері маңызды. Сондықтан AI негізіндегі бағалау жүйелері сенімді тілдік деректерге, сапалы оқу материалдарына және педагогикалық талаптарға сүйенуі қажет.

Қорытынды

Қорыта айтқанда, қазақ тілін меңгеру деңгейін бағалауда жасанды интеллектіні пайдалану - білім беру үдерісін жаңғыртудың перспективалы бағыттарының бірі. AI технологиялары оқушының лексикалық, грамматикалық, оқылым, жазылым, тыңдалым және айтылым дағдыларын кешенді түрде бағалауға мүмкіндік береді. Сонымен қатар автоматты кері байланыс беру, оқушының жеке ерекшеліктерін ескеру және оқу тапсырмаларын бейімдеу арқылы тіл үйрену тиімділігін арттыруға жағдай жасайды.

Болашақта қазақ тілін оқытуға арналған жасанды интеллект жүйелерін дамыту үшін қазақ тілінің сапалы цифрлық корпустарын көбейту, тілдік модельдерді жетілдіру, қазақ тілінің грамматикалық және фонетикалық ерекшеліктерін терең ескеретін алгоритмдер әзірлеу маңызды. Жасанды интеллектіні мұғалімнің кәсіби тәжірибесімен үйлестіре отырып пайдалану қазақ тілін меңгеруді бағалаудың объективті, жедел және жекелендірілген жүйесін қалыптастыруға мүмкіндік береді.

Осылайша, жасанды интеллект қазақ тілін бағалаудың дәстүрлі тәсілдерін толықтырып қана қоймай, білім алушының жеке оқу қажеттіліктеріне негізделген жаңа бағалау моделін қалыптастыруға жол ашады. Ең бастысы- технологияны мақсатсыз қолдану емес, оны қазақ тілін сапалы меңгертуге бағытталған тиімді педагогикалық құрал ретінде пайдалану.

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MICROLEARNING STRATEGIES IN ENGLISH LANGUAGE EDUCATION: OPPORTUNITIES FOR MODERN LEARNERS

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Abstract

The rapid advancement of digital technologies and the changing characteristics of contemporary learners have encouraged educators to explore more flexible and learner-centered instructional approaches. In this context, microlearning has emerged as an innovative educational strategy that delivers content in small, focused, and easily accessible learning units. This approach aligns with the needs of modern learners, who often prefer short, engaging, and technology-supported learning experiences that can be accessed anytime and anywhere through digital devices.

The purpose of this paper is to examine the role of microlearning strategies in English language education and to analyze their potential benefits for language acquisition. The study reviews the theoretical foundations of microlearning and explores its practical applications in developing English language skills, including vocabulary, grammar, reading, writing, listening, and speaking. Special attention is given to the integration of mobile technologies, digital platforms, and interactive learning tools that support the implementation of microlearning in English as a Foreign Language (EFL) context.

The findings indicate that microlearning contributes significantly to learner motivation, engagement, and knowledge retention. By presenting information in manageable segments, microlearning reduces cognitive overload and enables learners to focus on specific learning objectives. Furthermore, the flexibility of microlearning supports personalized and self-paced learning, allowing students to take greater responsibility for their educational progress. The approach is particularly beneficial for digital-native learners who are accustomed to consuming information through short-form digital content.

Despite its numerous advantages, several challenges associated with microlearning are also discussed, including the risk of oversimplifying complex language concepts, technological limitations, and the need for careful instructional design. The paper argues that microlearning should not replace comprehensive language instruction but rather complement traditional teaching methods to create a more effective and engaging learning environment.

In conclusion, microlearning represents a promising pedagogical approach in contemporary English language education. Its learner-centered nature, flexibility, and compatibility with digital technologies make it an effective tool for meeting the educational needs of modern learners. Future research is recommended to investigate the long-term impact of microlearning on language proficiency and learner autonomy across diverse educational settings.

Keywords: microlearning, English language education, EFL, digital learning, mobile learning, learner engagement, language acquisition, educational technology.

1. Introduction

The rapid growth of digital technologies has significantly transformed the educational landscape, influencing both teaching methodologies and learning behaviors. Contemporary

learners are increasingly exposed to vast amounts of information through digital media, social networks, mobile applications, and online learning platforms. As a result, their learning preferences have evolved, with many students favoring flexible, interactive, and easily accessible educational experiences over traditional teacher-centered approaches. Modern learners are often characterized by shorter attention spans, a preference for multimedia content, and the ability to access information instantly through digital devices. These characteristics have encouraged educators to reconsider conventional instructional methods and explore innovative approaches that align with the needs of the twenty-first-century learner.

In today's fast-paced educational environment, learners frequently face challenges associated with information overload and limited time for study. Traditional learning models often require students to process large amounts of information during extended instructional sessions, which may reduce concentration and retention. Consequently, the demand for shorter, more focused, and flexible learning experiences has increased considerably. Educational researchers and practitioners have therefore sought teaching approaches that promote effective learning while accommodating the changing lifestyles and learning habits of students. One such approach that has gained significant attention in recent years is microlearning.

Microlearning refers to an instructional strategy that delivers educational content in small, focused, and manageable learning units. Rather than presenting large amounts of information in a single session, microlearning breaks complex topics into concise modules that typically require only a few minutes to complete. These learning units often include short videos, quizzes, podcasts, infographics, flashcards, or interactive digital activities designed to address specific learning objectives. The concept of microlearning emerged alongside the development of digital technologies and mobile learning environments, where learners increasingly consume information in brief and targeted formats. The approach is grounded in the principle that learning can be more effective when content is delivered in smaller segments that are easier to process, understand, and retain.

The growing popularity of smartphones, tablets, and online educational platforms has further accelerated the adoption of microlearning in various educational contexts. In language education, particularly English as a Foreign Language (EFL) instruction, microlearning provides opportunities to develop language skills through short but frequent learning activities. Students can strengthen vocabulary, grammar, pronunciation, reading, listening, speaking, and writing skills through regular engagement with microlearning resources. Furthermore, the accessibility of digital tools enables learners to continue their language learning beyond the classroom, fostering greater autonomy and lifelong learning habits.

Microlearning is particularly relevant in English language education because language acquisition requires continuous practice and repeated exposure to linguistic input. Small learning units allow students to review and reinforce language concepts regularly without experiencing cognitive overload. Additionally, the interactive and technology-enhanced nature of microlearning can increase learner motivation, engagement, and participation. As educational institutions continue to integrate digital technologies into teaching and learning processes, microlearning has emerged as a promising strategy for supporting effective and personalized language instruction.

The purpose of this study is to explore the opportunities offered by microlearning strategies in English language education and to evaluate their impact on modern learners. The paper aims to examine the theoretical foundations of microlearning, identify its practical applications in the development of English language skills, and analyze its advantages and challenges within contemporary educational settings. The significance of this study lies in its contribution to understanding how microlearning can enhance learner engagement, improve knowledge retention, and support flexible and student-centered learning experiences. By investigating the role of microlearning in English language teaching, this research seeks to provide valuable insights for

educators, curriculum designers, and researchers interested in innovative approaches to language education.

2. The Concept of Microlearning

The increasing integration of digital technologies into education has led to the emergence of innovative instructional approaches designed to meet the needs of contemporary learners. Among these approaches, microlearning has gained considerable attention due to its flexibility, accessibility, and effectiveness in facilitating learning in digital environments. The concept of microlearning is based on the idea that educational content can be delivered in small, focused units that target specific learning objectives and can be completed within a short period of time.

One of the earliest scholars to explore the concept of microlearning was **Hug (2005)**, who described it as a learning approach involving small educational units and short-term learning activities. According to Hug, microlearning is particularly suitable for modern learners who frequently engage with information in brief and fragmented formats through digital technologies. The author argues that learning can become more effective when complex information is divided into smaller, manageable segments that reduce cognitive overload and support knowledge retention.

Further development of the concept was provided by **Buchem and Hamelmann (2010)**, who emphasized the role of microlearning in technology-enhanced education and professional development. They highlighted that microlearning enables learners to access concise learning materials whenever and wherever they need them. This flexibility makes microlearning particularly effective in environments where learners require immediate access to information and opportunities for continuous learning.

Similarly, **Jomah et al. (2016)** defined microlearning as an educational strategy that provides content in small, focused units that can be accessed through digital and mobile technologies. According to the authors, microlearning supports learner engagement by presenting information in a concise and structured manner, allowing students to concentrate on one specific concept or skill at a time. The study also emphasizes that microlearning promotes self-directed learning and increases learner autonomy.

In general, microlearning can be defined as a learner-centered instructional model that delivers educational content through short, goal-oriented, and easily digestible learning units. Rather than exposing learners to extensive amounts of information in a single session, microlearning focuses on delivering knowledge in small segments that facilitate understanding, retention, and practical application. As a result, this approach has become increasingly popular in various educational contexts, including language learning, corporate training, and online education.

Key Characteristics of Microlearning

Several distinctive features differentiate microlearning from traditional instructional approaches. These characteristics contribute to its effectiveness and growing popularity in English language education.

- **Short Duration of Learning Activities**

One of the most important characteristics of microlearning is the brevity of learning sessions. Microlearning activities typically last between **three and ten minutes**, allowing learners to engage with content without experiencing cognitive fatigue. Short learning sessions are particularly beneficial in maintaining learners' attention and motivation, especially in an age where digital distractions are common.

- **Focus on a Single Learning Objective**

Microlearning is designed to address one specific learning objective at a time. Each learning unit concentrates on a particular concept, skill, or piece of information rather than covering

multiple topics simultaneously. This focused approach allows learners to achieve a clear understanding of the target content and promotes more efficient knowledge acquisition.

- **Mobile Accessibility**

The development of smartphones, tablets, and other portable devices has significantly expanded the use of microlearning. Most microlearning materials are designed to be accessed through mobile technologies, enabling learners to study anytime and anywhere. Mobile accessibility supports continuous learning and allows students to make productive use of small periods of free time throughout the day.

- **Personalized Learning Experience**

Microlearning promotes individualized learning by allowing students to progress at their own pace and according to their specific needs. Learners can choose suitable learning materials, revisit content whenever necessary, and focus on areas requiring improvement. This flexibility enhances learner autonomy and encourages self-regulated learning.

- **Immediate Feedback**

Another essential feature of microlearning is the provision of instant feedback. Many microlearning activities include quizzes, interactive exercises, and automated assessment tools that allow learners to immediately evaluate their performance. Immediate feedback helps learners identify mistakes, reinforce correct answers, and improve their understanding of the material.

3. Microlearning Strategies in English Language Education

Microlearning has become an increasingly valuable instructional approach in English language education due to its ability to deliver focused content through short and engaging learning activities. Since language acquisition requires continuous practice and repeated exposure to linguistic input, microlearning provides learners with opportunities to develop specific language skills in manageable and meaningful ways. By integrating digital technologies, mobile applications, and interactive resources, teachers can create effective microlearning experiences that support vocabulary development, grammar acquisition, and the improvement of receptive and productive language skills.

3.1. Vocabulary Learning

Vocabulary acquisition is one of the most suitable areas for the implementation of microlearning. Instead of memorizing long word lists, learners can study a small number of words through regular and focused learning sessions. This approach promotes long-term retention and reduces cognitive overload.

One widely used strategy is the "**Word of the Day**" activity, in which students learn a new word, its definition, pronunciation, and example sentence each day. This method encourages consistent vocabulary growth and repeated exposure to lexical items.

Digital flashcards are another effective microlearning tool. Applications such as **Quizlet** and **Anki** allow learners to review vocabulary through short, interactive exercises. These platforms often employ spaced repetition techniques, which help learners retain information more effectively over time. Furthermore, vocabulary quizzes, matching activities, and mobile-based challenges can increase learner engagement and motivation while supporting independent learning.

3.2. Grammar Learning

Grammar instruction can also benefit significantly from microlearning strategies. Traditional grammar lessons are often lengthy and rule-oriented, which may reduce learner engagement. Microlearning addresses this issue by presenting grammar concepts in concise and focused formats.

Short instructional videos lasting three to five minutes can introduce individual grammar points, such as verb tenses, conditionals, or passive constructions. These videos allow students to understand specific structures without becoming overwhelmed by excessive information.

In addition, teachers can design **mini-activities** and **micro-assessments** that target a single grammar objective. Examples include sentence-completion tasks, error-correction exercises, and multiple-choice quizzes. Such activities provide immediate practice and help learners reinforce newly acquired knowledge. The availability of instant feedback further contributes to effective grammar learning and self-assessment.

3.3. Listening Skills Development

Listening comprehension is a fundamental component of language acquisition, and microlearning offers numerous opportunities for developing this skill. Short listening activities enable learners to practice regularly without requiring extended periods of concentration.

For example, learners can listen to **one- or two-minute podcasts**, dialogues, news reports, or audio clips focused on specific topics. These materials expose students to authentic language use while helping them improve pronunciation recognition, vocabulary comprehension, and listening accuracy.

Additionally, teachers can create concise audio-based tasks that require students to identify key information, answer comprehension questions, or summarize the main ideas of a recording. Frequent exposure to short listening activities enhances learners' confidence and gradually develops their overall listening proficiency.

3.4. Speaking Skills Development

Microlearning can effectively support the development of speaking skills through brief but regular oral practice activities. Many learners experience anxiety when speaking English; therefore, short speaking tasks may reduce pressure and encourage active participation.

One useful strategy involves **voice recording activities**, where students record short responses to prompts and submit them through digital learning platforms. These recordings may focus on self-introductions, opinions, daily routines, or responses to specific questions.

Another effective technique is the use of **video responses**, which allow students to practice pronunciation, fluency, and communication skills while expressing their ideas in a structured manner. Mobile applications such as language-learning platforms and AI-powered speaking tools provide additional opportunities for learners to engage in short speaking exercises and receive feedback on their performance.

3.5. Reading Skills Development

Microlearning can make reading activities more accessible and engaging by presenting information in concise formats. Rather than assigning lengthy texts, teachers can provide learners with short reading passages that focus on specific language objectives.

Examples include **micro-articles**, brief news stories, advertisements, social media posts, and informational texts. These materials can be completed within a few minutes, making them suitable for independent learning and classroom activities.

Infographics represent another valuable microlearning resource. By combining visual and textual information, infographics help learners understand content more efficiently while simultaneously improving reading comprehension. Short reading tasks may also include vocabulary identification, main-idea recognition, and critical-thinking questions that promote deeper engagement with the text.

3.6. Writing Skills Development

Writing is often considered one of the most challenging language skills; however, microlearning can simplify the writing process by dividing it into smaller and more manageable tasks.

One effective strategy involves **micro-blog writing**, where learners produce short texts on familiar topics. These activities encourage regular writing practice without requiring extensive compositions. Similarly, teachers can assign **single-paragraph writing tasks** focused on one specific objective, such as describing a place, expressing an opinion, or summarizing information.

Social media-based writing activities can also serve as valuable microlearning tools. Students may create short posts, comments, reflections, or discussion responses within educational platforms. Such tasks develop written communication skills while reflecting authentic digital communication practices.

Microlearning strategies provide diverse opportunities for enhancing English language education. Through focused and interactive activities, learners can develop vocabulary, grammar, listening, speaking, reading, and writing skills in a flexible and engaging manner. The integration of mobile technologies, digital platforms, and personalized learning experiences makes microlearning particularly relevant for modern learners and contributes to more effective language acquisition outcomes.

4. Opportunities of Microlearning

Microlearning offers numerous advantages for both learners and educators in English language education. Its learner-centered nature and compatibility with modern technologies make it an effective approach for enhancing language acquisition and classroom engagement. As educational environments continue to evolve, microlearning provides flexible and innovative solutions that address the needs of contemporary learners.

4.1. Increased Motivation

One of the most significant benefits of microlearning is its ability to increase learner motivation. Traditional learning sessions often involve lengthy explanations and extensive assignments that may lead to fatigue and decreased engagement. In contrast, microlearning presents information in small and manageable segments, making learning less overwhelming and more enjoyable.

Short learning activities provide learners with a sense of immediate accomplishment, as they can complete tasks within a few minutes and observe their progress regularly. This positive learning experience encourages students to remain engaged and participate actively in the learning process. Furthermore, interactive elements such as quizzes, games, flashcards, and multimedia content increase learners' interest and sustain motivation over time.

4.2. Better Knowledge Retention

Microlearning contributes significantly to knowledge retention by presenting information in smaller units that are easier to process and remember. Research in cognitive psychology suggests that individuals retain information more effectively when learning materials are divided into manageable chunks rather than delivered in large quantities at once.

The repetitive and focused nature of microlearning allows learners to revisit content frequently, reinforcing previously acquired knowledge. In English language education, regular exposure to vocabulary items, grammar structures, and language functions through microlearning activities strengthens long-term memory and facilitates language acquisition. As a result, learners are more likely to recall and apply what they have learned in real-life communication situations.

4.3. Flexibility and Accessibility

Another major advantage of microlearning is its flexibility. Unlike traditional classroom instruction, microlearning enables learners to access educational content whenever and wherever convenient. Students are no longer restricted by specific schedules or physical learning environments.

This flexibility is particularly valuable for modern learners who must balance academic studies with professional, personal, and social responsibilities. Through online platforms and digital

learning resources, learners can engage in short learning activities during breaks, while commuting, or in other available moments throughout the day. Consequently, microlearning supports continuous learning and promotes lifelong educational development.

4.4. Mobile Learning Support

The widespread use of smartphones and tablets has made mobile learning an integral part of modern education. Microlearning aligns naturally with mobile learning because its content is designed to be consumed quickly and conveniently through portable devices.

Language learners can access videos, podcasts, digital flashcards, quizzes, and learning applications directly from their mobile phones. This accessibility encourages more frequent engagement with the target language and creates opportunities for continuous practice outside the classroom. Mobile-supported microlearning also helps learners make productive use of small periods of free time, thereby increasing overall exposure to English language input.

4.5. Personalized Learning

Microlearning promotes personalized learning experiences by allowing students to progress according to their individual abilities, interests, and learning preferences. Unlike traditional one-size-fits-all instruction, microlearning enables learners to select content that matches their specific needs and learning goals.

Students can spend more time reviewing challenging topics while moving quickly through material they already understand. This individualized approach fosters learner autonomy and encourages self-directed learning. In English language education, personalized microlearning can help students focus on particular skills such as vocabulary expansion, pronunciation improvement, grammar practice, or academic writing development, leading to more effective learning outcomes.

5. Challenges of Microlearning

Despite its many advantages, microlearning also presents several challenges that educators should consider when implementing this approach in English language education. Understanding these limitations is essential for ensuring that microlearning is used effectively and appropriately.

5.1. Oversimplification of Content

One potential drawback of microlearning is the risk of oversimplifying complex subject matter. Since learning content is presented in small segments, certain topics may not receive sufficient explanation or depth. Language learning often involves interconnected concepts that require comprehensive understanding, and dividing content into excessively small units may lead to fragmented knowledge.

Teachers must therefore ensure that microlearning activities remain connected to broader instructional objectives and contribute to a coherent learning experience.

5.2. Limited Deep Learning

While microlearning is effective for introducing concepts and reinforcing knowledge, it may be less suitable for developing higher-order thinking skills that require extensive analysis, reflection, and problem-solving. Complex language tasks such as academic writing, literary analysis, and critical discussion often demand sustained attention and deeper cognitive engagement.

Consequently, microlearning should complement rather than replace comprehensive instructional approaches that promote deeper learning and critical thinking.

5.3. Dependence on Technology

The successful implementation of microlearning often relies on access to digital technologies, stable internet connections, and appropriate learning platforms. Learners who lack technological resources or digital literacy skills may face difficulties participating fully in microlearning activities.

Technical problems, software limitations, and connectivity issues can also interfere with the learning process. Therefore, educational institutions should provide adequate technological support and ensure equal access to digital learning opportunities.

5.4. Increased Teacher Preparation Time

Although microlearning activities are relatively short, designing high-quality microlearning content can require considerable time and effort from educators. Teachers must carefully select learning objectives, create engaging materials, develop assessments, and integrate technology effectively.

Preparing videos, quizzes, interactive exercises, and digital resources often demands additional planning and technical expertise. As a result, educators may experience an increased workload during the implementation phase of microlearning initiatives.

6. Recommendations for English Language Teachers

To maximize the benefits of microlearning while minimizing its limitations, English language teachers should adopt thoughtful and strategic implementation practices.

- **Integrate Microlearning with Traditional Instruction**

Microlearning should be used as a supplement to conventional teaching rather than a substitute for comprehensive language instruction. Combining short digital activities with classroom discussions, collaborative projects, and extended language practice creates a balanced learning environment that addresses diverse educational needs.

- **Encourage the Use of Mobile Applications**

Teachers can recommend educational applications such as Quizlet, Anki, Duolingo, BBC Learning English, and other language-learning platforms that provide opportunities for regular microlearning practice. Mobile applications support continuous exposure to the target language and encourage autonomous learning beyond the classroom.

- **Design Short and Goal-Oriented Activities**

Effective microlearning requires clearly defined learning objectives. Each activity should focus on a specific skill, concept, or language point to ensure clarity and effectiveness. Brief tasks that target single objectives are more likely to maintain learner attention and support successful learning outcomes.

- **Provide Regular Feedback**

Timely and constructive feedback is essential for successful language learning. Teachers should provide learners with opportunities to evaluate their performance through quizzes, self-assessment activities, peer feedback, and instructor comments. Regular feedback helps students identify areas for improvement and maintain motivation.

- **Utilize AI-Powered Educational Tools**

Recent developments in artificial intelligence offer valuable opportunities for enhancing microlearning experiences. AI-powered platforms can provide personalized learning pathways, adaptive assessments, pronunciation analysis, automated feedback, and individualized recommendations. By integrating AI technologies into microlearning activities, teachers can create more engaging, efficient, and learner-centered educational experiences.

In conclusion, when carefully designed and strategically implemented, microlearning can serve as a powerful instructional approach that supports learner engagement, flexibility, and language development in contemporary English language education.

Conclusion

Microlearning has emerged as a highly effective and innovative instructional approach in contemporary English language education. The growing influence of digital technologies and the changing learning preferences of students have increased the demand for flexible, accessible, and learner-centered educational methods. In response to these developments, microlearning

provides a practical solution by delivering content through short, focused, and easily manageable learning units that align with the needs of modern learners.

The findings of this study indicate that microlearning offers numerous benefits for English language teaching and learning. Through the use of concise learning activities, students can develop language skills in a more engaging and efficient manner. Microlearning promotes learner motivation, strengthens knowledge retention, supports autonomous learning, and enables continuous access to educational content through digital and mobile technologies. Furthermore, its adaptability allows learners to progress at their own pace and focus on individual learning needs, thereby contributing to more personalized learning experiences.

The study also highlights the value of microlearning in the development of various language skills, including vocabulary, grammar, listening, speaking, reading, and writing. By providing frequent opportunities for practice and reinforcement, microlearning facilitates continuous language exposure and encourages active learner participation. Its integration with mobile applications, online platforms, and emerging technologies such as artificial intelligence further enhances its effectiveness and relevance in modern educational environments.

Despite its many advantages, microlearning is not without limitations. Challenges such as the potential oversimplification of content, limited opportunities for deep learning, technological dependence, and increased preparation demands for teachers should be carefully considered. Therefore, microlearning should not be viewed as a replacement for traditional language instruction but rather as a complementary strategy that enriches and supports existing teaching practices.

In conclusion, microlearning represents a promising pedagogical approach for meeting the educational demands of the digital age. Its flexibility, accessibility, and learner-centered character make it particularly suitable for contemporary English language learners. When effectively integrated into language teaching programs, microlearning can significantly improve learner engagement, language acquisition, and overall educational outcomes. Future research should further investigate the long-term impact of microlearning on language proficiency, learner autonomy, and academic achievement across different educational contexts and learner populations.

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Psychological Sciences

Teachers' role in modern educational system with artificial intelligence supplies

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Keywords: artificial intelligence, teachers' role and responsibility, modern technology system, educational programs

Artificial intelligence technologies offer great promise with their capacity to mimic human intelligence. They have become widespread in many areas of our lives, from cookies in web browsers to voice assistants on smartphones and self-driving cars. In the context of education, these technologies can contribute to improving predictive and self-regulated learning by offering students free and personalized learning pathways or helping teachers better understand their students' needs and abilities. However, the complexity and interdisciplinary nature of the AI field in education have led to conflicting views on the benefits and obstacles of these technologies. Some challenges still hinder the mass adoption of AI in national education systems across Europe. These challenges include ethical concerns, lack of agreement and policy guidelines, and conflicting views on data usage. Therefore, research is still needed to understand whether AI can achieve its ultimate goal of providing quality education opportunities to more students without jeopardizing children's safety. There has been a long-standing debate within the scientific community regarding the definition of Artificial Intelligence. Since the field's inception, various theoretical approaches to the essence and reproducibility of intelligence have proliferated. According to many experts, when the concept of intelligence is considered from a narrow perspective, it is observed that almost every expert has their own unique definition of intelligence.

The concept of Artificial Intelligence (AI) is based on the ability of machines to perform thinking processes and intelligent behaviors. The fundamental premise of AI is that a system can independently interpret large amounts of external data and adapt flexibly to achieve specific results (Haug and Drazen, 2023). For AI to be considered intelligent, it must possess the ability to perform such tasks. In this sense, AI can be defined as a set of methods, tools, and systems for solving problems typically addressed by human intelligence. This definition helps us understand the essence and goals of AI, while also allowing us to identify the potential and limitations of the technology (Gupta et al., 2021). Therefore, teachers' use of artificial intelligence has the potential to transform education and brings a number of advantages. AI offers teachers the opportunity to manage and personalize students' learning processes more effectively. This technology can help them better understand students' learning needs and use this information to optimize their learning experiences. Teachers can also monitor student progress, evaluate student performance, and provide individual support when needed using AI-based tools (Zhang and Lu, 2021). This allows teachers to assume a better guidance and support role in the classroom. Furthermore, with the use of AI, teachers can better understand students' strengths and weaknesses and adapt their teaching materials and methods accordingly. As a result, AI can help teachers maximize students' potential and create a more effective learning environment (Shastri et al., 2021). Therefore, the use of AI technologies in education should be considered an important tool to support teachers' professional development and improve student success.

AI technology has been characterized by the widespread use of deep neural networks (DNNs) in applications such as speech recognition and robotics, signifying the efficient processing and widespread adoption of AI technologies. Furthermore, the impact of AI on business models, organization, and work has been explored, highlighting the stylized history of AI and its transformative impact on various aspects of industry. Additionally, the evolution of AI and machine learning has been examined to measure and understand their impact, influence, and leadership at leading AI conferences, shedding new light on the dynamics involved in the field's evolution (Pasquinelli, 2023). The development of AI has been driven by the convergence of research areas, the efficient processing of DNNs, and their transformative impact on business models and organization. These factors have contributed to the evolution of artificial intelligence and its widespread adoption across various sectors, shaping the current landscape of AI. Overall, the evolution of artificial intelligence is marked by significant advances in research, technology, and its impact on various industries, reflecting a dynamic and rapidly developing field that continues to shape the future of technology and society. The formal birth of Artificial Intelligence in Education (AIEd) dates back thirty years to the publication of the first issue of the IJAIED journal. Since then, the aim of the AIEd community has focused on understanding and creating systems that can effectively mimic one-on-one human instruction. This field contributes to the interdisciplinary nature of AI by integrating methods and tools from various disciplines into educational problems. The importance and ethical use of data to understand students' learning behaviors and improve learning systems have also been emphasized.

Turning to teacher-oriented systems, one of the key benefits of using AI to support teaching is the ability to monitor classrooms in real time. According to Taşçı and Çelebi (2020), data analytics in education, particularly in the form of learning analytics (LA), has been a point of attraction for learning technology researchers and practitioners worldwide over the last decade. As Yao and Yang (2020) also point out, AI algorithms provide teachers with real-time information about students' learning patterns, enabling them to improve the quality of each student's learning experience with data-driven evidence. This paves the way for instructors to better understand each student's abilities and needs, as well as identify learning patterns both inside and outside the classroom. Furthermore, the data collected can be relatively simple—e.g., personal details or user-generated content produced in tasks or assignments—or more detailed, such as verbal or emotional responses to those same tasks or assignments (Jules and Salajan, 2019). Again, in relation to teaching applications, AI can also provide automated feedback, for example, by providing insights to teachers or extra help to students. This, for example, can save educators from having to answer the same questions repeatedly (Baker et al., 2019). Yao and Yang (2020) also emphasize that real-time automated feedback creates new opportunities for teacher-student interaction by eliminating the time and space constraints that limit the traditional learning model.

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