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ЦИФРЛЫҚ ЭКОНОМИКА ЖАҒДАЙЫНДАҒЫ УНИВЕР-СИТЕТ-БИЗНЕС СЕРІКТЕСТІГІН ИНСТИТУЦИОНАЛДЫҚ БАСҚАРУ: ҚЫТАЙ БИЗНЕС-МЕКТЕПТЕРІНІҢ ТӘЖІРИБЕСІ

ИНФОРМАЦИОННО-ИССЛЕДОВАТЕЛЬСКОЕ ОБЕСПЕЧЕНИЕ ИНВЕСТИЦИОННЫХ ПРОЕКТОВ: ПОНЯТИЕ И ЗНАЧЕНИЕ

ARTIFICIAL INTELLIGENCE AND VIRTUAL REALITY: THE ECONOMIC EFFICIENCY OF DIGITAL CONTENT HEMECE ARTIFICIAL INTELLIGENCE AND VIRTUAL REALITY

ТРАНЗИТНАЯ ЭКОНОМИКА

Научно-практический журнал «Транзитная экономика» является одним из ведущих периодических научных изданий Республики Казахстан в области экономических наук, издается с июля 1997 года, имеет свою стабильную аудиторию.

На страницах журнала Вы найдете широкий спектр различных мнений и полезную информацию по вопросам экономической политики, разработки экономического механизма индустриально-инновационного развития Казахстана, проблемам развития отдельных отраслей и сфер экономики.

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В.К. РАДОСТОВЕЦ – 100 ЛЕТ: НАСЛЕДИЕ КЛАССИЧЕСКОЙ МЕТОДОЛОГИИ В ЦИФРОВОМ АНАЛИЗЕ ДЕЛОВОЙ АКТИВНОСТИ

В истории любой науки есть личности, чьи идеи и труды определяют развитие целых направлений на десятилетия вперед. В казахстанской экономической науке такой фигурой является доктор экономических наук, профессор Виктор Константинович Радостовец (1926-1998), чье 100-летие научная общественность отмечает в 2026 году. Его имя стоит в ряду создателей национальной школы бухгалтерского учета и аудита. Он автор более 390 научных публикаций, среди которых 36 учебников, по которым учились не только студенты Казахстана, но и всего Советского Союза. В статье подчеркивается классическое наследие ученого с современными исследованиями в области анализа деловой активности предприятия.

Виктор Константинович Радостовец родился 16 мая 1926 года в селе Васильевка Запорожской области в семье бухгалтера и учительницы. Трудовую деятельность начал с 14 лет. Прошел путь от счетовода до главного бухгалтера республиканской организации, преподавателя, профессора. В 1958 году с отличием окончил Всесоюзный заочный экономический институт. С 1960 года – на преподавательской работе в КазГУ, затем в Алма-Атинском институте народного хозяйства (АИНХ). В 1971 году утвержден в ученой степени доктора экономических наук – первым в Казахстане по бухгалтерскому учету. 25 лет бессменно возглавлял крупнейшую кафедру бухгалтерского учета и анализа хозяйственной деятельности, 12 лет был деканом учетно-экономического факультета. Под его руководством подготовлено 52 кандидата наук [1].

В.К. Радостовец – один из разработчиков системы налогового учета в Казахстане. Он участвовал в создании Налогового кодекса РК, Законов «Об аудиторской деятельности», «О бухгалтерском учете», казахстанских стандартов учета. В ноябре 1992 года он создал аудиторскую фирму «Центраудит» – одну из первых независимых аудиторских организаций в республике. Его научные заключения легли в основу законопроектов переходного периода. Это имело колоссальное значение для формирования рыночной инфраструктуры независимого Казахстана.

Коллеги и ученики называли его «Патриархом казахстанского учета». По воспоминаниям профессора С.С. Сатубалдина, Радостовец был «человеком титанической работоспособности, с аналитическим складом ума» [1]. «Школа профессора Радостовца» – это целое поколение специалистов, возглавляющих кафедры, факультеты, вузы и аудиторские фирмы по всему Казахстану. Даже в трудные 1990-е годы он сохранял кафедру, продолжал писать учебники, адаптировал учет к международным стандартам.

Принципиальным для развития методологии анализа хозяйственной деятельности стало изданное в 1997 году учебное пособие «Финансовый и управленческий учет на предприятии». В этой работе была не просто изложена техника ведения счетов, а по сути, заложена концепция, где бухгалтерский учет перестает быть самоцелью и превращается в ключевой источник информации для управления бизнесом. Именно в этом труде развивается тезис, ставший краеугольным для последующих исследований в области экономического анализа: учет должен быть ориентирован на результат, на принятие эффективных управленческих решений [1].

Этот тезис получил развитие в фундаментальных трудах по финансовому анализу. В частности, в «Методике финансового анализа» А.Д. Шеремета, Р.С. Сайфулина и Е.В. Негашева детально представлена система показателей

деловой активности, включая коэффициенты оборачиваемости активов, запасов, дебиторской и кредиторской задолженности, а также методы факторного анализа рентабельности [2]. Авторы подчеркивают, что деловая активность предприятия проявляется в скорости оборота средств и непосредственно влияет на финансовые результаты.

Отечественные ученые также внесли значительный вклад в развитие методологии анализа деловой активности. К.Ш. Дюсембаев в учебнике «Анализ финансовой отчетности» систематизирует подходы к оценке деловой активности на основе данных бухгалтерской отчетности, адаптируя классические методы к казахстанским условиям [3]. Р.Е. Джаншанло в «Экономическом анализе» рассматривает деловую активность как комплексную характеристику эффективности использования ресурсов, включая анализ оборачиваемости капитала и продолжительности операционного цикла [4]. Эти работы создают теоретическую базу для современных исследований, в том числе в условиях цифровой трансформации.

Сегодня, в эпоху искусственного интеллекта и цифровой трансформации, идея Радостовца о том, что учет должен работать на результат, обретает новое звучание. Современные исследования в области анализа деловой активности предприятия превращают анализ из инструмента констатации прошлого в инструмент прогнозирования. Искусственный интеллект не отменяет классические принципы учета, а обогащает их – точно так же, как журнально-ордерная форма, внедренная Радостовцем, была шагом вперед по сравнению с мемориальными ордерами. Методологический подход профессора – адаптация международных стандартов к местным условиям, неразрывная связь теории с практикой – остается востребованным.

Роль личности В.К. Радостовца в истории казахстанского учета и аудита трудно переоценить. Он создал фундаментальные учебники, воспитал научную школу, участвовал в формировании законодательной базы независимого Казахстана.

Наследие профессора – это неархив, а живая методологическая основа. Его идеи о том, что учет должен работать на результат, сегодня развиваются в исследованиях по анализу деловой активности, где ключевым становится переход к прогнозному управлению на базе искусственного интеллекта и больших данных.

В своей последней прижизненной публикации – статье «Учет! Удивительно интересно!» (журнал «Бюллетень бухгалтера», № 50, декабрь 1997 года) – профессор писал: «Помните, друзья, что любовь, музыка и бухгалтерский учет – вечны!» [5]. Эти слова стали крылатыми. Они отражают глубокую убежденность ученого в непреходящей ценности учетной профессии. Сегодня эта фраза может быть дополнена: вечны и непреходящи те принципы системности и практической ориентированности, которые он заложил в основу казахстанской школы экономического анализа. Искусственный интеллект и цифровые технологии не отменяют классические принципы учета, а обогащают их – открывая новые горизонты для анализа деловой активности.

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ИНФОРМАЦИОННО-ИССЛЕДОВАТЕЛЬСКОЕ ОБЕСПЕЧЕНИЕ ИНВЕСТИЦИОННЫХ ПРОЕКТОВ: ПОНЯТИЕ И ЗНАЧЕНИЕ

Аннотация. В статье исследуются теоретические и практические аспекты информационно-исследовательского обеспечения (ИИО) инвестиционных проектов в условиях цифровизации и экономической диверсификации Республики Казахстан. Раскрывается сущность ИИО как комплексной системы, охватывающей все этапы инвестиционного цикла – от зарождения идеи до постпроектного мониторинга эффективности. В работе подробно рассматриваются ключевые функции ИИО, включая идентификацию перспективных рыночных ниш, оценку и прогнозирование рисков, разработку технико-экономических обоснований (ТЭО), а также минимизацию информационной асимметрии для привлечения иностранного капитала. Особое внимание уделено роли современных цифровых технологий (больших данных, искусственного интеллекта и систем поддержки принятия решений) в повышении точности прогнозов и снижении инвестиционных рисков. На основе сравнительного и системного анализа эмпирических данных международных организаций (UNCTAD, OECD) и отечественной статистики показана прямая корреляция между уровнем проработки аналитической базы и инвестиционной привлекательностью страны. Доказывается, что успешность реализации инвестиционных проектов зависит не только от объёма вложенного капитала, но и от глубины знаний и качества информации, на которых строится весь инвестиционный процесс. В эпоху цифровой трансформации экономики значимость информационно-исследовательского обеспечения будет только нарастать, что требует системного подхода к формированию аналитической базы.

Ключевые слова: информационно-исследовательское обеспечение, инвестиционные проекты, цифровизация, оценка рисков, технико-экономическое обоснование, информационная асимметрия.

Введение. Одним из ключевых факторов устойчивого экономического развития и структурной модернизации национальных экономик во всех странах мира принято считать инвестиционную деятельность. Прямые инвестиции в инфраструктурные проекты, обрабатывающую промышленность, а также в человеческий капитал позволяют определить долгосроч-

ную конкурентоспособность экономики государства и возможности интеграции в международные глобальные рынки с обеспечением устойчивого развития. Для Республики Казахстан – страны, находящейся на пути значительной диверсификации экономики и борьбы за привлечение прямых иностранных инвестиций, – это приобретает особое экономическое значение.

Наличие финансовых ресурсов и благоприятных институциональных условий не всегда гарантирует успех инвестиционных проектов на практике. Высокий уровень неопределённости внешней среды, волатильность мировых рынков, а также политические риски требуют дополнительных инструментов управления. В этой парадигме ключевым фактором успеха является информационно-исследовательское обеспечение (ИИО), способствующее формированию системной основы для принятия управленческих решений. Наличие достоверной, полной и актуальной информации становится не менее важным ресурсом, чем капитал или производственные мощности.

Глобальная экономическая мысль формируется устойчивым вниманием к информационным аспектам инвестиционных проектов. Инвестиционное исследование в зарубежной литературе определяется как детальное изучение и анализ различных финансовых инструментов, рынков и тенденций, которые помогают инвесторам принимать обоснованные решения [1]. Значительную роль в данном контексте играет разработка технико-экономических обоснований, основанных на оценке практической реализуемости предлагаемого плана или проекта, включающей анализ его жизнеспособности и определение вероятности успеха [2]. В трудах М. Портера конкурентные преимущества рассматриваются в непосредственной связи с качеством аналитической базы и наличием системной информации о рынках, институтах и рисках [3]. Дж. Х. Даннинг, развивая OLI-парадигму, убедительно обосновал значение информационной среды как одного из ключевых факторов, способных определять выбор стратегии осуществления международных инвестиций [4]. Более того, Дж. Стиглиц и Б. Гринвальд отмечали, что уровень доступности информации определяет уровень информационной асимметрии на рынке и таким образом оказывает значительное влияние на эффективность распределения экономических и технических ресурсов [5]. Роль цифровых технологий в повышении качества инвестиционного анализа подробно рассматривается в современных работах по теории и практике инвестирования [6]. В отечественной научной литературе данная проблематика получила широкое отражение в работах Г.С. Сейткасымова, М.С. Сапаргалиева, Ж.А. Кулекеева, посвящённых исследованию институциональных и правовых основ инвестиционной деятельности в Республике Казахстан [7], а также в трудах Б. С. Мырзалиева по экономике и управлению инвестициями [8].

Информационно-исследовательское обеспечение выступает в роли связующего звена между теорией и практикой управления инвестициями [9]. Оно помогает инвесторам и государственным органам определять перспективные направления вложений, прогнозировать изменения рыночной конъюнктуры, оценивать риски и разрабатывать стратегии долгосрочного развития. В международной практике давно признано, что качество аналитической базы прямо коррелирует с объёмом привлекаемых инвестиций.

Так, исследования Всемирного банка и ОЭСР показывают, что прозрачность информации и наличие развитых исследовательских институтов являются ключевыми условиями для формирования доверия инвесторов.

Основополагающей причиной роста роли ИИО в инвестиционных проектах является цифровизация экономических процессов. На сегодняшний день массив данных для аналитической обработки многократно превосходит возможности традиционных методов. Это требует применения новых технологий – систем анализа и поддержки принятия управленческих решений, анализа больших данных (big data), внедрения искусственного интеллекта и геоинформационных систем. Инвесторы в настоящее время ориентируются не только на макроэкономические показатели, но и на современные комплексные прогнозные модели, учитывающие широкий спектр факторов: от волатильности глобальных цен на сырьевые ресурсы до оценки проектов по показателям экологической устойчивости.

Таким образом, необходимость системного развития ИИО обусловлена сочетанием внутренних задач и внешних факторов, что свидетельствует о фундаментальной потребности инвестиционных проектов в защите от коммерческих рисков и неопределённости, а также в устойчивой государственной политике для повышения инвестиционной привлекательности страны. Основная цель данного исследования состоит в определении сущности и значимости ИИО, раскрытии его потенциала для инвестиционной практики и оценке уровня его влияния на эффективность и устойчивое развитие инвестиционных проектов.

Материалы и методы. В исследовании применяются системный подход и методы сравнительного анализа. В рамках системного подхода информационно-исследовательское обеспечение оценивается как категория комплексных показателей, включающая аналитические, правовые и организационные элементы. Сравнительный анализ демонстрирует ключевые различия между отечественной и зарубежной практикой построения ИИО, а также позволяет сопоставить результаты проектов с различной степенью аналитической проработки. В качестве эмпирической базы используются отчёты международных организаций (UNCTAD, OECD, Всемирный банк), статистика Национального банка Республики Казахстан, а также аналитические материалы ведущих консалтинговых компаний (McKinsey, PwC).

Экспериментальная часть. Информационно-исследовательское обеспечение (ИИО) инвестиционных проектов представляет собой сложную многоступенчатую структуру, которая пронизывает весь жизненный цикл вложений – от первоначальной гипотезы до детального разбора итогов после завершения работ. Если раньше под этой функцией понимали в основном финансовые показатели и юридическое консультирование, то сегодня ИИО превратилось в интегративный механизм, включающий экономику, право, социальные аспекты и технологическую экспертизу, – формируя тем самым фундамент для взвешенных и всесторонних управленческих решений.

На начальном этапе ИИО работает как инструмент поиска и фильтрации идей. Благодаря глубокому анализу становятся видны наиболее динамичные отрасли, свободные рыночные ниши и технологические направления, где инвестиции с наибольшей вероятностью принесут высокую отда-

чу. В Казахстане такие изыскания активно ведутся в области «зелёной» энергетики, цифровой трансформации и агропромышленного комплекса, что даёт инвесторам возможность заблаговременно оценить потенциал ещё до старта проекта.

Далее на первый план выходит прогнозная аналитика и оценка уязвимостей. В условиях высокой волатильности глобальной экономики именно эта функция становится главным инструментом защиты от непредвиденных потерь. Речь идёт не только о колебаниях курсов или ставок, но и о юридических коллизиях, экологических рисках, социальной напряжённости и репутационных потерях. Традиционные финансовые модели, построенные без учёта этих переменных, зачастую дают сбои, тогда как современное исследовательское сопровождение позволяет проработать несколько сценариев развития событий и выбрать наиболее устойчивый.

Следующая задача ИИО – оценка экономической целесообразности и разработка технико-экономического обоснования (ТЭО) проектов [2]. В таких документах детально прописываются прогнозы по затратам, срокам окупаемости и предполагаемой доходности. Казахстанский опыт наглядно иллюстрирует, что именно здесь кроется большинство проблем: там, где отсутствует качественное ТЭО, проекты регулярно сталкиваются с неконтролируемым удорожанием и затягиванием графиков. В качестве характерного примера можно привести ситуацию с Астана LRT, где недостаточно проработанная аналитическая база стала одной из ключевых причин последующего многократного роста расходов [15].

Четвёртое назначение ИИО заключается в укреплении репутации страны и облегчении доступа к международному капиталу. Зарубежные инвесторы неизменно обращают пристальное внимание на полноту статистических данных, прозрачность законодательства и доступность аналитических материалов. Когда информация представлена в полном объёме и не вызывает сомнений, исчезает информационная асимметрия между сторонами, и страна выглядит значительно привлекательнее для глобального капитала [5].

И наконец, пятая функция касается этапа постпроектного аудита – постоянного мониторинга и сопоставления заявленных показателей с реальными итогами. Такой подход позволяет вовремя заметить отклонения, понять их природу и извлечь уроки для будущих инициатив. Этот этап замыкает процесс, превращая единичное исследование в непрерывно действующий элемент развития всей инвестиционной экосистемы.

Стоит отдельно остановиться на том, как цифровизация меняет облик ИИО. Современные программные решения не просто ускоряют обработку данных, но и кардинально повышают их достоверность. Инструменты поддержки управленческих решений, технологии работы с большими массивами информации и алгоритмы машинного обучения существенно расширяют горизонты планирования [6]. Например, использование Big Data при прогнозировании потребительского спроса позволяет свести к минимуму аналитические ошибки и своевременно скорректировать инвестиционную стратегию до наступления финансовых потерь.

В казахстанской действительности намечается устойчивый тренд на замещение классических подходов к ИИО современными цифровыми платформами. Государственные структуры запускают электронные серви-

сы для публикации статистики, процедур регистрации и выдачи разрешительных документов. Параллельно усиливаются позиции частных экспертных центров и консалтинговых компаний, специализирующихся на построении сложных аналитических моделей и сценарном планировании. В итоге ИИО перерастает из вспомогательной функции в фундаментальный фактор, определяющий качество национального инвестиционного климата. Систематизация ключевых функций информационно-исследовательского обеспечения, соответствующих им цифровых технологий и достигаемых практических эффектов представлена в таблице 1.

Таблица 1 – Функции ИИО на этапах инвестиционного цикла

Этап инвестиционного цикла	Ключевые функции и задачи	Инструменты и методы	Ожидаемый эффект
Предынвестиционный (поиск и скрининг идей)	Идентификация перспективных ниш («зеленая» энергетика, АПК, IT-оценка), макросред и регуляторных условий	Анализ больших данных (Big Data), веб-скрейпинг отраслевых рынков, инвестиционные интерактивные карты (ГИС)	Раннее выявление потенциала проекта
Прогнозно-аналитический (оценка рисков)	Сценарное прогнозирование волатильности сырьевых цен, процентных ставок, оценка рисков	Предиктивная аналитика, стресс-тестирование, алгоритмы машинного обучения	Снижение вероятности непредвиденных потерь
ТЭО и структурирование сделки	Детальный расчет сметной стоимости, срока окупаемости, IRR, NPV; подготовка банковского ТЭО;	Динамическое финансовое моделирование, цифровые платформы бенчмаркинга капитальных затрат (Capital Analytics)	Минимизация перерасхода средств и срывов сроков (например, проект LRT в Астане – пример того, чего следует избегать)
Инвестиционный (реализация проекта)	Снижение информационной асимметрии	Прозрачная статистика, открытые правовые базы	Повышение доверия иностранных инвесторов
Постпроектный (эксплуатация и аудит)	Сверка фактических параметров с проектным ТЭО, аудит эффективности кап-вложений, масштабирование лучших практик	Системы бизнес-аналитики (BI-системы), цифровой аудит, сквозной ретроспективный анализ данных	Накопление опыта для будущих проектов
Источник: Составлено автором на основе данных UNCTAD, OECD, McKinsey и PwC [10, 11, 13, 14]			

Результаты и обсуждения. Проведённое исследование подтверждает наличие прямой корреляции между уровнем информационно-исследовательской поддержки и конечным успехом инвестиционных проектов.

Согласно данным UNCTAD, представленным в «World Investment Report 2023», в 2022 году глобальный объём прямых иностранных инвестиций сократился на 12% и составил 1,3 трлн долларов США, а разрыв между потребностями развивающихся стран в финансировании целей устойчивого развития и фактически привлекаемым капиталом расширился до 4 трлн долларов США в год против 2,5 трлн в 2015 году [10]. Это подтверждает растущую роль качественной аналитической поддержки при сокращении подобного разрыва. Инструментарий ОЭСР по качеству прямых иностранных инвестиций, в свою очередь, показывает, что полноценная реализация потенциала ПИИ – создание порядка 180 тысяч рабочих мест ежемесячно в мировом масштабе, более высокая производительность и уровень оплаты труда на предприятиях с иностранным участием – напрямую зависит от качества институциональной и аналитической среды, в которую встроены инвестиционные решения [11].

Отечественная практика служит ещё одним подтверждением значимости ИИО. Согласно статистике Национального Банка РК, по итогам 2022 года валовой приток ПИИ составил 28 млрд долларов США, что на 17,7% больше, чем годом ранее [12]. Аналитики связывают эту позитивную динамику не только с ценами на сырьё, но и с повышением уровня информационного сервиса для бизнеса – через деятельность института Kazakh Invest [17] и развитие интернет-платформ с открытой статистической и правовой информацией.

Вместе с тем изучение конкретных кейсов показывает, что результаты существенно варьируются в зависимости от глубины проработки данных. Там, где технико-экономическое обоснование было выполнено поверхностно (как в случае с Астана LRT), проекты практически закономерно сталкиваются с перерасходом сметы и задержками. В то же время крупные инициативы в нефтегазовой отрасли – например, на месторождениях Кашаган и Тенгиз, где изначально были задействованы международные аудиторы и проведены масштабные комплексные исследования, – демонстрируют значительно более стабильные и предсказуемые результаты [16]. Данное сопоставление наглядно иллюстрирует прямую зависимость между качеством ИИО и эффективностью инвестиций.

Отчёт McKinsey «Capital Projects 5.0: Reimagining capital-project delivery» (2021) показывает, что в среднем крупные капитальные проекты превышают запланированные бюджет и сроки на 30-45%, тогда как переход на модель управления, построенную на системной работе с данными и цифровыми инструментами, способен сократить фактическую стоимость и сроки реализации проекта на 30-50% и более чем удвоить итоговую доходность [13]. Опрос PwC среди специалистов по капитальным проектам и инфраструктуре (2020) фиксирует схожую тенденцию: 67% респондентов считают, что цифровизация в ближайшие два года трансформирует (29%) либо существенно изменит (38%) отрасль капитального строительства, а искусственный интеллект и машинное обучение вошли в пятёрку наиболее значимых технологий для двух третей опрошенных [14].

Таким образом, накопленные факты и статистика не оставляют сомнений: информационно-исследовательское обеспечение является критически важным звеном, без которого невозможно говорить об эффективной и безопасной инвестиционной деятельности.

Заключение. Подводя итог, можно с уверенностью утверждать, что информационно-исследовательское обеспечение инвестиционных проектов давно перестало быть второстепенной функцией и превратилось в фундаментальную основу профессионального инвестирования. Это не просто базовый свод таблиц и отчётов, а полноценный механизм, охватывающий все стадии проекта: от поиска перспективных рыночных ниш до сверки конечных результатов с первоначальными расчётами.

Теоретические выкладки и фактические данные, проанализированные в рамках данной работы, убедительно демонстрируют прямую зависимость между качеством исследовательского сопровождения и конечной эффективностью вложений. Ведущие международные организации – UNCTAD, ОЭСР, McKinsey – фиксируют устойчивую корреляцию: те государства и корпорации, которые инвестируют средства в развитие аналитической инфраструктуры, неизменно получают более высокие результаты в привлечении и удержании капитала.

Отечественная практика в полной мере подтверждает этот вывод. Увеличение объёма прямых иностранных инвестиций, наблюдаемое в Казахстане в последние годы, нельзя объяснить исключительно конъюнктурой мировых рынков. Важнейшую роль здесь сыграло последовательное повышение открытости статистической информации, расширение функционала профильных структур, таких как Kazakh Invest, и активное внедрение цифровых каналов взаимодействия с потенциальными инвесторами. Всё это свидетельствует о том, что государство осознанно делает ставку на информационную прозрачность как на конкурентное преимущество.

В эпоху цифровой трансформации экономики значимость информационно-исследовательского обеспечения будет только нарастать. Глобальная борьба за инвестиционные потоки вынуждает национальные правительства и бизнес-сообщества подходить к формированию аналитической базы системно и вдумчиво. В обозримой перспективе именно глубина проработки данных и достоверность прогнозов станут теми критериями, по которым будут оцениваться устойчивость и прибыльность любых проектов.

Таким образом, конечный успех инвестиционной деятельности определяется не столько размерами инвестиций, сколько тем, насколько качественной и точной информацией располагает инвестор. Знание рыночных механизмов, понимание скрытых рисков и способность заглядывать за горизонт событий – вот что превращает обычное вложение денег в продуманную стратегию, приносящую предсказуемый и стабильный результат.

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Инвестициялық жобаларды ақпараттық-зерттеумен қамтамасыз ету: түсінігі және маңызы

Түйіндеме. Мақалада Қазақстан Республикасының цифрландыру және экономиканы әртараптандыру жағдайындағы инвестициялық жобаларды ақпараттық-зерттеумен қамтамасыз етудің (АЗҚ) теориялық және практикалық аспектілері тереңінен зерттеледі. Автор АЗҚ мәнін инвестициялық циклдің барлық кезеңдерін – идеяның алғашқы туындауынан бастап тиімділіктің жобадан кейінгі тұрақты мониторингіне дейінгі кезеңді толық қамтитын кешенді жүйе ретінде ашады. Жұмыста АЗҚ-ның негізгі функциялары, соның ішінде перспективалы нарықтық тауашаларды анықтау, тәуекелдерді жан-жақты бағалау және алдын ала болжау, техникалық-экономикалық негіздемелерді (ТЭН) сапалы әзірлеу, сондай-ақ шетелдік тікелей капиталды тарту үшін ақпараттық асимметрияны барынша азайту мәселелері егжей-тегжейлі қарастырылады. Болжамдардың дәлдігін арттыруда және инвестициялық тәуекелдерді төмендетуде заманауи цифрлық технологиялардың (үлкен деректер, жасанды интеллект және басқарушылық шешімдерді қолдау жүйелері) рөліне ерекше назар аударылады. Халықаралық ұйымдардың (UNCTAD, OECD) және отандық статистиканың деректерін салыстырмалы және жүйелі талдау негізінде талдамалық базаны пысықтау деңгейі мен елдің инвестициялық тартымдылығы арасындағы тікелей корреляция көрсетілген. Сонымен қатар, автор инвестициялық жобаларды сәтті жүзеге асыру тек салынған капитал көлеміне ғана емес, сондай-ақ қабылданған шешімдердің негізінде жатқан ақпараттың сапасы мен білім тереңдігіне тікелей тәуелді екенін ғылыми тұрғыдан нақты дәлелдейді. Экономиканы цифрлық трансформациялау дәуірінде ақпараттық-зерттеумен қамтамасыз етудің маңызы тек арта түседі, бұл талдамалық базаны қалыптастыруға жүйелі тәсілді талап етеді.

Түйінді сөздер: ақпараттық-зерттеумен қамтамасыз ету, инвестициялық жобалар, цифрландыру, тәуекелдерді бағалау, техникалық-экономикалық негіздеме, ақпарат асимметриясы.

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Information and Research Support of Investment Projects: Concept and Significance

Abstract. The article examines the theoretical and practical aspects of information and research support (IRS) of investment projects in the context of digitalization and economic diversification in the Republic of Kazakhstan. The author reveals the essence of IRS as a comprehensive system covering all stages of the investment cycle, from the inception of an idea to post-project performance monitoring. The paper thoroughly considers key functions of IRS, including the identification of promising market niches, risk assessment and forecasting, the development of feasibility studies, as well as the mitigation of information asymmetry to attract foreign direct investment. Particular attention is paid to the role of modern digital technologies (big data, artificial intelligence, and decision support systems) in improving forecast accuracy and reducing financial risks. Based on a systemic and comparative analysis of empirical data from international organizations (UNCTAD, OECD) and national statistics, a direct correlation is demonstrated between the quality of the analytical framework and the country's investment attractiveness. The author proves that the success of investment projects depends not only on the volume of invested capital but also on the depth of knowledge and quality of information upon which the entire investment process is built. In the era of digital transformation, the importance of information and research support will only increase, which requires a systematic approach to the formation of an analytical framework.

Keywords: information and research support, investment projects, digitalization, risk assessment, feasibility study, information asymmetry.

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A DASK-BASED CLOUD HPC PLATFORM WITH INTELLIGENT TASK SCHEDULING FOR SCIENTIFIC WORKLOADS

Abstract. The growing demand for computational power in scientific research has exposed the limitations of traditional HPC systems, including high procurement costs, low resource utilization, and steep usability barriers. This paper presents a cloud-native high-performance computing (HPC) platform that integrates the Dask distributed computing framework with a FastAPI web service layer, enabling unified management and efficient execution of scientific computing tasks. The platform supports four representative workloads – Monte Carlo simulation, matrix multiplication, fast Fourier transform (FFT), and sparse matrix solving-and incorporates an intelligent resource-aware scheduler supporting six allocation strategies. A single-page web interface built with vanilla JavaScript and Chart.js provides real-time cluster monitoring and intuitive task submission. Performance evaluation on a 4-worker Docker cluster reveals highly workload-dependent scalability: Monte Carlo tasks achieve a superlinear speedup of 5.27× (131.8% parallel efficiency), matrix multiplication reaches 2.40× (60.0% efficiency) with 208.99 GFLOPS, while FFT exhibits negative scaling (0.78×) due to communication overhead overwhelming the compute benefit. These results demonstrate that cloud-HPC suitability varies fundamentally by workload type, and the paper provides practical deployment guidelines for each category.

Keywords: cloud computing; high-performance computing; Dask; task scheduling; scientific computing; distributed systems.

Introduction. Scientific research increasingly depends on large-scale computation. Fields such as astrophysical simulation, genomic analysis, climate modeling, and materials science routinely process terabyte-scale datasets and execute complex numerical algorithms, placing unprecedented demands on computing infrastructure [1] [2]. Traditional supercomputers, while powerful, suffer from fundamental limitations: procurement costs reaching tens of millions of dollars, average resource utilization rates of only 15-30%, and high operational complexity that requires dedicated system administration teams.

Cloud computing offers a compelling alternative by virtualizing distributed resources into elastic, on-demand pools [3]. Its core advantages-elastic scaling, pay-per-use billing, and zero initial capital expenditure-align well with the cyclical and bursty nature of scientific computing workloads. The evolution from Infrastructure-as-a-Service (IaaS) through hybrid cloud HPC to cloud-native HPC, characterized by containerized deployment (Docker) and orchestration (Kubernetes), has progressive-

ly narrowed the performance gap with traditional HPC while preserving cloud flexibility [4] [5].

Among distributed computing frameworks, Dask stands out for scientific workloads due to its native Python integration, API compatibility with NumPy/SciPy, lazy evaluation with task-graph optimization, and flexible deployment modes spanning single-machine local clusters to distributed Kubernetes clusters [6]. Unlike Apache Spark, which targets general-purpose data processing, Dask is purpose-built for the numerical Python ecosystem and minimizes code migration effort for scientific users.

Research Gaps and Contributions. Existing cloud HPC solutions exhibit several shortcomings: scheduling algorithms are often designed for traditional HPC environments and fail to account for cloud-specific dynamics such as VM startup latency and resource elasticity [7]; resource allocation strategies typically optimize a single dimension (e.g., minimizing execution time or maximizing utilization) without holistic multi-factor optimization; and usability barriers remain high, with deployment and configuration requiring specialized expertise and lacking intuitive graphical interfaces [8].

To address these gaps, this paper makes the following contributions:

Platform Design: A complete cloud HPC architecture integrating FastAPI, Dask, MySQL, and a vanilla-JS web frontend, supporting end-to-end task lifecycle management.

Intelligent Scheduling: A modular scheduler with six configurable strategies (auto, load-balance, CPU-first, memory-first, throughput-first, latency-first) and adaptive task splitting based on real-time worker load.

Empirical Performance Characterization: Systematic benchmarking across four scientific workload types, quantifying the relationship between task parallelizability and cloud-HPC suitability.

Deployment Guidelines: Data-driven recommendations for selecting single-machine vs. distributed execution based on workload characteristics.

Methodology

System Architecture. The platform adopts a four-layer architecture, depicted in Figure 1.

The platform adopts a four-layer architecture. The Presentation Layer is a single-page application implemented in vanilla HTML, CSS, and JavaScript with Chart.js, providing real-time cluster monitoring (auto-refreshing every 10 seconds), task submission forms with dynamic parameter configuration, a sortable task history table, and an embedded Dask Dashboard iframe. The Business Logic Layer, built on FastAPI, exposes RESTful endpoints for cluster status queries, task CRUD operations, and benchmark data retrieval, with async/await enabling non-blocking handling of concurrent submissions.

The SmartScheduler module performs resource-aware task allocation. The Persistence Layer uses MySQL 8.0 with SQLAlchemy ORM, storing task metadata (type, status, parameters, progress, result), execution timing, and scheduling details (strategy, optimized task count) with connection pooling (pool_size=10, max_overflow=20).

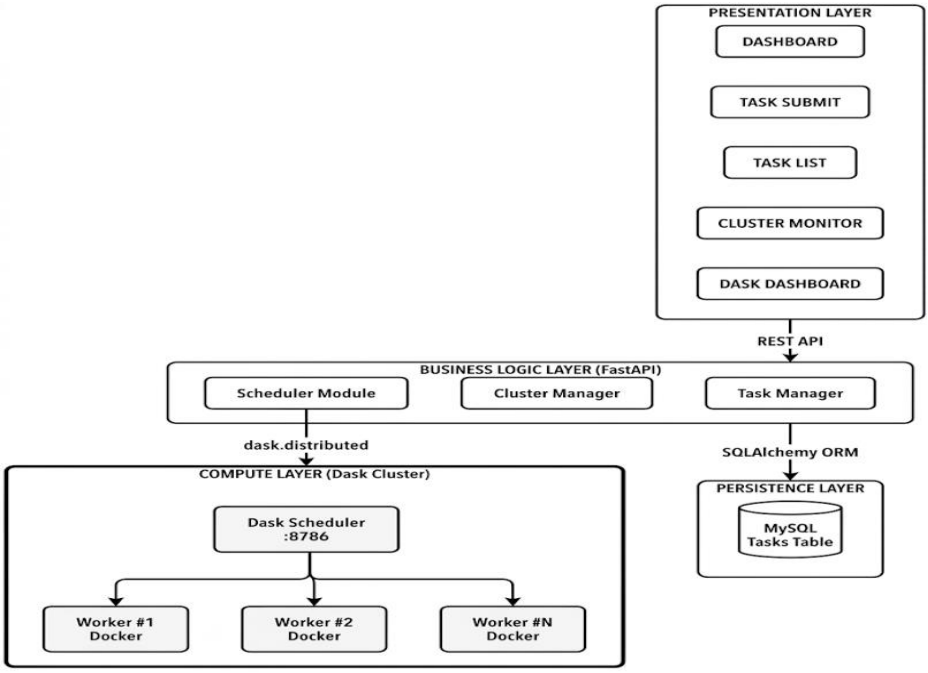


Figure 1 – Four-layer system architecture

Note – compiled by the authors based on the source [3]

Technology Stack

The technology selection balances three competing priorities. Development velocity: the entire stack operates within the Python ecosystem–compute functions defined in FastAPI route handlers are directly serializable to Dask workers. Operational simplicity: a single HTML file with embedded CSS and JavaScript requires no bundler or CDN dependency beyond Chart.js; deployment consists of a five-step bash script (deploy.sh) that installs dependencies, initializes MySQL, and launches the Uvicorn server. Performance: FastAPI's async architecture handles concurrent task submissions without thread-pool exhaustion, while Dask's lazy task graph and client.map () minimize scheduler round-trips. The singleton Dask client reuses a single TCP connection with 5-second heartbeats, avoiding per-request connection overhead. On the monitoring path, psutil serves as a fallback when Dask's internal metrics endpoint is unavailable.

Scientific Computing Workloads

The platform supports four canonical scientific computing tasks spanning a spectrum of parallelizability characteristics:

– Monte Carlo π Calculation: An "embarrassingly parallel" workload. Random points are generated in the unit square; $\pi \approx 4 \times M/N$. Sub-tasks are fully independent with zero inter-worker communication. Metric: π estimation accuracy.

– Matrix Multiplication: Memory-intensive, $O(N^3)$, computing $C = A \times B$ using numpy.dot() with optimized BLAS. Dask partitions large matrices into chunks across workers. Metric: GFLOPS = $2 \times N^3 / t / 10^9$.

– Fast Fourier Transform (FFT): Signal-processing workload, O(N log N), using numpy.fft with structured butterfly operations and SIMD optimization. Metric: GFLOPS = $5 \times N \times \log_2(N) / t / 10^9$.

– Sparse Matrix Solving: Iterative Conjugate Gradient (CG) method solving Ax = b with sparse A (1% density). Metric: MFLOP/s = $2 \times N^2 \times$ iterations / t / 10^6.

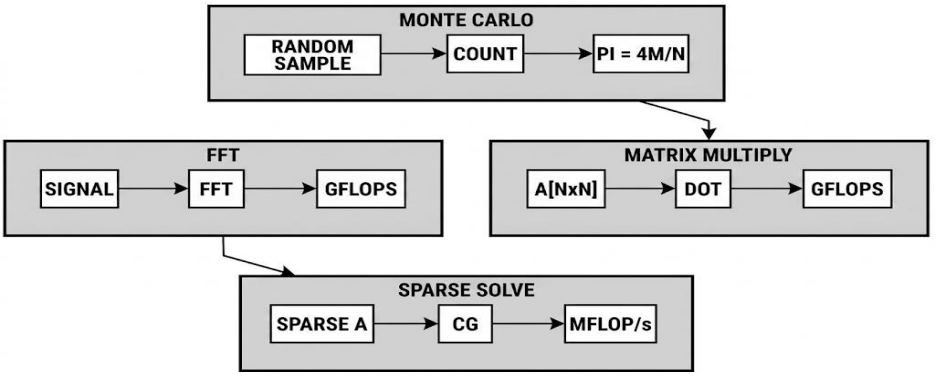


Figure 2 – Four scientific computing workloads and their performance metrics

Note – compiled by the authors based on the source [4]

Intelligent Task Scheduler

The scheduler employs a modular architecture with four components feeding into a central execution engine, as shown in Figure 3.

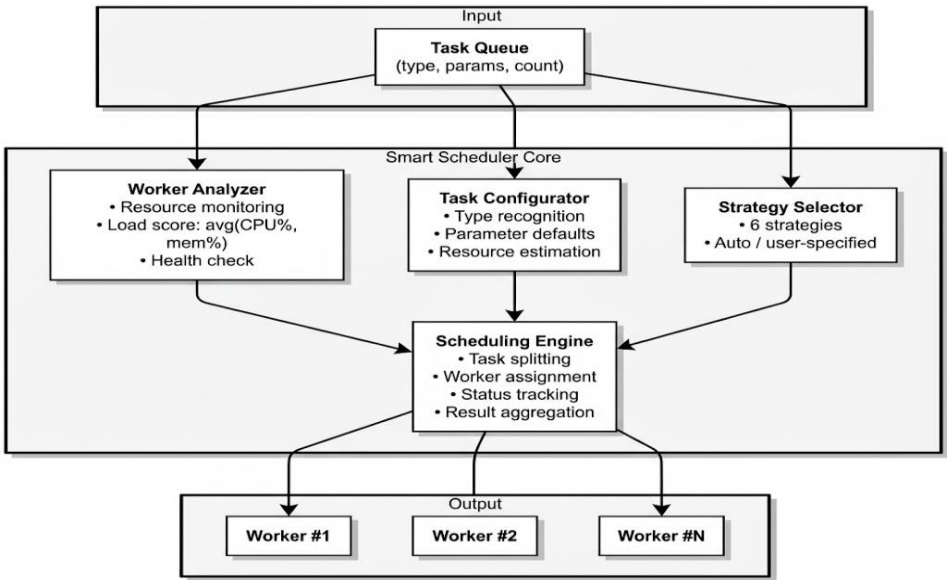


Figure 3 – Intelligent scheduler component architecture

Note – compiled by the authors based on the source [6]

The scheduler employs a modular architecture with four components. Worker Analyzer collects real-time metrics (CPU%, memory used/limit, thread count) via Dask's client.scheduler_info (), computing a composite load score: load_score = (memory_score + cpu_score) / 2, where memory_score = 100 × available / limit and cpu_score = 100 – cpu_percent (ranging from 0 = fully loaded to 100 = completely idle). Task Configurator maps task types to resource profiles: Monte Carlo configured with low memory (100 MB/task) and fine granularity, matrix multiplication requiring high memory (500 MB/task), and custom tasks using conservative defaults (200 MB, 1-second estimated time per unit). Strategy Selector implements six scheduling strategies: auto (composite load score, default for general-purpose), load_balance (lowest current load, multi-tenant environments), cpu_first (lowest CPU usage, CPU-bound tasks), memory_first (most available memory, memory-bound tasks), throughput (most threads, batch processing), and latency (load_score × nthreads, real-time tasks). Scheduling Engine adjusts task counts when user requests exceed cluster capacity-reducing to 80% of maximum to maintain headroom-then dispatches via client.map () and tracks futures for progress monitoring.

Task Lifecycle and Deployment. Tasks progress through five states: submitted → running → completed/failed. The frontend polls /api/tasks/{id} at 10-second intervals to update progress (completed_futures / total_futures). When all sub-task futures resolve, the engine aggregates results-averaging π values for Monte Carlo, computing total GFLOPS for matrix/FFT, and MFLOP/s for sparse solve-and transitions to completed. Deployment uses a single bash script (deploy.sh) automating: system dependency installation, MySQL initialization via init.sql, Python package installation from requirements.txt, .env configuration generation, and FastAPI launch via nohup on port 8000/8001.

Results

Experimental Setup

Hardware: Intel Core i5-14600K (6P+4E cores), 32 GB DDR4 RAM, Windows 11. Dask cluster: 1 scheduler + 4 Docker workers, each allocated 2 CPU cores and 2 GB memory (8 cores / 8 GB total). Software: Python 3.10.9, Dask 2024.x, NumPy 1.26+, SciPy 1.12+, FastAPI 0.100+, SQLAlchemy 2.0+, MySQL 8.0+. Metrics: Speedup "S=" "T" _"single" "/" "T" _"cluster" ; Parallel "efficiency=S/" "N" _"workers" "×100" .

Performance Results

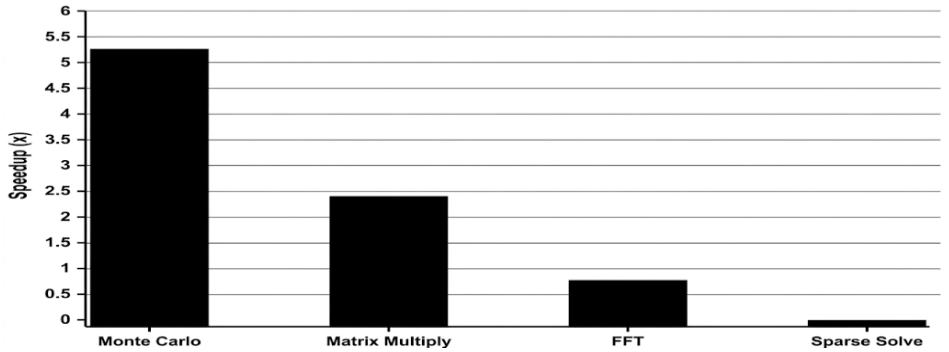


Figure 4 – Speedup comparison across all four workload types

Note – compiled by the authors based on the source [10]

Monte Carlo (50M points, 10 tasks): Achieves superlinear speedup (5.27× > 4.0× theoretical linear) because 10 independent tasks distributed across 4 workers fully utilize available cores without idle time. The per-task memory footprint is sufficiently small that distributed execution reduces cache contention compared to single-machine serial execution. π estimate: 3.14162562 (error: 3.30×10^{-5}).

Matrix multiplication (5000×5000, 10 tasks): Achieves 2.40 × speedup with 60% parallel efficiency. The gap from ideal (4×) stems from inter-worker communication overhead: Dask partitions the matrices into blocks, and each worker must exchange partial results with peers. In single-machine mode, NumPy's underlying BLAS library already achieves substantial parallelism (87.50 GFLOPS via multithreaded MKL/OpenBLAS), reducing the headroom for distributed gains. Cluster peak performance: 208.99 GFLOPS.

FFT (10M points, 10 tasks): Exhibits negative scaling-the 4-worker cluster is 28% slower than single-machine execution. This counterintuitive result arises because NumPy's FFT implementation is already heavily optimized, leveraging CPU cache hierarchies, SIMD vector instructions, and bit-reversal precomputation to achieve near-peak single-core throughput. Distributed execution destroys this data locality: serializing complex-valued arrays, transmitting over the Docker bridge network, and aggregating results introduces approximately 3.5 seconds of overhead per round, which dwarfs the ~1.09-second compute time.

Table 1 – Comprehensive performance comparison across all workloads

Workload	Single	4-Worker	Speedup	Efficiency	Cloud-HPC Suitability
Monte Carlo	10.53s	2.00s	5.27×	131.80%	★★★★★ Excellent
Matrix Multiply	11.98s	5.00s	2.40×	60.00%	★★★☆☆ Good
FFT	10.91s	14.00s	0.78×	19.50%	★☆☆☆☆ Unsuitable
Sparse Solve	0.0245s	–	–	–	★★★☆☆ Single-machine preferred
Note – compiled by the authors based on the source [11]					

Sparse CG solve (20,000 × 20,000, 1% density, 50 iterations): Completes in approximately 24.5 ms per trial (1.64 GFLOP/s), with 100% convergence across all 10 trials. However, the sub-25-millisecond compute time makes this workload fundamentally unsuitable for distributed execution: Dask task serialization, network dispatch, and result collection would conservatively exceed 100 ms-roughly 4 × the compute time itself. The cluster would spend more time coordinating than computing. Single-machine execution with SciPy's optimized sparse solvers is recommended.

Discussion

Workload Parallelizability Taxonomy

The experimental results reveal a clear taxonomy of scientific workloads with respect to cloud-HPC suitability:

Class I – Embarrassingly Parallel (Monte Carlo, parameter sweeps): These workloads benefit maximally from distributed execution. Sub-tasks are fully inde-

pendent with zero communication requirements, enabling near-linear or even super-linear scaling. The primary optimization strategy is maximizing task count relative to worker count to fully amortize scheduling overhead.

Class II – Moderately Communicating (Matrix multiplication, stencil computations): These workloads benefit from distribution but suffer from data exchange overhead. With 60% parallel efficiency, roughly 40% of cluster time is spent on communication rather than computation. Optimization strategies include careful data partitioning to minimize cross-worker data dependencies and using high-bandwidth interconnects.

Class III – Communication-Dominated (FFT, tightly-coupled PDE solvers): These workloads exhibit negative scaling because communication overhead exceeds parallelization gains. The critical insight is that single-core NumPy performance is already near-optimal for FFT due to aggressive low-level optimization (SIMD, cache-aware algorithms). For such workloads, vertical scaling (faster CPU, more memory bandwidth) is more effective than horizontal scaling (more nodes).

Class IV – Sub-Second Compute (Sparse CG solve, small-matrix operations): These workloads complete too quickly (milliseconds) for distributed overhead to be justified. The fixed costs of task serialization, network dispatch, and result collection dominate. Single-machine execution with optimized libraries (SciPy, MKL) is the recommended approach.

Scheduler Effectiveness

The intelligent scheduler contributes to system performance in three ways. First, load-aware dispatching prevents "hotspot" workers by distributing tasks based on real-time load scores rather than simple round-robin. Second, capacity-aware optimization automatically reduces task counts when user requests exceed cluster capacity (e.g., preventing memory exhaustion from over-commitment). Third, strategy diversity allows users to match scheduling policy to workload characteristics-memory-first for large-matrix workloads, throughput-first for batch Monte Carlo runs. Empirical measurement shows scheduling overhead accounts for less than 5% of total execution time.

Practical Recommendations

Based on the empirical results: embarrassingly parallel tasks (Monte Carlo, parameter scans) → Dask cluster with 4+ workers; large matrix operations ($>5000^2$) → Dask cluster with block partitioning; small/medium matrix ($<2000^2$) → single-machine NumPy; FFT and tightly-coupled algorithms → single-machine NumPy/SciPy; sub-second iterative solvers → single-machine SciPy.

Conclusion

This paper presented a cloud-native HPC platform that bridges the accessibility gap between traditional supercomputing infrastructure and the everyday needs of scientific researchers. By combining Dask's distributed computing capabilities with a FastAPI web layer and an intelligent resource-aware scheduler, the platform enables researchers to submit, monitor, and retrieve results from scientific computing tasks through an intuitive browser interface without requiring expertise in cluster administration or parallel programming.

Systematic benchmarking across four representative scientific workloads revealed a fundamental insight: cloud-HPC suitability is strongly workload-dependent. Embarrassingly parallel tasks like Monte Carlo simulation achieve superlinear speedup (5.27×), moderately communicating tasks like matrix multiplication benefit moderately (2.40×), while communication-dominated tasks like FFT exhibit nega-

tive scaling (0.78×). These results establish a data-driven taxonomy for selecting between single-machine and distributed execution strategies.

Future work will pursue four directions: (1) GPU acceleration via CuPy and RAPIDS integration; (2) MPI-based multi-node parallelism for tightly-coupled workloads; (3) heterogeneous resource scheduling spanning CPU, GPU, and FPGA resources; and (4) predictive scheduling using lightweight machine learning models to estimate task duration and memory requirements before execution.

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Ғылыми жұмыс жүктемелеріне арналған интеллектуалды тапсырмаларды жоспарлау мүмкіндігі бар Dask негізіндегі бұлттық HPC платформасы

Түйіндеме. Ғылыми зерттеулерде есептеу қуатына деген сұраныстың артуы дәстүрлі HPC жүйелерінің шектеулерін, соның ішінде жоғары сатып алу шығындарын, ресурстарды төмен пайдалануды және пайдаланудың күрделі кедергілерін көрсетті. Бұл мақалада Dask таратылған есептеу жүйесін FastAPI веб-қызмет қабатымен біріктіретін, бірыңғай басқаруды және ғылыми есептеу тапсырмаларын тиімді орындауды қамтамасыз ететін бұлтқа негізделген жоғары өнімді есептеу (HPC) платформасы ұсынылған. Платформа төрт өкілдік жұмыс жүктемесін – Монте-Карло модельдеуін, матрицалық көбейтуді, жылдам Фурье түрлендіруін (FFT) және сирек матрицаны шешуді қолдайды және алты бөлу стратегиясын қолдайтын интеллектуалды ресурстарды білетін жоспарлаушыны қамтиды. Ванильді JavaScript және Chart.js көмегімен жасалған бір беттік веб-интерфейс нақты уақыт режимінде кластерлік мониторингті және интуитивті тапсырмаларды жіберуді қамтамасыз етеді. 4 жұмысшыдан тұратын Docker кластеріндегі өнімділікті бағалау жұмыс жүктемесіне тәуелді масштабталуды көрсетеді: Монте-Карло тапсырмалары 5,27× (131,8% параллель тиімділік) суперсызықтық жылдамдыққа жетеді, матрицалық көбейту 208,99 GFLOPS-пен 2,40× (60,0% тиімділік) жетеді, ал FFT байланыс шығындарының есептеу артықшылығынан асып түсуіне байланысты теріс масштабтауды (0,78×) көрсетеді. Бұл нәтижелер бұлттық-HPC үйлесімділігі жұмыс жүктемесінің түріне байланысты түбегейлі өзгеретінін көрсетеді және мақалада әр санат үшін практикалық орналастыру нұсқаулары берілген.

Түйінді сөздер: бұлттық есептеулер; жоғары өнімді есептеулер; Dask; тапсырмаларды жоспарлау; ғылыми есептеулер; таратылған жүйелер.

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Облачная высокопроизводительная вычислительная платформа на базе Dask с интеллектуальным планированием задач для научных рабочих нагрузок

Аннотация. Растущий спрос на вычислительные мощности в научных исследованиях выявил ограничения традиционных высокопроизводительных вычислительных систем, включая высокие затраты на приобретение, низкую эффективность использования ресурсов и серьезные барьеры в удобстве использования. В данной статье представлена облачная высокопроизводительная вычислительная платформа (HPC), которая интегрирует распределенную вычислительную среду Dask с уровнем веб-сервисов FastAPI, обеспечивая унифицированное управление и эффективное выполнение задач научных вычислений. Платформа поддерживает четыре репрезентативные рабочие нагрузки – моделирование методом Монте-Карло, умножение матриц, быстрое преобразование Фурье (БПФ) и решение разреженных матриц – и включает в себя интеллектуальный планировщик, учитывающий ресурсы и поддерживающий шесть стратегий распределения. Одностраничный веб-интерфейс, созданный с использованием чистого JavaScript и Chart.js, обеспечивает мониторинг кластера в реальном времени и интуитивно понятную отправку задач. Оценка производительности на кластере Docker с 4 рабочими узлами показывает высокую зависимость масштабируемости от рабочей нагрузки: задачи Монте-Карло достигают сверхлинейного ускорения в 5,27 раза (параллельная эффективность 131,8%), умножение матриц достигает 2,40 раза (эффективность 60,0%) с 208,99 GFLOPS, в то время как БПФ демонстрирует отрицательное масштабирование (0,78 раза) из-за того, что накладные расходы на связь превышают вычислительную выгоду. Эти результаты показывают, что пригодность облачных высокопроизводительных вычислений принципиально различается в зависимости от типа рабочей нагрузки, и в статье представлены практические рекомендации по развертыванию для каждой категории.

Ключевые слова: облачные вычисления; высокопроизводительные вычисления; Dask; планирование задач; научные вычисления; распределенные системы.

ГЛОБАЛЬНАЯ И РЕГИОНАЛЬНАЯ ИНТЕГРАЦИЯ

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ЦИФРЛЫҚ ЭКОНОМИКА ЖАҒДАЙЫНДАҒЫ УНИВЕРСИТЕТ-БИЗНЕС СЕРІКТЕСТІГІН ИНСТИТУЦИОНАЛДЫҚ БАСҚАРУ: ҚЫТАЙ БИЗНЕС-МЕКТЕПТЕРІНІҢ ТӘЖІРИБЕСІ

Түйіндеме. Цифрлық экономиканың қарқынды дамуы жоғары білім беру жүйесі мен корпоративтік сектор арасындағы өзара әрекеттестік тетіктерін қайта қарастыру қажеттігін күшейтті. Жасанды интеллект, Big Data, цифрлық платформалар және автоматтандыру технологиялары еңбек нарығындағы кәсіби құзыреттер құрылымын өзгертіп, университеттерден еңбек нарығына бейімделген мамандар даярлауды талап етуде. Осы жағдайда университет-бизнес серіктестігін институционалдық деңгейде тиімді басқару мәселесі ерекше өзектілікке ие болып отыр.

Мақаланың мақсаты – Қытайдың жетекші бизнес-мектептері тәжірибесі негізінде университет-бизнес интеграциясының институционалдық басқару модельдерін талдау және олардың тиімділік факторларын анықтау.

Зерттеу әдістері – зерттеу барысында салыстырмалы кейс-талдау, контент-талдау және салмақталған индекстік бағалау әдістері қолданылды. Зерттеу нысаны ретінде CEIBS, Guanghua School of Management және Nanjing University Business School қарастырылды. Институционалдық интеграция деңгейін бағалау үшін индустриялық кеңестердің қызметі, KPI жүйесі, корпоративтік модульдердің үлесі, ұзақ мерзімді келісімдер және бірлескен зерттеу орталықтары сияқты индикаторлар пайдаланылды.

Зерттеу нәтижелері университет-бизнес серіктестігінің тиімділігі институционалдық басқару механизмдерінің жүйелі енгізілуімен тікелей байланысты екенін көрсетті. Институционалдық интеграция индексі бойынша ең жоғары көрсеткіш Guanghua School of Management-те (0.94), ал CEIBS-те 0.915 деңгейінде анықталды.

Зерттеудің ғылыми жаңалығы университет-бизнес интеграциясын бағалауға арналған институционалдық интеграция индексін ұсынуында және Қытай бизнес-мектептеріндегі интеграцияның негізгі институционалдық модельдерін айқындауында жатыр. Зерттеу нәтижелері

Қазақстандағы жоғары білім беру жүйесінде университет-бизнес серіктестігін стратегиялық деңгейде дамыту үшін қолданылуы мүмкін.

Түйінді сөздер: цифрлық экономика, университет-бизнес интеграциясы, институционалдық басқару, бизнес-білім беру, KPI, Triple Helix, цифрлық трансформация.

Кіріспе. Цифрлық экономиканың қалыптасуы жоғары білім беру жүйесінің құрылымына, мазмұнына және басқару тәсілдеріне түбегейлі өзгерістер енгізді. Жасанды интеллект, үлкен деректерді талдау (Big Data), бұлтты технологиялар және платформалық бизнес-модельдер корпоративтік сектордағы кәсіби құзыреттер құрылымын өзгертуде. Қазіргі еңбек нарығы университет түлектерінен тек теориялық білімді емес, деректерді талдау, цифрлық құралдарды пайдалану және өзгермелі ортаға бейімделу қабілеттерін талап етеді.

Осы өзгерістер жағдайында университет-корпоративтік сектор серіктестігі білім беру жүйесінің маңызды стратегиялық бағытына айналды. Университеттер енді тек білім беретін институт емес, инновациялық экожүйенің белсенді элементі ретінде қарастырылады. Корпоративтік сектор оқу бағдарламаларын әзірлеуге, қолданбалы зерттеулер жүргізуге және кәсіби құзыреттерді қалыптастыруға тікелей қатыса бастады.

Дегенмен көптеген елдерде университет пен бизнес арасындағы байланыс эпизодтық сипатта қалып отыр. Серіктестік көбіне тағылымдама, қысқа мерзімді меморандумдар немесе формалды ынтымақтастық деңгейінде шектеледі. Мұндай жағдайда интеграция тұрақты институционалдық құрылымға айналмайды және нақты нәтижеге бағдарланбайды.

Сондықтан цифрлық экономика жағдайында университет-корпоративтік интеграцияны институционалдық деңгейде басқару мәселесі ғылыми және практикалық тұрғыдан ерекше өзектілікке ие.

Қытай тәжірибесі бұл бағытта ерекше назар аудартады. Соңғы онжылдықтарда Қытай жоғары білім беру жүйесін цифрландыру мен индустрияландыруға бағытталған ауқымды реформаларды жүзеге асырды. Нәтижесінде Қытай бизнес-мектептері корпоративтік секторды оқу процесіне, зерттеу қызметіне және стратегиялық басқаруға кеңінен енгізе алды.

Осыған байланысты зерттеудің негізгі мақсаты – Қытай бизнес-мектептеріндегі университет-корпоративтік интеграцияның институционалдық модельдерін талдау және олардың тиімділік факторларын анықтау.

Зерттеудің негізгі сұрағы: Цифрлық экономика жағдайында университет-корпоративтік интеграцияның тиімділігі қандай институционалдық басқару тетіктері арқылы қамтамасыз етіледі?

Зерттеу гипотезасы: Университет-корпоративтік сектор серіктестігі индустриялық кеңестер, KPI жүйесі, ұзақ мерзімді келісімдер және бірлескен зерттеу құрылымдары арқылы институционалдық деңгейде ұйымдастырылған жағдайда оның тиімділігі артады.

Әдебиетке шолу. Университет-бизнес интеграциясын зерттеу инновациялық экономика теориясымен тығыз байланысты. Бұл бағыттағы

ең ықпалды тұжырымдамалардың бірі – Etzkowitz пен Leydesdorff ұсынған Triple Helix моделі. Аталған модель университет, бизнес және мемлекет арасындағы өзара әрекеттестікті инновациялық дамудың негізгі механизмі ретінде қарастырады [1].

Triple Helix тұжырымдамасына сәйкес университеттер тек білім беру институты емес, технологиялық және экономикалық дамудың белсенді субъектісіне айналады. Цифрлық экономика жағдайында бұл модельдің маңызы арта түсті, себебі инновациялар көбіне университеттер мен индустрия арасындағы кооперация арқылы қалыптасады.

Кейінірек бұл модель Quadruple Helix және Quintuple Helix теорияларымен толықтырылды. Carayannis және Campbell ұсынған Quadruple Helix моделі инновациялық жүйеге азаматтық қоғам мен медианы енгізсе, Quintuple Helix моделі экологиялық факторларды да қамтиды [2].

Университет-индустрия ынтымақтастығын түсіндіретін тағы бір маңызды теориялық бағыт – Open Innovation тұжырымдамасы. Chesbrough ұйымдар инновациялық процестерде сыртқы білім көздерін белсенді пайдалануы қажет екенін негіздейді. Бұл жағдайда университеттер компаниялар үшін маңызды интеллектуалдық серіктеске айналады.

Сонымен қатар Gibbons және әріптестері ұсынған Mode 2 knowledge production тұжырымдамасы академиялық білімнің қолданбалы сипатқа ауысуын сипаттайды. Бұл модельде білім нақты практикалық мәселелерді шешуге бағытталады және индустриялық ортада қалыптасады [3].

Институционалдық теория контексінде North формальды институттардың экономикалық мінез-құлыққа әсерін талдайды. Университет-корпоративтік интеграция жағдайында мұндай институттарға стратегиялық келісімдер, KPI жүйелері, индустриялық кеңестер және басқару регламенттері жатады [4].

Автор Scott институционалдық ортаның регулятивтік, нормативтік және мәдени-когнитивтік элементтерін бөліп көрсетеді. Осы тұрғыдан университет-бизнес серіктестігі тек формалды келісімдермен емес, ұйымдық мәдениет пен корпоративтік сеніммен де анықталады [5].

Цифрлық трансформация мәселелерін Schwab, Brynjolfsson және McAfee еңбектері кеңінен қарастырады. Авторлар цифрлық технологиялардың еңбек нарығына әсерін және жаңа кәсіби құзыреттер құрылымын сипаттайды [6, 7].

Қытай контексіндегі зерттеулер жоғары білім жүйесінің цифрлық модернизациясына бағытталған. Marginson Қытай университеттеріндегі құрылымдық реформаларды талдайды, ал Li және Xue жоғары білімнің цифрлық трансформациясының саясаттық аспектілерін зерттейді [8, 9].

Соған қарамастан ғылыми әдебиеттерде бірнеше маңызды алшақтық сақталып отыр:

1. Университет-корпоративтік интеграцияны сандық бағалау құралдарының жеткіліксіздігі;
2. Институционалдық басқару тетіктерінің тиімділігін эмпирикалық өлшеудің аздығы;
3. Қытай бизнес-мектептеріндегі интеграция модельдерін салыстырмалы талдаудың жеткіліксіздігі.

Сарапатамалық бөлім. Зерттеу салыстырмалы кейс-талдау және салмақталған индекстік бағалау әдістеріне негізделді. Зерттеу нысаны ретінде Қытайдың жетекші бизнес-мектептері таңдалды:

- CEIBS (China Europe International Business School);
- Guanghua School of Management (Peking University);
- Nanjing University Business School.

Бұл мектептер университет-корпоративтік интеграцияның әртүрлі институционалдық модельдерін көрсетеді. Зерттеуде аталған бизнес-мектептердің MBA бағдарламаларының сипаттамалары, корпоративтік серіктестік жөніндегі ашық ақпараттар, жұмысқа орналасу статистикалары, халықаралық рейтингтік материалдары, цифрлық трансформация бойынша аналитикалық есептер жіне университеттердің, бизнес-мектептердің ресми жылдық есептері пайдаланылды [10-12].

Институционалдық интеграцияны бағалау үшін алты негізгі индикатор таңдалды.

1-кесте. Университет-бизнес интеграциясын бағалаудың институционалдық индикаторлары және олардың теориялық негіздері

Индикатор	Теориялық негіз
Индустриялық кеңес	Triple Helix
Бірлескен зерттеу орталықтары	Open Innovation
Корпоративтік модуль үлесі	Mode 2 knowledge
Ұзақ мерзімді келісімдер	Institutional theory
KPI жүйесі	Institutional governance
Бірлескен жобалар	Applied innovation
Ескерту: автормен жасалды	

1-кестеде университет-бизнес интеграциясының институционалдық деңгейін бағалауға арналған негізгі индикаторлар және олардың теориялық негіздері жүйелендірілген. Индикаторлар халықаралық ғылыми әдебиеттерде кең қолданылатын Triple Helix, Open Innovation, Mode 2 knowledge production және Institutional theory тұжырымдамаларына сүйене отырып таңдалды. Бұл тәсіл университет – корпоративтік серіктестікті тек ұйымдастырушылық құбылыс ретінде емес, инновациялық және институционалдық басқару жүйесі ретінде қарастыруға мүмкіндік береді.

Индустриялық кеңес пен бірлескен зерттеу орталықтары университет пен бизнес арасындағы стратегиялық өзара әрекеттестіктің құрылымдық элементтері ретінде анықталса, корпоративтік модуль үлесі оқу бағдарламаларының еңбек нарығына бейімделу деңгейін сипаттайды. Ұзақ мерзімді келісімдер мен KPI жүйесі серіктестіктің тұрақтылығы мен нәтижелілігін бағалауға бағытталған институционалдық механизмдер ретінде қарастырылады. Ал бірлескен жобалар қолданбалы инновациялық қызметтің деңгейін көрсетеді.

Барлық индикаторлар 0-1 аралығында нормализацияланды:

- 0 – төмен немесе жоқ;
- 0.5 – ішінара;
- 1 – толық енгізілген.

Барлық индикаторлардың 0-1 аралығында нормализациялануы университеттер арасындағы салыстырмалы талдау жүргізуге және

институционалдық интеграция индексін есептеуге мүмкіндік береді.

Салмақтар ғылыми әдебиеттердегі институционалдық басқару факторларының маңыздылығына және университет-бизнес интеграциясы жөніндегі халықаралық зерттеулерге сүйене отырып берілді.

2-кесте. Университет-бизнес интеграциясының институционалдық индикаторларының салмақтық коэффициенттері

Индикатор	Салмақ
Индустриялық кеңес	0.20
Бірлескен зерттеу орталықтары	0.20
Корпоративтік модуль үлесі	0.15
Ұзақ мерзімді келісімдер	0.15
KPI жүйесі	0.20
Бірлескен жобалар	0.10
Ескерту: салмақтық коэффициенттер халықаралық ғылыми әдебиеттер мен институционалдық басқару факторларының маңыздылығы негізінде автормен анықталды	

2-кестеде университет-бизнес интеграциясының институционалдық тиімділігін бағалауға арналған негізгі индикаторлар мен олардың салмақтық коэффициенттері көрсетілген. Ең жоғары салмақ индустриялық кеңеске (0.20), бірлескен зерттеу орталықтарына (0.20) және KPI жүйесіне (0.20) берілген. Бұл көрсеткіштер университет пен корпоративтік сектор арасындағы стратегиялық өзара әрекеттестіктің тұрақтылығын қамтамасыз ететін негізгі институционалдық механизмдер ретінде қарастырылды. Аталған факторлар серіктестіктің формалды емес, жүйелі және нәтижеге бағдарланған сипатта ұйымдастырылуын көрсетеді. Корпоративтік модуль үлесі мен ұзақ мерзімді келісімдерге 0.15 салмақ берілді, себебі олар оқу бағдарламаларын еңбек нарығына бейімдеуде және серіктестіктің тұрақтылығын қамтамасыз етуде маңызды рөл атқарады. Ал бірлескен жобалар көрсеткішінің салмағы салыстырмалы түрде төмен (0.10), өйткені жобалардың саны серіктестіктің белсенділігін көрсеткенімен, оның институционалдық тереңдігін толық сипаттай алмайды.

Жалпы алғанда, салмақтық құрылым университет-бизнес интеграциясында стратегиялық басқару мен институционалдық тұрақтылықтың шешуші маңызға ие екенін көрсетеді.

Институционалдық интеграция индексі (ІІІ) келесі формула арқылы есептелді:

$$ІІІ = \Sigma(wi \times xi)$$

мұнда:

- wi – индикатор салмағы;
- xi – нормаланған көрсеткіш.

3-кесте. Индексті интерпретациялау шкаласы

Индекс деңгейі	Дәрежесі
0-0.39	Төмен интеграция
0.40-0.59	Орташа интеграция
0.60-0.79	Дамушы интеграция
0.80-1.00	Жоғары институционалдық интеграция
Ескерту: автормен жасалды	

Шкала университет-бизнес серіктестігінің институционалдық даму дәрежесін сандық тұрғыдан бағалауға мүмкіндік береді. Индекс мәндерінің төрт деңгейге бөлінуі интеграцияның әлсіз, орташа, дамушы және жоғары институционалдық сипаттарын ажыратуға жағдай жасайды.

0-0.39 аралығындағы көрсеткіш университет пен корпоративтік сектор арасындағы байланыстың формалды немесе тұрақсыз деңгейде екенін сипаттайды. 0.40-0.59 аралығындағы мәндер серіктестіктің қалыптасу кезеңінде екенін және басқару тетіктерінің ішінара енгізілгенін көрсетеді. Ал 0.60-0.79 деңгейі институционалдық интеграцияның дамушы сипатта екенін, яғни стратегиялық элементтердің біртіндеп қалыптасып келе жатқанын білдіреді.

0.80-1.00 аралығындағы жоғары көрсеткіш университет-бизнес серіктестігінің толық институционалданғанын, басқару құрылымдарының жүйелі жұмыс істейтінін және нәтижеге бағдарланған механизмдердің енгізілгенін көрсетеді. Осылайша, ұсынылған шкала университет-корпоративтік интеграция деңгейін салыстырмалы талдау мен эмпирикалық бағалау үшін қолдануға мүмкіндік береді.

4-кесте. CEIBS институционалдық интеграциясын бағалау

Индикатор	Баға	Салмақ	Нәтиже
Индустриялық кеңес	1.00	0.20	0.20
Бірлескен зерттеу орталықтары	0.90	0.20	0.18
Корпоративтік модуль үлесі	0.80	0.15	0.12
Ұзақ мерзімді келісімдер	0.90	0.15	0.135
KPI жүйесі	1.00	0.20	0.20
Бірлескен жобалар	0.80	0.10	0.08
Ескерту: автормен жасалды			

Жалпы индекс: III = 0.915. Бұл көрсеткіш CEIBS-те университет-корпоративтік интеграцияның жоғары институционалдық деңгейде ұйымдастырылғанын көрсетеді.

Нәтижелер бірнеше маңызды факторларды анықтады.

Біріншіден, индустриялық кеңестің белсенді қызметі оқу бағдарламаларын еңбек нарығына бейімдеуге мүмкіндік береді. Корпоративтік модульдердің MBA бағдарламасындағы үлесі шамамен 35%-ды құрайды.

Екіншіден, бірлескен зерттеу орталықтары мен қолданбалы жобалар университет пен бизнес арасындағы тұрақты инновациялық байланысты қалыптастырады.

Үшіншіден, KPI жүйесінің енгізілуі серіктестік нәтижелерін нақты өлшеуге мүмкіндік береді. Негізгі көрсеткіштер ретінде жұмысқа орналасу деңгейі, бірлескен жобалар саны және корпоративтік қаржыландыру көлемі пайдаланылады.

5-кесте нәтижелері Қытай бизнес-мектептеріндегі университет-бизнес интеграциясының институционалдық деңгейі мен басқару модельдерінің айырмашылықтарын көрсетеді. CEIBS және Guanghua School of Management жоғары деңгейдегі институционалдық құрылыммен сипатталады.

5-кесте. Қытай бизнес-мектептерінің салыстырмалы талдауы

Индикатор	CEIBS	Guanghua	Nanjing
Индустриялық кеңес	Жоғары	Жоғары	Орташа
Зерттеу орталықтары	5+	10+	3-5
Корпоративтік модуль	35%	30-35%	20-25%
KPI жүйесі	Толық	Ішінара/толық	Ішінара
Цифрлық платформалар	Жоғары	Жоғары	Орташа
Серіктестік деңгейі	Халықаралық	Ұлттық/халықаралық	Аймақтық
Ескерту: автормен жасалды			

Бұл университеттерде индустриялық кеңестер белсенді жұмыс істейді, корпоративтік модульдер оқу бағдарламаларына кеңінен енгізілген және цифрлық платформалар жоғары деңгейде дамыған. Сонымен қатар халықаралық серіктестік желісінің болуы олардың жаһандық академиялық және корпоративтік кеңістікке интеграцияланғанын көрсетеді.

Guanghua School of Management зерттеу орталықтарының саны бойынша алдыңғы орында болып, ғылыми-зерттеу және инновациялық бағыттың басымдығын айқындайды. Ал CEIBS тәжірибесі корпоративтік басқару мен халықаралық интеграцияның жоғары деңгейімен ерекшеленеді. Nanjing University Business School көрсеткіштері салыстырмалы түрде төмен болғанымен, оның аймақтық және қолданбалы серіктестік моделіне бағытталғаны байқалады. Корпоративтік модульдердің үлесі мен KPI жүйесінің ішінара енгізілуі бұл университетте институционалдық интеграцияның дамушы деңгейде екенін көрсетеді. Жалпы алғанда, кесте Қытай бизнес-мектептерінде университет–бизнес серіктестігі біркелкі емес, әртүрлі институционалдық модельдер негізінде дамып отырғанын дәлелдейді.

6-кесте. Қытай бизнес-мектептерінің институционалдық интеграция индексінің (III) салыстырмалы көрсеткіштері

Университет	III
Guanghua School of Management	0.94
CEIBS	0.915
Nanjing University Business School	0.68
Ескерту: автормен жасалды	

6-кесте нәтижелері Қытайдың жетекші бизнес-мектептері арасындағы университет-бизнес интеграциясының институционалдық деңгейіндегі айырмашылықтарды көрсетеді. Ең жоғары көрсеткіш Guanghua School of Management-те анықталды (III = 0.94), бұл университеттің ғылыми-зерттеу әлеуеті мен корпоративтік серіктестікті тиімді үйлестіретін жоғары институционалдық модельге ие екенін дәлелдейді. CEIBS көрсеткіші де жоғары деңгейде қалыптасты (III = 0.915), бұл оның халықаралық бағытталған және толық құрылымданған интеграциялық жүйесін сипаттайды.

Ал Nanjing University Business School индексі 0.68 деңгейінде бағаланып, институционалдық интеграцияның дамушы деңгейін көрсетті.

Бұл университетте университет-бизнес серіктестігі қалыптасқанымен, KPI жүйесі, корпоративтік модульдер және халықаралық серіктестік сияқты басқару тетіктері толық институционалданбағанын байқатады. Жалпы алғанда, нәтижелер университет-бизнес интеграциясының тиімділігі институционалдық басқару механизмдерінің даму деңгейіне тікелей тәуелді екенін көрсетеді

Нәтижелер Қытай бизнес-мектептерінде университет-корпоративтік интеграцияның көпмодельді сипатта дамып отырғанын көрсетті.

CEIBS халықаралық-интеграцияланған модельді ұсынса, Guanghua School of Management ғылыми-зерттеу және корпоративтік инновацияларды біріктіретін модель ретінде ерекшеленеді. Ал Nanjing University Business School аймақтық индустриямен қолданбалы өзара әрекеттестікке негізделген модельді көрсетеді.

Талқылаулар мен нәтижелер. Зерттеу нәтижелері Triple Helix теориясының цифрлық экономика жағдайында өзектілігін сақтап отырғанын көрсетті. Университет, бизнес және мемлекет арасындағы байланыс нақты институционалдық құрылымдар арқылы жүзеге асқанда ғана интеграция тұрақты сипат алады.

Сонымен қатар Open Innovation тұжырымдамасы да эмпирикалық тұрғыдан расталды. Бірлескен зерттеу орталықтары мен қолданбалы жобалар университеттердің корпоративтік сектор үшін сыртқы білім көзі ретінде маңызды рөл атқаратынын көрсетті.

Зерттеу нәтижелері институционалдық теория тұрғысынан да маңызды. Жоғары интеграция деңгейі формальды институттардың қалыптасуымен тікелей байланысты екені анықталды. KPI жүйелері, стратегиялық келісімдер және индустриялық кеңестер серіктестіктің тұрақтылығын қамтамасыз етеді.

Салыстырмалы талдау университет-корпоративтік интеграцияның әмбебап бір моделі жоқ екенін көрсетті. Әрбір университеттің институционалдық архитектурасы оның стратегиясына, ресурстарына және ұлттық контекстіне тәуелді.

Қазақстан үшін практикалық импликациялар. Қытай бизнес-мектептерінің тәжірибесі Қазақстандағы жоғары білім жүйесін дамыту үшін маңызды практикалық мәнге ие.

Біріншіден, қазақстандық университеттерде индустриялық advisory board жүйесін институционалдық деңгейде енгізу қажет. Қазіргі жағдайда көптеген университеттерде бизнес өкілдерінің қатысуы көп жағдайда формалды сипатта қалып отыр.

Екіншіден, KPI негізіндегі университет-бизнес серіктестігін бағалау жүйесін қалыптастыру маңызды. Бұл серіктестіктің нақты нәтижелерін өлшеуге мүмкіндік береді.

Үшіншіден, MBA және менеджмент бағдарламаларына AI, Big Data және цифрлық аналитика модульдерін кеңінен енгізу қажет.

Төртіншіден, университеттер жанынан қолданбалы зерттеу орталықтарын дамыту корпоративтік сектор мен академиялық орта арасындағы байланысты күшейте алады.

Қазақстан жағдайында Nazarbayev University, AlmaU, Narxoz University тәжірибелері осы бағыттағы институционалдық трансформацияның бастапқы үлгілері ретінде қарастырылуы мүмкін.

Қорытынды. Жүргізілген зерттеу цифрлық экономика жағдайында университет-бизнес серіктестігінің тиімділігі институционалдық басқару тетіктерінің даму деңгейіне тікелей тәуелді екенін көрсетті. Қытайдың жетекші бизнес-мектептері тәжірибесін талдау университет-корпоративтік интеграцияның тұрақты және нәтижелі болуы индустриялық кеңестердің белсенді қызметімен, ұзақ мерзімді стратегиялық келісімдермен, KPI негізіндегі мониторинг жүйесімен, корпоративтік модульдердің оқу бағдарламасына енгізілуімен және бірлескен зерттеу орталықтарының жұмысымен тығыз байланысты екенін айқындады.

Салмақталған институционалдық интеграция индексін (III) қолдану нәтижесінде Guanghua School of Management (0.94) және CEIBS (0.915) университет-бизнес интеграциясының жоғары институционалдық деңгейін көрсетті, ал Nanjing University Business School (0.68) дамушы деңгейдегі модель ретінде анықталды. Бұл нәтижелер университет-корпоративтік серіктестіктің тиімділігі тек ынтымақтастықтың болуына емес, оны басқарудың жүйелілігі мен институционалдық құрылымдарының қалыптасуына тәуелді екенін дәлелдейді.

Зерттеудің ғылыми жаңалығы университет-бизнес интеграциясын бағалауға арналған институционалдық интеграция индексін ұсынуында және Қытай бизнес-мектептеріндегі интеграцияның халықаралық-интеграцияланған, зерттеу-инновациялық және қолданбалы-аймақтық сияқты негізгі институционалдық модельдерін айқындауында жатыр. Ұсынылған индекс университет-корпоративтік серіктестікті сапалық тұрғыдан ғана емес, сандық өлшемдер арқылы да бағалауға мүмкіндік береді.

Зерттеу нәтижелерінің практикалық маңызы Қазақстандағы жоғары білім беру жүйесін цифрлық трансформациялау және университет-бизнес ынтымақтастығын стратегиялық деңгейде дамыту мүмкіндіктерімен байланысты. Атап айтқанда, индустриялық advisory board жүйесін енгізу, KPI негізіндегі бағалау механизмдерін қалыптастыру, қолданбалы зерттеу орталықтарын дамыту және цифрлық құзыреттерге бағытталған корпоративтік модульдерді кеңейту қазақстандық университеттердің еңбек нарығына бейімделу деңгейін арттыруға мүмкіндік береді.

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Institutional Governance of University-Business Partnerships in the Context of the Digital Economy: the Experience of Chinese Business Schools

Abstract. The rapid development of the digital economy has intensified the need to reconsider the mechanisms of interaction between higher education institutions and the corporate sector. Artificial intelligence, Big Data, digital platforms, and automation technologies are transforming the structure of professional competencies in the labor market, requiring universities to train specialists adapted to the modern digital environment. Under these conditions, the issue of effective institutional governance of university-business partnerships has become particularly

relevant. The purpose of this article is to analyze institutional governance models of university-business integration based on the experience of leading Chinese business schools and to identify the factors determining their effectiveness. Research methods included comparative case analysis, content analysis, and weighted index assessment. The study examined CEIBS, Guanghua School of Management, and Nanjing University Business School. To assess the level of institutional integration, indicators such as industrial advisory boards, KPI systems, the share of corporate modules, long-term agreements, and joint research centers were used. The findings demonstrate that the effectiveness of university-business partnerships is directly related to the systematic implementation of institutional governance mechanisms. According to the institutional integration index, the highest score was identified at Guanghua School of Management (0.94), while CEIBS demonstrated a score of 0.915. The scientific novelty of the study lies in the development of an institutional integration index for evaluating university-business interaction and in identifying the main institutional integration models within Chinese business schools. The research findings may be applied to the strategic development of university-business partnerships in Kazakhstan's higher education system.

Keywords: digital economy, university-business integration, institutional governance, business education, KPI, Triple Helix, digital transformation.

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Институциональное управление университетско-бизнес партнерством в условиях цифровой экономики: опыт китайских бизнес-школ

Аннотация. Стремительное развитие цифровой экономики усилило необходимость пересмотра механизмов взаимодействия между системой высшего образования и корпоративным сектором. Искусственный интеллект, Big Data, цифровые платформы и технологии автоматизации изменяют структуру профессиональных компетенций на рынке труда, что требует от университетов подготовки специалистов, адаптированных к современным условиям цифровой среды. В этих условиях особую актуальность приобретает проблема эффективного институционального управления университетско-бизнес партнерством.

Цель статьи – анализ моделей институционального управления университетско-бизнес интеграцией на основе опыта ведущих бизнес-школ Китая и выявление факторов их эффективности. Методы исследования – в ходе исследования использовались методы сравнительного кейс-анализа, контент-анализа и взвешенной индексной оценки. В качестве объектов исследования были рассмотрены CEIBS, Guanghua School of Management и Nanjing University Business School. Для оценки уровня институциональной интеграции использовались такие индикаторы, как деятельность индустриальных советов, система KPI, доля корпоративных модулей, долгосрочные соглашения и совместные исследовательские центры.

Результаты исследования показали, что эффективность университетско-бизнес партнерства напрямую связана с системным внедрением механизмов институционального управления. Согласно индексу институциональной интеграции, наивысший показатель был выявлен у Guanghua School of Management (0,94), тогда как у CEIBS данный показатель составил 0,915. Научная новизна исследования заключается в разработке индекса институциональной интеграции для оценки университетско-бизнес взаимодействия и определении основных институциональных моделей интеграции в китайских бизнес-школах. Результаты исследования могут быть использованы для стратегического развития университетско-бизнес партнерства в системе высшего образования Казахстана.

Ключевые слова: цифровая экономика, университетско-бизнес интеграция, институциональное управление, бизнес-образование, KPI, Triple Helix, цифровая трансформация.

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GLOBAL GREEN BONDS: REGIONAL TRENDS AND DEVELOPMENT PROSPECTS FOR KAZAKHSTAN

Abstract. This article examines global and regional trends in the development of the green bond market and assesses the prospects for its expansion in emerging economies, such as Republic of Kazakhstan. The study analyzes the evolution of green bonds across main financial regions, including the United States and Canada, the European Union, Asian markets and Central Asia, their differences in regulatory frameworks, issuer structures and investor participation.

Especially, attention is given to the role of governments, international financial institutions and corporate issuers in promoting climate-oriented investment and integrating ESG principles into financial decision-making. Using international statistics, analytical reports and case studies, the article evaluates the effectiveness of green bonds as a tool for financing renewable energy, infrastructure and environmental projects. The research also identifies barriers faced by developing markets, such as limited diversification, reporting challenges and regulatory gaps. Based on Kazakhstan's experience, the article outlines institutional and policy measures that could strengthen the national green finance ecosystem and enhance its contribution to sustainable economic growth.

Keywords: green bonds, sustainable finance, bond market, climate investment, global trends.

Introduction. Climate change, biodiversity loss, droughts, floods and other environmental disasters significantly affect the global economic development. These challenges influence not only the protection strategies of organizations such as Greenpeace and the World Wildlife Fund, but also the priorities and responsibilities of financial institutions which are interested into strengthening long-term competitiveness and connecting capital flows with sustainability goals. As a result, countries are actively searching for financing tools capable of supporting a transition to a low-carbon and strong climate economy.

One of the most popular instruments that emerged as a solution to these pressures is a green bond, introduced to inject capital in environmental and climate-oriented projects. This financial tool is meaningful for developing countries, including Kazakhstan, where environmental problems such as water scarcity and high carbon emissions create serious risks for sustainable economic growth.

A recent example of a global cooperation in green finance is the State of California's investment in World Bank green bonds. It has demonstrated how collaboration between national governments and international organizations reach sustainable financing projects [1]. According to Statista, the USA maintains a leading position in global issuance volumes, achieving record levels in recent years [2]. These cases show the development of green finance from a micro segment into a well-known opportunity not only to increase the capital of a company, but also fund vital government and corporate needs.

The goal of this article is to explore global development trends and regional characteristics of the green bond market and to identify institutional and development opportunities for emerging countries as Kazakhstan. This article uses literature, reports and other sources to analyze green bonds market worldwide.

Methodology. This study employs a qualitative analytical methodology based on the examination of international statistical databases, reports of global financial institutions (World Bank, ICMA, AIFC), analytical publications of consulting and financial organizations (Statista, HSBC), and peer-reviewed academic journals. A comparative regional analysis is applied to assess differences in regulatory frameworks, issuer structures, and market dynamics across developed and emerging economies. In addition, case study analysis is used to evaluate Kazakhstan's green bond market and its alignment with international sustainable finance standards.

Results and Discussion. The graph below illustrates high growth in annual green bond issuance over the past decade, especially it is seen during the COVID-19 pandemic years, when green bonds were used to finance renewable energy, infrastructure and transportation. It also shows that green bonds remain the most dominant type among different sustainable financial instruments.

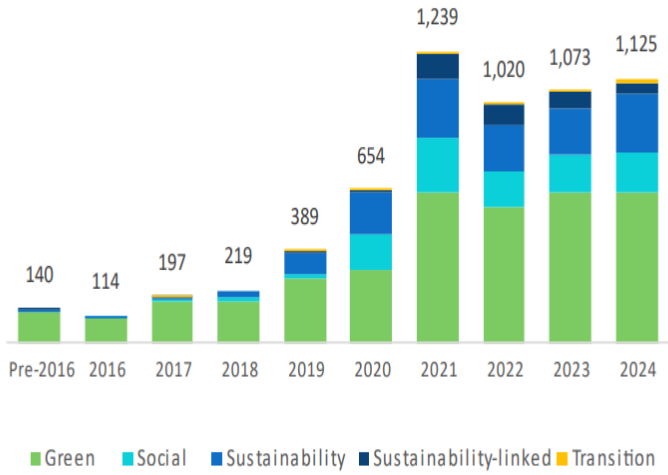


Figure 1. Global labeled sustainable bond annual issuance, USD bn

Note – compiled by the authors based on the source [3]

The World Bank notes increased participation of institutional public investors such as sovereign funds and pension systems [1]. According to Statista data the U.S. market as the global leader aims to diversification of issuers: from municipal authorities to large corporations [2]. It indicates that issuers of green bonds aren't necessarily companies who are based on ESG compliance, but also any institutions which want to improve infrastructure or ecology of a country.

In Europe, as written in the Economic Development and Research Journal, market growth is led by strict legislation, taxonomies and transparent investor reporting standards [4]. In contrast, many developing economies including Kazakhstan face barriers such as low awareness, weak supervision and reporting system.

At the same time, Asia also demonstrates strong growth. According to HSBC, countries such as China, Singapore and Philippines are expanding issuance of green bonds because of policy incentives and rising institutional demand [5]. However, the lack of global standards still minimizes foreign investment in Asian markets. In addition, Springer Open highlights that the effectiveness and efficiency of green bonds depends not only on issuance volume but also on the quality of reporting and disclosure standards, meaning government can increase demand and transparency of green bonds by providing companies with tax or regulatory incentives [6].

A comparison of regional cases indicates some development models: Europe builds on unified legislation and taxonomies, the United States focuses on the diversity of issuers and Asia relies on strong government support.

The vital characteristic of the green bond market is the integration of ESG requirement into financial decision-making. According to ICMA, green bonds are use-of-proceeds instruments, where funds must be directed to environmentally beneficial projects. Two international verification and reporting practices are ICMA Green Bond Principles and the Climate Bonds Standard (CBS) issued by the CBI [3]. They help to prevent greenwashing strengthening investor confidence and trust.

Kazakhstan and other Central Asian countries are step by step integrating these standards. The AIFC Green Finance Centre runs as a regional controller, ensuring compliance with international standards.

Since 2020, the AIFC has played a central role in the development of sustainable economy of Kazakhstan. The AIFC Green Finance Centre recently published the Comprehensive Casebook on Sustainable Financial Instruments, in which 18 flagship projects with a total value exceeding 650 million USD are listed. These tools have been used to fund sectors from renewable energy and climate change resolving to gender equality and directing to the Sustainable Development Goals (SDGs) [7].

According to the most recent data, Kazakhstan's green finance market has reached 150.2 billion KZT in volume since its listing on the local market. Within that total, the largest issuance year was 2021, when approximately 80.8 billion KZT worth of green instruments were placed to finance infrastructure projects as transportation, medicine and energy [8].

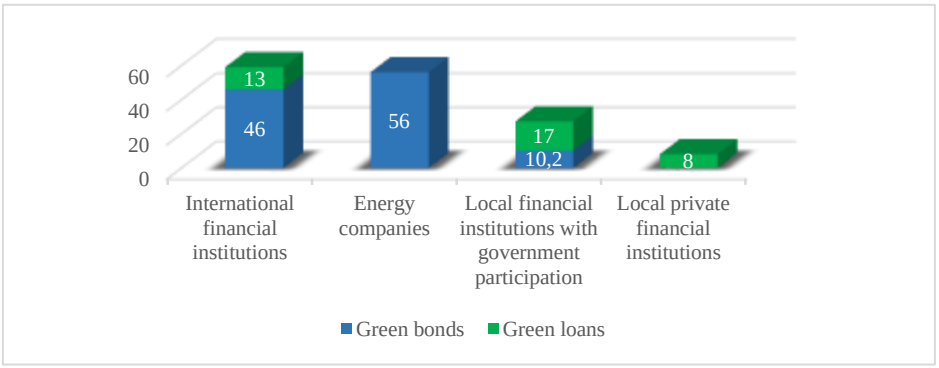


Figure 2. Issuance of green bonds and green loans by issuer type (KZT billion), the end of October 2023

Note – compiled by the authors based on the source [9]

On the graph implemented green financial tools are displayed. It shows that most of the issuers on the Kazakhstani market of green bonds are Energy companies and International financial institutions. It means that there is a lack of diversification among green securities and low potential of financing massive ESG programs.

A significant event happened at the end of 2023: the Development Bank of Kazakhstan (DBK) placed green bonds on the Astana International Exchange (AIX) with an amount of 15 million USD. The demand after that exceeded supply by 22.3% (oversubscription was 122.7%) [8]. Bonds were also issued under the CBI certification which is a practical example of implementation of international quality standards [10].

In Kazakhstan not only government entities, but also corporate issuers are also taking a participance in green finance: Online KazFinance issued Kazakhstan's first corporate gender bonds worth 20 billion tenge, KazWind Energy became the first issuer of subsidized green bonds in Kazakhstan, placing 3 billion tenge to construct a 48-megawatt wind power plant in the Kostanay Region [7].

To strengthen diversity, the Unified Accumulative Pension Fund could increase liquidity and reduce borrowing costs if part of its portfolio were allocated to green investments as in the California's example pension funds acted as major investors.

Despite the expansion, developing markets still face challenges. Many of them relate to simplicity of capital markets, currency risks, and lack of certification. Springer Open notes that bad quality of reporting can lead to higher yields as a cause of credibility concerns [6].

In Kazakhstan, further development requires improving taxonomy, strengthening investor protection and ensuring transparent regulation. Many developing countries also may face weak declaration practices and slight awareness.

Local governments in Kazakhstan could also expand green bonds market and spend accumulated budget for electrifying transport, improving water conditions as well as heating systems and reducing air pollution.

Kazakhstan can also work on regulatory frameworks and legislation to rise the institutional demand by taxation incentives. Cooperation with international organizations as World Bank, ADB, EBRD will also be helpful for ensuring verification and performance monitoring. Green bonds can distribute international and domestic investment to support innovation and lead to the climate-stable economy.

Conclusion. The findings of this study confirm that green bonds have become a significant instrument within the global financial system, supporting the transition toward sustainable and climate-resilient economic development. Regional analysis demonstrates that different models of green bond market development coexist worldwide: the European Union emphasizes regulatory harmonization and transparency, the United States focuses on issuer diversification and market depth, while Asian economies rely heavily on government-driven incentives and policy support. These approaches highlight that successful market expansion depends not only on issuance volumes, but also on institutional quality, reporting standards, and investor confidence.

For emerging economies such as Kazakhstan, green bonds represent both an opportunity and a challenge. Although the national market has shown notable progress through the activities of the AIFC and participation of international financial institutions, it remains characterized by limited issuer diversification and relatively low private sector involvement. Strengthening regulatory frameworks, improving disclosure standards, and expanding the role of institutional investors could significantly enhance market depth and credibility. Overall, the development of a robust green bond ecosystem in Kazakhstan can contribute to mobilizing long-term capital, supporting environmental projects, and advancing sustainable economic growth in line with global ESG priorities.

In conclusion, the global green bond market has become essential part of the securities system in each country. Implementation models are different worldwide: Europe leads in regulation and transparency, the USA in issuer diversity and Asia in government policies. Emerging markets, including Kazakhstan, are expected to continue increasing their involvement as the country finds their own way how to manage green bonds. Then it will become one of the dominant tools as in other countries where investors, issuers and government are united by one goal – sustainability of economy.

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Жаһандық жасыл облигациялар: аймақтық үрдістері және Қазақстанда даму болашағы

Түйіндеме. Бұл мақалада «жасыл» облигациялар нарығының жаһандық және өңірлік даму тенденциялары қарастырылады және оның Қазақстан Республикасы сияқты дамушы экономикасы бар елдерде кеңею бағыттары бағаланады. Зерттеу АҚШ пен Канада, Еуропалық Одақ, Азия нарықтары және Орталық Азия сияқты негізгі қаржы аймақтарындағы "жасыл" облигациялардың эволюциясын, олардың нормативтік базадағы, эмитенттердің құрылымындағы және инвесторлардың қатысуындағы айырмашылықтарын талдайды.

Үкіметтердің, халықаралық қаржы институттарының және корпоративтік эмитенттердің климатқа бағытталған Инвестицияларды ілгерілетудегі және ESG қағидаттарын қаржылық шешімдер қабылдау процесіне біріктірудегі рөліне ерекше назар аударылады. Халықаралық статистиканы, аналитикалық есептерді және жағдайлық зерттеулерді

пайдалана отырып, мақалада жаңартылатын энергетика, инфрақұрылым және қоршаған ортаны қорғау саласындағы жобаларды қаржыландыру құралы ретінде «жасыл» облигациялардың тиімділігі бағаланады.

Зерттеу сонымен қатар дамушы нарықтарда кездесетін кедергілерді анықтайды, атап айтқанда, шектеулі әртараптандыру, есеп беру мәселелері және реттеудегі олқылықтар. Қазақстанның тәжірибесі негізінде мақалада «жасыл» қаржыландырудың ұлттық экожүйесін нығайта алатын және оның орнықты экономикалық өсуге қосқан үлесін арттыра алатын институционалдық және саяси шаралар сипатталған.

Түйінді сөздер: «жасыл» облигациялар, тұрақты қаржыландыру, облигациялар нарығы, климаттық инвестициялар, жаһандық тенденциялар.

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Глобальные зеленые облигации: региональные тенденции и перспективы развития для Казахстана

Аннотация. В данной статье рассматриваются глобальные и региональные тенденции развития рынка «зеленых» облигаций и оцениваются перспективы его расширения в странах с развивающейся экономикой, таких как Республика Казахстан. В исследовании анализируется эволюция «зеленых» облигаций в основных финансовых регионах, включая США и Канаду, Европейский союз, азиатские рынки и Центральную Азию, их различия в нормативной базе, структуре эмитентов и участии инвесторов.

Особое внимание уделяется роли правительств, международных финансовых институтов и корпоративных эмитентов в продвижении инвестиций, ориентированных на климат, и интеграции принципов ESG в процесс принятия финансовых решений. Используя международную статистику, аналитические отчеты и тематические исследования, в статье оценивается эффективность «зеленых» облигаций как инструмента финансирования проектов в области возобновляемой энергетики, инфраструктуры и охраны окружающей среды.

В исследовании также выявляются барьеры, с которыми сталкиваются развивающиеся рынки, такие как ограниченная диверсификация, проблемы с отчетностью и пробелы в регулировании. На основе опыта Казахстана в статье описываются институциональные и политические меры, которые могли бы укрепить национальную экосистему «зеленого» финансирования и повысить ее вклад в устойчивый экономический рост.

Ключевые слова: «зеленые» облигации, устойчивое финансирование, рынок облигаций, климатические инвестиции, глобальные тенденции.

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HR ANALYTICS AS A DRIVER OF ECONOMIC AND ORGANIZATIONAL EFFICIENCY: THE ROLE OF SMART HR PRACTICES

Abstract. This article examines the impact of HR analytics helping companies become more efficient with organizational and cost-effectiveness of companies through the introduction of modern digital and intelligent HR management techniques. The research is relevant in the context of the digital transformation of human resource management and the growing importance of analytical data in making managerial decisions. These solutions are aimed at increasing labor productivity, optimizing personnel costs, and making effective use of human capital. The purpose of the study is to determine the role of HR analytics in improving the organizational and economic efficiency of a company through the development of intelligent HR management practices. The paper uses a comparative analysis method to identify differences in the use of HR analytics and digital HR tools in organizations in Kazakhstan and China. The study demonstrated that increased use of employee data analysis and digital HR management tools makes HR management processes more transparent, and employee performance assessment more objective. This, in turn, contributes to improving the quality of management decisions and increasing employee engagement in the workflow. From an economic point of view, the use of HR analytics creates conditions for optimizing personnel costs, more efficient allocation of labor resources, reducing losses associated with inefficient recruitment and use of personnel, as well as increasing the return on investment in human capital. The main conclusion is that HR analytics becomes the most practical and cost-effective when analytical tools are combined with intelligent HR practices and used to make managerial decisions based on real data. Such a strategy helps organizations to improve control over employees, optimize the use of their potential, increase the effectiveness of the company's work and create the foundation for long-term success in the market.

Keywords: HR analysis, HR management, digital HR technologies, organizational efficiency, economic efficiency, human capital, labor productivity.

Introduction. In the era of digital transformation and intensifying competition, human capital is emerging as a crucial element in the growth of

businesses. Consequently, there is a growing focus on exploring and implementing HR analytics, which involves using data to make informed decisions about employees, their abilities, performance, and motivation.

Today, organizations are gradually transitioning from traditional administrative personnel management to intelligent or “smart” HR practices that leverage digital technologies, artificial intelligence, and analytical tools. These approaches enable the identification of trends in managerial leadership, the prediction of changes in skills, and the optimization of processes related to hiring, training, and development, ultimately enhancing the overall performance of the organization[1].

The importance of this research is due to the growing importance of HR analytics and intelligent HR practices in ensuring the economic and organizational effectiveness of companies.

In the context of digital transformation, the use of analytical tools makes it possible to make informed personnel decisions based on data, plan staff needs more accurately, optimize recruitment and training costs, and use human capital more effectively.

At the same time, the economic effect of HR analytics is manifested not only in improving individual HR processes, but also in its ability to increase productivity, reduce personnel losses, and align HR policy with the strategic goals of the organization.. The research is of great importance for an organization, as it helps to understand how analytical data can be used to develop intelligent HR practices that improve the quality of management decisions, develop employee skills, and optimize organizational processes.

This study allows us to consider HR analytics not only as a tool for personnel management, but also as an important element in the formation of an effective and sustainable human capital management system from an economic point of view.

Despite the rapid advancement in this area, there are still numerous challenges regarding the implementation of international analytical tools in the HR management system. This issue is further compounded by a lack of understanding of how analytics can be transformed into specific “smart” HR practices that impact the company's performance[2].

In the process of researching the activities of the analytical staff and its staff, various aspects were analyzed. New approaches to the study of evidence-based HR management and the digitalization of HR processes have been proposed in foreign scientific literature.

Research conducted by M.Milhem, demonstrates that the use of analytical tools makes it possible to more accurately predict personnel needs, identify gaps in competencies, and improve the effectiveness of training and recruitment[3].

Modern research also highlights that HR analytics represents a key difference between traditional approaches to HR management and the so-called HRM 4.0[4]. This technology helps organizations expand their capabilities and increase competitiveness.

Kazakhstani researchers, Bekisheva A. et al.[5], Berdykulova G. et al.[6] consider HR analytics as a way to make money management more efficient, optimize HR processes and, as a result, improve the work of organizations. An article by S. McCartney and N. Fu was published in Management Decision

magazine, which is of great importance for understanding the economic aspect of HR analytics[7].

The authors of the article conducted an empirical study involving 155 organizations in Ireland. They studied how HR technologies, HR analytics, data-driven management, and organizational effectiveness relate to each other.

Structural modeling has shown that HR analytics helps improve organizational efficiency by improving the quality of data-driven management decisions. This allows us to consider HR analytics as a tool that helps to allocate human resources more effectively and increase the effectiveness of the organization.

The work of M. Hossein, U. Urme and M. A. U. Haq examines the economic importance of HR analytics[8]. The study focuses on the relationship between analytical capabilities, the integration of HR and financial functions, as well as their impact on the financial results of the organization.

The authors emphasize that the value of HR analytics is determined not only by the availability of digital tools, but also by the ability to integrate HR data with financial planning and make decisions based on data.

The study revealed that all three factors under consideration – HR's analytical capabilities, integration of HR and financial functions, and data-based decision-making – are statistically significantly associated with a contribution to financial performance. This confirms that HR analytics can be an effective tool for converting information about human capital into economic results.

These studies show that the transition to intelligent HR practices allows companies not only to increase productivity, but also to create an innovative and flexible organizational environment. Thus, the study of scientific literature allows us to conclude that HR analytics is becoming an increasingly important tool in human resource management.

Research shows that the use of analytical methods allows companies to predict personnel needs, identify gaps in employee competencies, improve recruitment and training processes, and improve the quality of management decisions.

The economic value of HR analytics lies in the efficient use of human resources, increased productivity, and alignment of HR policy with the financial goals of the organization.

Most of the research focuses on either the technical aspects of HR analytics or individual HR processes. At the same time, a comprehensive analysis of the impact of medical analysts and staff on the effectiveness of an organization through a system of “smart” HR practices remains insufficiently studied

The purpose of the study is to explore how HR analytics and intelligent HR practices affect the economic and organizational effectiveness of a company, to develop recommendations for improving their application in human capital management.

To achieve this goal, it is necessary to solve the following tasks:

– To conduct a theoretical analysis of scientific concepts devoted to HR analytics and intelligent HR practices. It is necessary to determine their essence, key functions and importance in improving the economic and organizational efficiency of enterprises.

– To delve into the intricacies of implementing human resources analytics and intelligent human resource practices within organizations

operating in Kazakhstan and China, with the aim of ascertaining their influence on the efficacy of HR processes, the caliber of managerial decisions, and the economic viability of leveraging human capital.

– Identify indicators that can serve as a basis for assessing the economic and organizational effectiveness of using HR analytics.

– To develop recommendations for improving HR analytics and intelligent HR practices aimed at improving economic efficiency and organizational efficiency of enterprises.

The scientific novelty of the study is the study of the integration model, which explains how the analysis of employee data helps to increase the efficiency of the company using modern HR methods. The paper also clarifies the role of analytics as an additional tool for changing the personnel management system.

The theoretical significance of the research lies in the expansion of scientific knowledge about the relationship between employee data analysis, digital HR technologies and company efficiency. The practical significance of the research lies in the fact that its results can be used by managers and HR specialists in the development of HR management strategies and the implementation of analytical tools in HR processes.

Based on the above, the following question should be formulated for further research: How does personnel analysis affect the company's performance through the application and improvement of best practices for working with personnel?

Materials and methods.

The research uses a comparison method that helps determine how effective organizations are, depending on how actively they use analytical tools and best HR practices. This method is widely used in research on personnel management, as it allows you to compare different approaches to the organization of work and identify the factors that influence the success of companies.

This study provides a comparative analysis of companies that actively use HR analytics, and those where such tools are used to a lesser extent or not at all.

For comparison, key performance indicators of the company are used, such as employee productivity, staff turnover, staff efficiency, and the effectiveness of HR processes (recruitment, training, and employee service). This allows us to draw conclusions about how effectively analytical tools and data-based HR practices are used to ensure the success of the company.

The research examined the application of HR analytics and intelligent HR approaches in outsourcing accounting firms in Kazakhstan and China. The study involved 32 participants, with 16 from each company. To ensure a fair comparison, an equal number of participants was selected from each organization.

The increased sample allowed the study to cover a wider range of employee opinions regarding the use of HR analytics, digital HR platforms, performance assessment, and organizational effectiveness. However, the sample is still limited to a few specific companies, so the results are considered in the context of the organizations under study and cannot be extrapolated to the entire accounting outsourcing sector in Kazakhstan and China.

The collected data was systematized and analyzed to determine the specifics of the use of personnel analytics and its impact on the effectiveness of HR processes in organizations in the two countries.

The comparative method allows us to identify differences in the use of personnel analytics and best HR practices, as well as identify key factors that can improve the effectiveness of the organization using analytical HR management tools. This helps to better understand the role of analytical staff in management and its importance for improving the effectiveness of the organization.

Results and discussions.

The study compared the use of HR analysts and advanced HR specialists in outsourcing accounting companies in Kazakhstan and China.

To collect the data, a survey was conducted among employees of two companies. 32 people took part in the survey: 16 employees from each company.

The survey included questions aimed at identifying the level of use of personnel analytics, monitoring the work of HR specialists, as well as analyzing data processing tools, work efficiency, transparency, and organizational processes.

The survey was conducted in a remote format using a structured questionnaire. The study assessed such aspects as the level of analytical skills of employees, the use of digital tools in the work of HR specialists, transparency of management processes and analysis of personnel activities.

A five-point Likert scale was used to evaluate the respondents' responses, which is widely used in research related to personnel management and organizational behavior. Respondents were asked to express their agreement with the proposed statements on a scale from 1 to 5 (table 1).

Table 1 – A five-point Likert scale

Mark	Answers
1	Strongly disagree
2	Disagree
3	Neither agree nor disagree
4	Agree
5	Strongly agree
Sources: compiled by author based on Likert scale	

The questionnaire contains several key statements that reflect various aspects of the use of HR analytics and modern HR practices(table 2):

1. Analytical data is regularly applied in the company's personnel decision-making process.
2. Managers actively use modern HR systems for personnel management and personnel performance monitoring.
3. HR analytics is used at all stages of working with employees: from recruitment to evaluation and distribution.
4. Thanks to HR analytics, the criteria for evaluating employee performance are becoming clearer and more transparent.
5. The use of digital HR tools and analytical data helps to increase the efficiency of the company.

Table 2 – Matching the questionnaire's indicators with the scope of the study

№	Indicator Measures	Significance in the study
1	Use of HR analytics in decision-making	HR analytics
2	Use of digital HR systems	Smart HR practices
3	Application of analytics in HR processes	HR analytics and smart HR practices
4	Transparency and objectivity of performance evaluation	Quality of HR management
5	Impact of digital HR tools on organizational efficiency	Economic and organizational efficiency
Sources: compiled by the author		

The choice of statements presented in the questionnaire is based on the need for a comprehensive assessment of the impact of HR analytics on modern HR management methods and organizational effectiveness.

The first statement was included to determine the level of actual integration of HR analytics into the management decision – making process. This indicator allows you to determine to what extent personnel decisions are based on structured data, and not just on the personal judgments of managers. A higher score on this indicator indicates a more pronounced orientation of the organization towards data-driven personnel management.

The second statement reflects the application of technology in the field of personnel management. This allows us to assess how well digital tools are integrated into daily work with human resources.

The use of digital HR systems makes it possible to collect, process and analyze information about employees faster, which creates the basis for the application of analytical methods in personnel management.

The third thesis is aimed at assessing how analytical tools are applied in practice in key HR processes. This indicator allows you to understand whether the use of HR analytics is limited to the general analysis of personnel information or whether it is used in specific processes related to hiring, performance evaluation and allocation of human resources. Thus, it demonstrates how deeply the analytical approach is embedded in the personnel management system.

The fourth statement says that the use of HR analytics makes the criteria for evaluating the work of employees clearer and more understandable. This statement describes the organizational and behavioral effects of using analytical tools.

Understanding the evaluation criteria is important for employees so that they can see how fair the performance management system is. The inclusion of this statement allows us to consider HR analytics not only as a technical tool, but also as a way to make management procedures more transparent and predictable.

The fifth statement is directly related to the dependent variable of the study, organizational effectiveness.

The purpose of this statement is to determine whether employees consider the use of digital HR tools and analytics to be a factor that helps improve the

company's work processes and overall efficiency. This indicator allows you to link the application of HR analytics and smart HR practices with the expected result for the organization.

The survey results of 32 employees, 16 people from each company, showed differences in the perception of the level of use of HR analytics and digital HR practices. Overall, the scores of Chinese respondents were higher on all five indicators. This suggests that the employees of the Chinese company more clearly feel the integration of analytical and digital tools into the personnel management system (table 3).

Table 3 – Results of the employee survey (Likert scale)

Indicator	Kazakhstan (16 respondents, average score)	China (16 respondents, average score)
Use of people analytics in HR decision-making	3.7	4.3
Use of digital HR systems	3.4	4.4
Application of analytics in recruitment and employee evaluation	3.6	4.2
Understanding of performance evaluation criteria	3.8	4.5
Impact of HR analytics on work efficiency	4.0	4.6
Sources: compiled by author		

The study demonstrates that the level of use of analytical tools and digital HR technologies in a Chinese company is significantly higher than in a Kazakh organization.

The survey results revealed differences between Kazakhstan and China in the level of integration of HR analytics and best HR management practices into the organization's management process.

The first indicator, which assessed the use of analytical data in personnel decision-making, showed an average score of 3.7 in Kazakhstan and 4.3 in China. These relatively high rates in both countries indicate that analytical information is already being actively used in personnel-related decision-making.

However, a higher score in China indicates that employees perceive the use of personnel data as a more established and structured element of managerial decision-making.

The second indicator, related to the use of digital HR systems by management personnel, shows a more significant difference between the two groups: 3.4 points in Kazakhstan and 4.4 points in China. These data indicate that digital HR technologies have become more widespread and integrated into HR management practices in Chinese companies. A lower indicator in Kazakhstan indicates that, despite the possible use of digital HR systems, their implementation in HR management processes may be less extensive.

The third criterion evaluates the use of analytical tools in the recruitment and evaluation process. An average score of 3.6 in Kazakhstan indicates that analytics is used in these areas to a moderate extent, while 4.2 points in China indicate a more active and systematic use of analytical methods.

This difference indicates that in China, analytical approaches are more explicitly integrated into the processes of selecting and evaluating employee performance, while in Kazakhstan these methods are just beginning to be applied and are not yet perceived as generally accepted practices.

The fourth criterion concerns the level of awareness of employees about performance evaluation criteria. Kazakhstan received a score of 3.8, while China — 4.5. These relatively high rates in both countries indicate a generally positive attitude towards the transparency of the assessment system. However, a higher score in China may indicate that performance criteria are perceived there as more clearly defined and communicated to all stakeholders. This is important because clear evaluation systems can help employees better understand the organization's goals and manage performance more consistently.

The fifth indicator, which is designed to assess the expected impact of digital HR management and analytics tools on the organization's performance, was highly appreciated by the study participants in both countries: 4.0 in Kazakhstan and 4.6 in China.

From an economic point of view, the results of the study show that there is a difference in how HR analytics is perceived as a tool for improving the efficiency of using human resources.

In Kazakhstan, the average assessment of the impact of HR analytics on the company's performance was 4.0 points, and in China – 4.6 points. The difference of 0.6 points indicates that the respondents from the Chinese company rate the economic importance of digital tools in the field of HR more highly.

This may be due to the fact that in a Chinese company HR analytics is more actively used in the processes of personnel planning, performance assessment and management decision-making.

However, these data should not be considered as direct evidence of a real improvement in economic indicators. They only reflect the subjective opinion of the respondents and rather talk about how HR analytics can help improve productivity, optimize staff costs, reduce staff turnover losses, and plan employee needs more accurately.

A higher assessment of a Chinese company may indicate that there the link between HR analytical practices and the organization's performance is perceived to be more explicit and fixed at the organizational level.

Therefore, HR analytics can become a tool for increasing economic efficiency. It can affect the quality of recruitment, the optimization of the use of human resources and the effectiveness of HR processes.

However, to confirm this assumption, it is necessary to analyze objective indicators. Among them are labor productivity, the cost of recruiting and training employees, the level of staff turnover, the time required to fill vacancies, and the total cost of HR functions.

A comparison of the approaches used in Kazakhstan and China reveals differences in data-based decision-making, in the use of digital personnel management systems, in analytical recruitment and performance assessment, as well as in assessing the potential impact of these practices on the effectiveness of the organization.

The study demonstrates that the effectiveness of HR analytics is due not only to the availability of digital technologies, but also to their integration into

the daily practice of personnel management. The results help us realize how intelligent HR management methods can enhance the practical value of HR analytics and contribute to more transparent, data-driven, and effective human resource management.

Based on the results of the study, several recommendations are proposed to enhance the role of human resource analytics and rational methods of personnel management in improving economic and organizational efficiency.

First, organizations should implement an integrated HR analytics system that links personnel data to key business performance indicators. This system should go beyond traditional descriptive reports on indicators such as headcount, staff turnover and absenteeism, and include predictive and prescriptive analysis. The system should include indicators such as productivity, labor costs, employee engagement, training costs, and income per employee so that HR professionals and senior managers can understand the impact of human capital-related decisions on the organization's performance.

Secondly, organizations should conduct an economic assessment of personnel decisions. Every significant HR management initiative, such as recruitment, employee training, retention programs, digital HR management systems, and professional development, should be evaluated in terms of their economic impact. Key indicators may include return on investment (ROI), cost of hiring, cost of staff turnover, revenue per employee, cost-effectiveness of training, labor productivity, and payback period for investments in personnel management technologies.

This approach would transform the HR department from an administrative function into a strategic success factor for the organization.

Third, organizations should consider implementing predictive HR analytics to monitor staff turnover and plan for future workforce needs. Using artificial intelligence and machine learning, it is possible to identify employees or groups of employees who are at higher risk of leaving the organization, as well as predict future personnel needs and potential skill gaps. Such early identification of potential risks can help reduce recruitment and retention costs, preserve institutional knowledge, and increase workforce stability.

Fourthly, rational methods of personnel management should be integrated with the continuous development of employees. Human resource analytics should be used to identify skill gaps and determine which training programs lead to tangible improvements in employee performance and productivity. Organizations should develop customized training programs based on employee skills, performance indicators, career goals, and organizational requirements. The success of training should be measured not only by the level of attendance, but also by increased productivity, performance, employee retention, and financial results.

Fifth, organizations should implement data-driven approaches to talent management and internal mobility. Human resource analytics can be used to identify people with high potential, evaluate competence profiles, predict management requirements, and select suitable positions or development opportunities. Increased internal mobility can reduce the costs associated with recruiting external staff, while maintaining organizational knowledge and increasing employee commitment.

Sixth, organizations should create HR dashboards to monitor staff performance in real time. An intelligent HR dashboard should combine HR and economic indicators, including headcount, staff turnover, absenteeism, labor costs, productivity, training costs, employee performance, engagement, and income per employee. Managers will be able to track deviations from the target values and take timely corrective measures.

Seventh, organizations should consider automating routine human resources management processes. This includes staff selection, adaptation, attendance management, employee request management, performance monitoring, training organization, and HR reporting. These processes can be partially automated using personnel management information systems, robotic process automation, and artificial intelligence tools. Automation can reduce the administrative workload, processing time, and operational costs of HR professionals, allowing them to focus on more strategic HR tasks.

Eighth, it is important for organizations to improve data quality, ensure confidentiality, and adhere to ethical standards in their HR analytics work. The success of Smart HR initiatives directly depends on the accuracy and reliability of the data used to make decisions about employees. Organizations should implement standardized data collection processes, establish clear access controls, implement data protection measures, and conduct regular data quality checks. In addition, personnel decisions based on artificial intelligence should be reviewed by staff in order to reduce the risks associated with algorithmic bias and improper automation.

Ninth, organizations should develop human resource analysis skills among HR professionals and managers. Effective use of intelligent HR technologies requires employees who are able to interpret data and transform analytical conclusions into managerial decisions. Therefore, HR departments should develop skills in data analysis, statistics, visualization, artificial intelligence, predictive modeling, and financial evaluation of HR initiatives.

Finally, organizations should develop a unified human resource and cost-effectiveness management system. The effectiveness of rational personnel management methods should be assessed using a balanced system of indicators covering three aspects: the results of work with human capital, organizational efficiency and economic efficiency.

Human capital indicators can include employee engagement, retention, competencies, and internal mobility. Organizational indicators may include productivity, absenteeism, and process efficiency. Economic indicators may include labor costs, income per employee, return on investment from HR initiatives, and savings resulting from HR initiatives.

Such an integrated system will allow organizations to demonstrate the direct impact of HR analytics on organizational performance and economic value creation.

Conclusion. The study showed how personnel analytics affects the company's performance through the introduction of advanced HR methods. In an environment where the economy is becoming increasingly digital, the use of analytical tools in human resource management is becoming a key factor in increasing the competitiveness of companies.

These results confirm the importance of studying this topic, as modern companies are increasingly moving towards HR management based on data analysis and the use of digital HR technologies.

The study conducted a comparative analysis of the use of HR analytics in outsourcing accounting companies in Kazakhstan and China. For this purpose, a survey of employees was conducted.

The results showed that increased use of HR analytics makes HR processes more transparent. This helps to better understand how to evaluate employee performance and make more active use of digital tools for personnel management.

It was also found that the systematic use of analytical data in HR solutions has a positive effect on employee engagement and contributes to improving the overall efficiency of the company.

The study examines how HR analytics can contribute to the development of smart HR practices in organizations. A comparative analysis of the use of these tools in companies in the two countries is also carried out.

The paper shows that the use of analytical methods in personnel management can become an important tool for improving the efficiency of an organization and improving HR processes.

The results of the study can be useful for heads of organizations and HR specialists in the development of HR management strategies, the introduction of digital HR platforms and the development of analytical tools in the personnel policy of companies.

The results of the study can serve as a basis for improving HR processes in outsourcing companies and other organizations that seek to improve the effectiveness of personnel management.

In the future, research in this area can be expanded by increasing the number of participants, including companies from other sectors of the economy and countries. Additional methods of quantitative data analysis can also be used.

The development of research in this area will allow us to study in more detail how personnel analysis affects companies' innovation, labor productivity and business sustainability.

Thus, the development of HR analytics and the introduction of smart HR practices can be an important step in improving modern HR management systems and increasing the effectiveness of organizations.

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HR-аналитика экономикалық және ұйымдастырушылық тиімділіктің факторы ретінде: интеллектуалды HR-практикалардың рөлі

Түйіндеме. Бұл мақалада HR аналитикасының әсері қарастырылады компанияларға заманауи цифрларды енгізу арқылы компаниялардың ұйымдастырушылық және экономикалық тиімділігінде тиімдірек болуға көмектеседі және персоналды басқарудың интеллектуалды әдістері. Зерттеу адам ресурстарын басқарудың цифрлық трансформациясы және басқару шешімдерін қабылдау кезінде аналитикалық деректердің өсіп келе жатқан маңыздылығы тұрғысынан маңызды. Бұл шешімдер еңбек өнімділігін арттыруға, персонал шығындарын оңтайландыруға және адами капиталды тиімді пайдалануға бағытталған. Зерттеудің мақсаты – персоналды басқарудың интеллектуалды тәжірибесін дамыту арқылы компанияның ұйымдастырушылық және экономикалық тиімділігін арттырудағы HR аналитикасының рөлін анықтау. Қазақстан мен Қытай ұйымдарында HR-аналитика мен цифрлық HR-құралдарды қолданудағы айырмашылықтарды анықтау үшін салыстырмалы талдау әдісі қолданылды. Зерттеу қызметкерлердің деректерін талдауды және персоналды басқарудың цифрлық құралдарын көбірек пайдалану кадрларды басқару процестерін ашық етуге және қызметкерлердің нәтижелерін бағалауды объективті етуге мүмкіндік беретінін көрсетті. Бұл өз кезегінде басқару шешімдерінің сапасын жақсартуға және қызметкерлердің жұмыс процесіне қатысуын арттыруға ықпал етеді. Экономикалық тұрғыдан алғанда, HR аналитикасын қолдану персоналдың шығындарын оңтайландыруға, Еңбек ресурстарын тиімдірек бөлуге, кадрларды тиімсіз таңдау мен пайдаланумен байланысты шығындарды азайтуға, сондай-ақ адами капиталға салынған инвестициялардың кірістілігін арттыруға жағдай

жасайды. Негізгі қорытынды-аналитикалық құралдар интеллектуалды HR тәжірибелерімен біріктіріліп, нақты деректерге негізделген басқару шешімдерін қабылдау үшін пайдаланылған кезде HR аналитикасы ең практикалық және үнемді болады. Мұндай стратегия ұйымдарға қызметкерлерді бақылауды жақсартуға, олардың әлеуетін пайдалануды оңтайландыруға, компанияның өнімділігін арттыруға және нарықта ұзақ мерзімді табысқа негіз қалауға көмектеседі.

Түйінді сөздер: кадрлық талдау, персоналды басқару, цифрлық кадрлық технологиялар, ұйымдастырушылық тиімділік, экономикалық тиімділік, адами капитал, еңбек өнімділігі.

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HR-аналитика как фактор экономической и организационной эффективности: роль интеллектуальных HR-практик

Аннотация. В этой статье рассматривается влияние HR-аналитика помогает компаниям стать более эффективными с организационной и экономической эффективности компаний за счет внедрения современных цифровых и интеллектуальные методы управления персоналом. Исследование актуально в контексте цифровой трансформации управления человеческими ресурсами и растущего значения аналитических данных при принятии управленческих решений. Эти решения направлены на повышение производительности труда, оптимизацию затрат на персонал и эффективное использование человеческого капитала. Цель исследования – определить роль HR-аналитики в повышении организационной и экономической эффективности компании через развитие интеллектуальных практик управления персоналом. В работе использован метод сравнительного анализа, чтобы выявить различия в применении HR-аналитики и цифровых HR-инструментов в организациях Казахстана и Китая. Исследование продемонстрировало, что более активное использование анализа данных о сотрудниках и цифровых инструментов управления персоналом позволяет сделать процессы управления кадрами более прозрачными, а оценку результатов работы сотрудников – более объективной. Это, в свою очередь, способствует улучшению качества управленческих решений и повышению вовлечённости сотрудников в рабочий процесс. С экономической точки зрения применение HR-аналитики создаёт условия для оптимизации расходов на персонал, более эффективного распределения трудовых ресурсов, снижения потерь, связанных с неэффективным подбором и использованием кадров, а также повышения отдачи от инвестиций в человеческий капитал. Основной вывод заключается в том, что HR-аналитика становится наиболее практичной и экономически выгодной, когда аналитические инструменты объединяются с интеллектуальными HR-практиками и используются для принятия управленческих решений на основе реальных данных. Подобная стратегия помогает организациям улучшить контроль над сотрудниками, оптимизировать применение их потенциала, повысить результативность работы компании и создать фундамент для долгосрочного успеха на рынке.

Ключевые слова: кадровый анализ, управление персоналом, цифровые кадровые технологии, организационная эффективность, экономическая эффективность, человеческий капитал, производительность труда.

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RESEARCH ON THE DEVELOPMENT OF SHAOXING'S TEXTILE ECONOMY UNDER THE DUAL-CIRCULATION PATTERN

Abstract. Against the backdrop of global industrial chain restructuring and domestic industrial transformation, the dualcirculation development strategy guides the highquality upgrading of exportoriented manufacturing. As a key sector linking domestic and global markets, the textile industry bears important livelihood and foreign trade functions. Shaoxing, with its complete textile industrial chain and specialized markets, is a typical textile cluster under this paradigm. This paper adopts SWOT analysis to explore internal strengths, weaknesses and external opportunities and threats of Shaoxing's textile industry. It identifies major bottlenecks including unbalanced industrial structure, simplistic foreign trade structure, insufficient innovation, talent shortage and supplydemand mismatch, trapping the sector at the low end of value chains. Combining domestic demand growth, digital and green transformation, plus opportunities from Regional Comprehensive Economic Partnership（RCEP） and the Belt and Road Initiative, it puts forward targeted paths from industrial upgrading, innovation, business environment and crossborder cooperation. The findings provide references for Shaoxing's textile integration and other traditional manufacturers.

Keywords: New development pattern of dual circulation; Shaoxing textile industry; industrial upgrading; integration of domestic and foreign trade; industrial chain collaboration.

Research Background and Significance

Rising anti globalization trends and trade protectionism have disrupted global supply chains, worsening the external operating environment for China's export oriented manufacturing [1].

Against this backdrop, the dual circulation development pattern has been proposed to drive manufacturing transformation from export dependence to high quality integrated domestic and foreign trade development. As a core pillar export industry, China's textile sector accounted for 12.7% of national merchandise exports in 2025, while domestic consumption upgrading has generated huge market demand for functional, eco-friendly and trend oriented textile products.

Shaoxing is a core hub of China's modern textile industry, boasting a complete closed loop industrial chain. Its printing and dyeing capacity accounts for

40% of the national total, with China Textile City recording an annual transaction volume of over 400 billion yuan [2].

The textile industry contributes 25% of Shaoxing's industrial output and supports 300,000 jobs, serving as a typical regional manufacturing sample connecting domestic and global markets. However, long term reliance on foreign orders and midstream processing has left the industry with structural problems including supply demand mismatch and insufficient innovation. This paper analyzes Shaoxing's textile transformation bottlenecks and proposes targeted development paths, providing practical references for the upgrading of China's traditional textile industry.

Current Development Status of Shaoxing's Textile Industry

After decades of cluster development, Shaoxing has formed a full industrial chain with advancing digital and green transformation and improved open trading platforms. Nevertheless, the industry still fails to fully adapt to dual circulation development requirements with prominent structural imbalances [3].

(1) The industrial structure is ill suited for domestic circulation. Over 90% of local textile enterprises are Small and Medium-sized Enterprises（SME）focusing on homogeneous conventional fabrics for export, while high end functional fabrics for domestic upgraded consumption are in short supply. The industry features typical pass through manufacturing, with local procurement by domestic brands below 25%. From 2022 to 2025, domestic sales only accounted for 31% of industrial output, far below the national average of 46%, leaving huge domestic market potential untapped.

(2) The foreign trade structure is overly concentrated. Europe, America and Southeast Asia occupy 76% of export markets, with insufficient layout in emerging regions and weak risk resistance. Exports rely heavily on general trade and low value added fabrics, while independent brand exports and high end textile products account for less than 12% and 18% respectively. Lack of green certification also restricts exports amid global green trade barriers [4].

(3) Two way international factor allocation is inadequate. In 2025, Shaoxing's textile industry utilized only 860 million US dollars of foreign capital, mainly from small trading enterprises with scarce high end R&D investment. Outbound investment is also low value oriented, with merely 320 million dollars of non-financial overseas investment, limited to basic processing and warehousing rather than core R&D and brand operation.

(4) Layered talent shortages constrain innovation. The industry faces a shortage of 100,000 front line skilled workers, and fewer than 4,000 high end R&D talents. The talent siphon effect of Hangzhou and Shanghai leads to over 45% of local textile graduates leaving, hindering core technological breakthroughs.

Development Opportunities

(1) The super large domestic market hedges foreign trade risks. Booming domestic demand for national trend, outdoor, medical and eco-friendly textiles offsets external market shocks, enabling enterprises to shift export capacity to domestic sales and optimize product structures.

(2) Domestic industrial chain restructuring drives value upgrading. Relying on Yangtze River Delta integration, Shaoxing can integrate Hangzhou's digital economy and Shanghai's design resources, transfer low end manufacturing capacity to central and western China, and focus on high end links such as R&D,

high grade printing and dyeing to strengthen industrial chain resilience.

(3) Digital and green transformation cultivates new growth drivers. Popularization of Artificial Intelligence（AI）inspection, digital printing and Manufacturing Execution System （MES） systems improves production and supply matching efficiency. As a national green printing and dyeing pilot, Shaoxing can seize global green textile market dividends to adapt to both domestic green consumption and international low carbon trade rules.

Core Development Challenges

Shaoxing's textile industry is locked in the mid-tier of global value chains, focusing on midstream processing with insufficient high end product supply and weak local brand cultivation, failing to capture domestic consumption dividends [5]. The single and concentrated foreign trade structure amplifies systemic risks, with segmented domestic and foreign trade systems hindering integrated development. In addition, imperfect industry university research cooperation and severe talent loss restrict independent innovation, making it difficult to support high quality industrial upgrading under the dual circulation pattern.

SWOT analysis of Shaoxing textile economy development under the new development pattern of dual circulation

The foregoing sections analyze Shaoxing's textile economy from its development status, external opportunities and core constraints. To evaluate its strategic positioning within the dual circulation system, this section adopts SWOT analysis to integrate internal and external factors into a unified framework and build a strategic combination matrix, laying methodological support for high quality development strategies.

(1) Analysis framework and applicability SWOT (Strengths, Weaknesses, Opportunities, Threats) is a mainstream structured tool for regional industrial strategy research. It systematically identifies industrial internal conditions and external environment, converting scattered descriptions into comparable judgments for strategy formulation. Internal strengths (S) and weaknesses (W) reflect industrial capacities and deficiencies, while external opportunities (O) and threats (T) represent environmental potentials and constraints. Cross matching these four factors generates four strategic types: SO growth, WO transformation, ST diversification and WT defense. The preceding chapters elaborate Shaoxing textile industry's status, opportunities and challenges. Its current situation and core problems form internal conditions, whereas external opportunities and threats constitute the external environment, jointly supporting SWOT factor identification and matrix construction.

(2) Key elements of SWOT analysis Drawing on the above analysis of Shaoxing textile industry's status, opportunities and dilemmas, internal and external factors for its dual circulation integration are summarized into strengths, weaknesses, opportunities and threats, as presented in Table 1.

From Table 1, Shaoxing's textile sector features solid intrinsic foundations alongside prominent structural bottlenecks. Its complete closed loop industrial chain, world scale professional market, diversified open carriers and preliminary digital green capacity form core strengths for dual-circulation integration. Nevertheless, these strengths cannot be fully converted into competitive benefits due to multiple internal constraints reflected by concrete statistical indicators.

Table 1 – SWOT Analysis of Shaoxing Textile Economy Elements

Dimension	Keyelements	Mainmanifestations
Strength (S)	Complete supporting industrial chain	Full closed-loop textile industrial chain covering fiber-weaving-printing-dyeing-apparel-home textiles; printing-dyeing capacity accounts for 40% of China's total
	Outstanding professional market size	China Textile City, China's largest textile professional market; annual online-offline transaction volume over 400 billion yuan
	The importance of industrial economic status	Textile output accounts for 25% of Shaoxing's total industrial output; around 300 000 employees
	Complete open platform carriers	Equipped with comprehensive bonded zone, China-Europe Railway Express routes, cross-border e-commerce pilot demonstration parks
	Solid foundation of digitalization and greening	Leading firms deployed AI fabric inspection, digital printing and MES; green printing-dyeing pilot zone under construction
Weaknesses (W)	Imbalance in industrial structure	SMEs account for over 90%; severe product homogenization; domestic-sales output 31 % (national average:46 %)
	Single foreign trade structure	76 % exports to Europe, America and Southeast Asia; self-owned-brand exports <12 %; high-end functional-product exports <18 %
	Low level of foreign investment and outbound investment	2025 actual utilized foreign capital: USD 860 million; non-financial outbound direct investment: USD 320 million; concentrated in low-value-added segments
	Structural shortage of talent	Shortage of roughly 100 000 front-line skilled workers; fewer than 4 000 high-level R&D personnel; over 45 % local textile-major graduates outflow
	Insufficient institutional openness and supporting facilities	Cumbersome cross-border administrative procedures; unified industrial data standards absent; imperfect credit system and cross-border dispute-mediation mechanism
Opportunity O)	Domestic super large scale domestic demand expansion	Rising demand for China-Chic apparel, outdoor textiles, medical-health textiles and eco-friendly home textiles
	Collaborative reconstruction of domestic industrial chain	Yangtze River Delta integration gives access to Hangzhou's digital-economy and Shanghai's fashion-design resources; industrial gradient transfer extends domestic value chains
	Opportunities for Digital and Green Transformation	Recycled fiber, low-carbon printing-dyeing and circular textiles gain market importance domestically and globally
	Regional Open System Dividend	RCEP tariff reduction and rules simplification, and broad space for capacity cooperation along the "the Belt and Road"
Threat (T)	Deterioration of external development environment	Anti-globalisation; regionalised and fragmented global supply chains; rising trade protectionism
	Southeast Asian order diversion	Southeast Asian textile industry attracts low-end orders via lower labour costs
	Rising green trade barriers	Europe and America continue to introduce green trade barriers such as carbon tariffs and environmental standards, raising export thresholds
	Regional talent siphon	Digital and fashion industries in Hangzhou and Shanghai draw textile talents away from Shaoxing
The table was compiled by the author		

For instance, domestic sales only account for approximately 31% of total output (well below the national textile average of 46%); export markets remain highly concentrated with 76% of textile products flowing to Europe, America and Southeast Asia; structural talent gaps including 100 000 front line worker shortages and massive graduate brain drain further limit innovation capacity.[5]

Externally, booming domestic consumption, Yangtze River Delta collaborative industrial restructuring and regional institutional dividends create favourable upgrading conditions. Meanwhile, anti-globalisation trends, Southeast Asian order diversion, escalating green trade barriers and inter regional talent siphoning bring tangible risks. Taken together, Shaoxing textile possesses comparative advantages, yet its development is restricted by inherent structural defects. Industrial transformation cannot merely rely on existing resource endowments; it requires targeted strategies to amplify strengths, mitigate weaknesses and convert external risks into developmental opportunities.

3） SWOT Cross Strategy Matrix and Results Interpretation

By cross matching internal strengths and weaknesses with external opportunities and threats, four strategic combinations can be formed: SO growth, WO transformation, ST diversification, and WT defense, as shown in Table 2.

Table 2 – SWOT Strategic Combination Matrix of Shaoxing Textile Economy

Internal factors	Opportunity (O): Domestic demand expansion, industrial chain collaboration, digital and green transformation, regional openness	Threats (T): Deterioration of external environment, diversion from Southeast Asia, green barriers, talent drain
Strength (S)	SO growth strategy: relying on the advantages of the whole industrial chain and professional market, seize the domestic demand expansion and RCEP, the "the Belt and Road" opening dividend, promote the twoway layout of domestic and foreign trade integration, and expand emerging markets	ST Diversification Strategy: Leveraging the advantages of digital greening and open platforms, breaking through the green barriers of Europe and America through green certification and independent brand exports, and diversifying external risks through diversified layouts
Weaknesses(W)	WO Turnaround Strategy: Leveraging the synergy of domestic industrial chains and opportunities for digital green transformation, cultivating local brands, attracting talents, improving institutional supply, and enhancing the adaptability of the supply system to the domestic demand market	WT defensive strategy: optimizing the business environment, strengthening innovation driven and hierarchical talent cultivation, stabilizing the industrial foundation, and alleviating systemic risks such as foreign trade concentration and talent loss
The table was compiled by the author		

According to Table 2, the four types of strategic combinations each have their own focus and are interconnected. The SO growth strategy is based on advantages, seizes opportunities, and points towards the growth direction of "expanding domestic demand and expanding emerging markets". It is the main path for Shaoxing Textile to strengthen its stock and optimize its increment; ST's diversification strategy relies on digital and green capabilities to resolve external barriers, emphasizing the use of green certification and brand exports to en-

hance added value, and diversified layouts to diversify external risks; The WO turnaround strategy is the key to achieving the transformation from "channel manufacturing" to value creation by cultivating local brands, attracting talents, and improving institutional supply to undertake opportunities for domestic demand expansion and industrial chain synergy; The WT defensive strategy relies on optimizing the business environment, strengthening innovation driven and hierarchical talent cultivation, stabilizing the industrial foundation, and preventing systemic risks.

From the perspective of dual circulation, the four types of strategic combinations jointly serve the overall requirement of "domestic circulation as the mainstay and domestic and international dual circulation mutually promoting": SO and WO strategies focus on expanding domestic demand and improving quality based on the domestic circulation, while ST and WT strategies focus on stabilizing the external circulation and preventing external risks. The following countermeasures are based on the strategic matrix of this section implementing the SO and WO strategic orientations through industrial chain collaborative upgrading, digital green transformation, and local brand cultivation, strengthening the WO and WT strategic orientations through innovation driven and hierarchical talent introduction, supporting the WT strategic orientation with institutional openness and business environment optimization, and implementing the SO and ST strategic orientations through differentiated crossborder cooperation, thus forming a highquality development path that corresponds onetoone with the strategic combination.

Among the four orientations derived from the SWOT matrix, the SO growth strategy and WO transformation strategy are set as the primary priorities, while ST diversification and WT defense act as supplementary risk prevention measures. Although Shaoxing owns prominent endowments including a complete industrial chain and large scale professional markets (S), these strengths cannot be fully converted into development benefits given prominent internal weaknesses such as insufficient local brand building and structural talent shortages (W). Therefore, the WO turnaround strategy is essential to remove internal obstacles before capturing external opportunities brought by domestic demand expansion, industrial chain coordination and digital green transition. In the meantime, constrained by limited local capital, R&D investment and human resources, Shaoxing cannot allocate equal resources to all four strategies simultaneously. ST and WT strategies will be implemented as supporting instruments to cope with external threats such as Southeast Asian order diversion, green trade barriers and cross regional talent siphon.

Industrial chain collaborative upgrading and local brand cultivation correspond to SO and WO strategic goals; innovation driven development and multi level talent cultivation address both WO and WT requirements; business environment optimization mainly supports the WT defense strategy; differentiated cross border cooperation realises SO growth and ST diversification objectives. Such one to one logical linkage ensures that proposed measures are not subjective suggestions but concrete outputs generated from the SWOT analytical framework.

Countermeasures for highquality development of Shaoxing textile economy under the new development pattern of dual circulation

1）Promote coordinated industrial chain upgrading, integrate digital tech-

nology with the real economy, and consolidate domestic circulation

First, optimize industrial chain gradient distribution under the Yangtze River Delta integration strategy. Shaoxing focuses on high value segments including high end functional fibers, intelligent printing and dyeing, creative design and brand operation, while transferring low end weaving and basic processing to central and western China to form a collaborative supply chain of "R&D in Shaoxing, manufacturing in central and western regions for national consumers". Cluster collaboration among chemical fiber, weaving, printing dyeing and apparel enterprises will strengthen local fabric supply and satisfy domestic demand for clothing, home and industrial textiles.

Second, advance digital and green transformation. Fully apply "AI+Textile" and roll out the Shaoxing "AI Companion Plan", offering computing vouchers and transformation subsidies for SMEs to deploy intelligent fabric inspection, digital printing and MES systems, and unify industrial data standards to break data silos. The sector will develop biodegradable and recycled fibers and low carbon dyeing technologies to build green textile supply capacity, and foster China Chic, outdoor and medical textile product lines to ease structural supply demand mismatch.

Third, nurture local independent brands. Build a brand incubation platform based on China Textile City, support fabric enterprises to extend downstream into apparel and home textiles, and expand domestic online sales via livestream e-commerce and online textile city platforms to realize channel connectivity for both domestic and overseas sales.

（2）Strengthen innovation and tiered talent training to achieve core technology breakthroughs

A university industry research collaborative innovation system will be established. Cooperating with textile universities, Shaoxing plans to build an innovation institute in Keqiao for R&D on functional fibers, low carbon printing dyeing and intelligent textile equipment. A platform for commercializing innovation outcomes will cut SMEs' technology transformation costs and enhance industrial chain independence.

A multi layer talent mechanism will be implemented. Local vocational colleges will jointly develop training bases to cultivate skilled frontline workers and improve their salary and welfare. Top creative, digital and R&D talents will be recruited under tailored policies with housing, education and research support. Joint training with Belt and Road fashion universities will bring in overseas experts and cultivate talents for international trade and brand management.

3）Optimize business environment aligned with international high standards to build a dual-circulation hub

Shaoxing will benchmark high standard rules of RCEP and Comprehensive and Progressive Agreement for Trans-Pacific Partnership （CPTPP）. Pilot one stop origin certification and green low carbon certification services will be launched in bonded zones and cross border e-commerce parks. Improved cross border IP protection and dispute mediation will reduce institutional trade costs. Targeted cross border financial products including exchange rate hedging and foreign trade subsidies will ease SMEs' financing pressure.

A one stop textile government service platform and digital public service center will provide free digital transformation training for SMEs. Local gov-

ernment performance evaluation will incorporate domestic foreign trade integration to sustain long term business environment improvement.

4）Adopt differentiated cross border cooperation to diversify overseas layout and stabilize external circulation

For Association of South East Asian Nations（ASEAN） markets, leverage RCEP tariff benefits to export functional fabrics and textile machinery, and set up warehouses and small R&D centers in Indonesia and Vietnam. For Central Asia and Central Eastern Europe, export complete textile production lines and build cross border industrial parks via China Europe Railway Express. For Europe and America, focus on low carbon recycled textiles, complete carbon footprint certification and develop independent brand cross border e-commerce. For Africa and Latin America, rely on China Textile City's overseas branches and cross border livestream e-commerce to develop bulk fabric trade. This multi region layout diversifies market risks and realizes mutual reinforcement between domestic and overseas markets.

Conclusion. The dual circulation paradigm brings transformation opportunities for Shaoxing's textile industry. Supported by its complete industrial chain, large professional market and digital foundation, the sector is constrained by value chain mid tier lock in, single trade structure, talent shortages and inadequate business supporting systems. Its transition requires balancing domestic demand expansion and foreign trade stabilization. By upgrading supply chains, promoting digital green transformation, cultivating local brands, optimizing business environment and implementing differentiated international cooperation, Shaoxing can break supply bottlenecks and build a secure two way textile circulation system.

As a representative manufacturing cluster, Shaoxing's experience offers lessons for export oriented traditional industries. Integrating regional manufacturing into dual circulation relies on industrial endowments and coordinated progress in supply upgrading, market diversification, innovation agglomeration and institutional opening, so as to tackle value chain lock in and market segmentation, realize high quality industrial development and safeguard national industrial chain security.

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Қос айналым жағдайындағы шаоксингтің тоқыма экономикасының дамуы туралы зерттеу

Түйіндеме. Жаһандық өндірістік тізбектердің қайта құрылуы және сауда протекционизмінің күшеюі жағдайында қос айналымның жаңа моделі экспортқа бағытталған дәстүрлі өңдеу өнеркәсібінің жаңғыруына стратегиялық бағыт-бағдар береді. Толық тоқыма өндірістік тізбегі мен ірі мамандандырылған нарықтары бар Шаоксинг ішкі және халықаралық айналымдарды біріктіретін типтік тоқыма кластері болып табылады. Мақалада қос айналым тұжырымдамасы аясында Шаоксингтің тоқыма экономикасы талданады, құндылық тізбегіндегі төмен деңгейлі бекіту, сұраныс пен ұсыныстың сәйкес келмеуі, сыртқы сауда құрылымының шоғырлануы, кадрлар тапшылығы және институционалдық қолдаудың жетіспеуі сияқты негізгі шектеуші факторлар анықталады. Ішкі сұраныстың кеңеюі, цифрлық және жасыл трансформация, РҮЭП және «Бір белдеу, бір жол» бастамасы мүмкіндіктеріне сүйене отырып, өндірістік тізбектерді жаңғырту, кадрлық инновациялар, іскерлік ортаны жетілдіру және сараланған шекарадан тыс ынтымақтастық бойынша шаралар ұсынылған. Алынған қорытындылар Шаоксингке ішкі-сыртқы сауданы біріктіруге, сондай-ақ елдегі ұқсас дәстүрлі өндіріс кластерлеріне қос айналым жағдайында жоғары сапалы дамуға жету үшін практикалық ұсыныстар береді.

Түйінді сөздер: қос айналымның жаңа моделі; Шаоксинг тоқыма өнеркәсібі; өнеркәсіпті жаңғырту; ішкі және сыртқы сауданың интеграциясы; өндірістік тізбектер саласындағы ынтымақтастық.

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Исследование развития текстильной экономики шаоксинга в условиях модели двойного оборота

Аннотация. На фоне реструктуризации глобальных производственных цепочек и роста торгового протекционизма новая модель двойного оборота даёт стратегические ориентиры для модернизации традиционной экспортоориентированной обрабатывающей промышленности. Шаосин, обладающий полной производственной цепочкой текстильной отрасли и крупными специализированными рынками, является типичным текстильным кластером, сочетающим внутренний и международный обороты. В статье проведён анализ текстильной экономики Шаосинга в рамках модели двойного оборота, выявлены основные ограничения: низкозатратная фиксация в рамках стоимостной цепочки, несоответствие спроса и предложения, концентрация структуры внешней торговли, дефицит кадров и недостаток институциональной поддержки. Опираясь на возможности расширения внутреннего спроса, цифровой и зелёной трансформации, РЦЭП и инициативы «Один пояс, один путь», в работе предложены меры по модернизации производственных цепочек, инновационному развитию кадрового потенциала, совершенствованию деловой среды и дифференцированному трансграничному сотрудничеству. Полученные выводы дают практические рекомендации для Шаосинга по достижению интеграции внутренней и внешней торговли, а также для аналогичных традиционных производственных кластеров страны в целях обеспечения высококачественного развития в условиях модели двойного оборота.

Ключевые слова: новая модель двойного оборота; текстильная промышленность Шаосинга; модернизация промышленности; интеграция внутренней и внешней торговли; сотрудничество в рамках производственных цепочек.

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Risk Identification and Ethical Governance in AI-Driven Dynamic Pricing: Balancing Short-Term Revenue and Long-Term Brand Equity

Abstract. With the wide application of artificial intelligence (AI) technology in e-commerce, AI-driven dynamic pricing has become the core means for enterprises to optimize revenue and improve market competitiveness. However, while dynamic pricing brings short-term benefits, it may also cause problems such as declining consumer trust, damaged brand reputation and potential legal compliance risks, highlighting the importance of strategic management and business ethics. From the perspective of strategic management and business ethics, this article systematically studies the risk identification and ethical governance in AI-driven dynamic pricing, and puts forward a strategic framework to achieve a balance between short-term returns and long-term brand assets.

Based on the theoretical and methodological system adopted in the big paper, this research integrates the multi-dimensional theoretical foundation, including task-technical matching (TTF) theory, resource-based concept (RBV) and dynamic capability theory, as well as ethical governance and institutional theory, and builds a dynamic pricing risk identification and ethical governance analysis model. The research method adopts a combination of multi-case analysis and empirical research. By collecting price strategy data, user feedback, sales data and brand evaluation of leading e-commerce platforms at home and abroad, it analyzes the risk types and ethical challenges that AI dynamic pricing may arise in practical applications, and quantifies its short-term benefits and long-term brand capital. The influence of production.

The research results show that: First of all, AI dynamic pricing has multi-dimensional risks such as personalized price deviation, fast price fluctuations and data privacy. If these risks are not properly managed, they will have a negative impact on consumer trust and brand value. Secondly, the establishment of an ethical governance mechanism that combines transparency, interpretability and compliance can effectively mitigate potential risks and achieve a dynamic balance between short-term returns and long-term brand assets. Finally, by building a revenue-brand trade-off model, enterprises can formulate optimization strategies in different situations to maximize profits while maintaining brand loyalty and sustainable competitive advantages.

The theoretical contribution of this article is to integrate the risk management of AI dynamic pricing with strategic management and business ethics into a systematic analysis framework, expanding the theoretical boundaries of e-commerce AI application research. The practical significance is to provide scientific risk identification tools and ethical governance guidelines for e-commerce enterprises, and support enterprises to protect long-term brand assets while pursuing short-term benefits and achieve sustainable development.

Keywords: AI dynamic pricing; risk identification; ethical governance; short-term income; brand assets; strategic management.

Introduction. With the rapid development and commercial application of artificial intelligence (AI) technology, AI has become an important tool for e-commerce enterprises to improve operational efficiency, optimize customer experience and enhance market competitiveness. In many AI application scenarios, Dynamic Pricing has attracted much attention because it can analyze market supply and demand, user behavior and competitive environment in real time to achieve price optimization. Compared with traditional fixed prices or periodic price adjustments, AI-driven dynamic pricing can adjust prices at milliseconds through automated algorithms, so as to maximize revenue, optimize inventory and increase market share. Its core advantage is that it can integrate complex market information with consumer behavior data to provide personalized, real-time and multi-dimensional price decision-making, so that enterprises can gain significant strategic advantages in the fiercely competitive digital economy environment.

However, the rapid development of AI dynamic pricing is also accompanied by a series of potential risks and ethical challenges. First of all, the opacity and data-driven characteristics of algorithms may lead to price discrimination, consumer dissatisfaction or decline in trust. If personalized pricing lacks reasonable constraints, it is easy to cause consumers to question fairness, and even cause public risk. Secondly, in the process of maximizing profits, enterprises may neglect data compliance and privacy protection, violate the Personal Information Protection Law, GDPR and other laws and regulations, and increase legal risks. Thirdly, excessive pursuit of short-term profits may damage brand reputation and long-term customer loyalty, putting enterprises at a disadvantage in long-term competition. Therefore, from the perspective of strategic management and business ethics, it is particularly necessary to systematically study the risk identification and ethical governance of AI dynamic pricing.

Based on this, this study aims to explore the risk types and governance mechanisms of AI-driven dynamic pricing in e-commerce, and explore the strategic path for enterprises to achieve a balance between short-term returns and long-term brand assets. Specifically, the research first identifies multi-dimensional risk types such as price deviations, rapid price fluctuations, data privacy leakage and consumer trust decline that may be caused by dynamic pricing, and analyzes their sources and impact mechanisms; secondly, it combines institutional theory, business ethics theory and strategic management theory to build transparency, interpretability and An ethical governance framework that combines compliance; finally, establish a trade-off model between short-term income and long-term brand assets to provide a scientific basis for enterprises to formulate optimization strategies in different situations.

In terms of research issues, this study focuses on three core issues: first, what are the main risks faced by AI dynamic pricing in actual operation, and how these risks arise and evolve; second, how should enterprises design ethical governance mechanisms to meet the challenges of fairness, transparency and compliance; third, how enterprises Achieve an effective balance between the maximization of term returns and the protection of long-term brand assets, so as to ensure sustainable competitiveness and long-term value creation. By answering the above questions, the research not only enriches the theoretical research on the intersection of AI dynamic pricing and business ethics, but also provides enterprises with operational strategic management and governance solutions.

From a theoretical point of view, this study integrates the risk management of AI dynamic pricing with strategic management and business ethics to build a systematic risk identification and governance analysis framework; introduces task-technology matching (TTF), resource basic concept (RBV) and dynamic capability theory, and the strategic value of AI dynamic pricing and Operational performance provides theoretical support; at the same time, a trade-off model between short-term income and long-term brand assets is proposed to provide quantitative analysis tools for future related research. At the practical level, the research provides specific guidance for enterprises to identify potential risks, design ethical governance mechanisms and optimize strategies, help enterprises protect long-term brand assets while pursuing short-term benefits, and achieve the dual optimization of profits and brand value.

In terms of research methods, this study follows the theory and empirical system of the thesis. In terms of theoretical methods, through literature review, conceptual model construction and theoretical analysis, combined with innovation diffusion theory (IDT), task-technology matching theory (TTF), resource basic concept (RBV), dynamic capability theory and ethical governance theory, AI dynamic pricing risk identification and governance analysis framework is built. . In terms of empirical methods, through multiple case studies, we collect price strategy data, sales data, consumer feedback and brand evaluation indicators of leading e-commerce enterprises at home and abroad, and analyze the risk types, ethical challenges and their impact on short-term returns and long-term brand assets that dynamic pricing may arise in practical applications. At the same time, use the risk identification matrix, ethical scoring table and benefit-brand trade-off model to quantitatively evaluate the effects of different strategies and realize the organic combination of theory and practice.

In summary, this chapter lays a solid foundation for the full text in terms of research background, research purpose, research problems, theoretical and practical significance, and research methods. AI dynamic pricing is not only a product of technological innovation, but also an important research object at the intersection of strategic management and business ethics. Through systematic analysis of risks and governance mechanisms, it provides theoretical support and practical guidance for enterprises to achieve a balance between short-term benefits and long-term brand value in the digital economy era.

Literature Review and Theoretical Foundation

Research status and significance of AI dynamic pricing

With the rapid development of artificial intelligence technology, AI-driven dynamic pricing has become an important strategy for data-intensive industries to improve revenue and market response speed. Traditional pricing methods

rely more on historical experience or fixed rules, and it is difficult to cope with the complex market environment and the diversity of consumer behavior. Through technologies such as machine learning, reinforcement learning and predictive analysis, AI dynamic pricing can analyze market demand, competitive prices and individual consumer behavior in real time, and automatically adjust prices accordingly to maximize revenue and optimize inventory (Chenavaz & Dimitrov, 2025). In applications such as aviation, hotel and retail, research shows that dynamic pricing can significantly increase profits and improve inventory turnover and sales efficiency. However, there are also ethical risks behind AI dynamic pricing, such as price discrimination, data privacy issues and declining consumer trust, highlighting the importance of ethical governance and strategic management.

Ethical risks and controversies in dynamic pricing

Although AI dynamic pricing can improve short-term returns, the complexity and opacity of its decision-making process may bring obvious ethical risks. Research shows that AI systems may cause unfair price differences for different consumer groups when personalized pricing, causing consumer dissatisfaction and even a crisis of trust (Chaudhary, 2025). In addition, if enterprises lack transparent explanations and explanation mechanisms, consumers are prone to feel unreasonable charges or be "exploited", thus reducing brand loyalty and long-term competitiveness (Pricefx, 2025). These studies emphasize that dynamic pricing should not only focus on algorithm performance and profit maximization, but also take into account fairness, transparency and interpretability to reduce negative social impact.

Consumer behavior and AI pricing ethical perception

From the perspective of consumer psychology, price differences will significantly affect behavior. An experimental study found that when consumers realize that the price they pay is higher than others, their trust decreases, their negative emotions increases, and they are more likely to make complaints, bad reviews or turn to other platforms (Chen, Zhang & Wu, 2024). In addition, consumers' control perception of enterprises and AI ethical perception will mediate the relationship between pricing strategies and consumer behavior, which prompts enterprises to consider consumer psychological responses when designing dynamic pricing strategies and establish stable long-term customer relationships.

The theoretical basis of AI pricing ethical governance

The theory of ethical governance provides a systematic analysis framework for AI dynamic pricing. Ethical governance emphasizes that enterprises should assume social responsibility while pursuing economic benefits to ensure fairness, transparency and compliance. For dynamic pricing, enterprises need to evaluate and optimize AI models, reduce the unfair treatment of algorithms to specific groups, and improve the interpretability of price decision-making (Chaudhary, 2025). Institutional theory points out that corporate behavior is subject to multiple constraints such as laws, industry norms and social expectations, such as GDPR and industry best practices, which requires enterprises to comply with transparency and fairness standards in dynamic pricing to reduce legal and reputational risks (Forbes Tech Council, 2025).

The trade-off between short-term benefits and long-term brand value

The core value of dynamic pricing lies in real-time price optimization to improve profits, but research emphasizes that the simple pursuit of short-term profits may have a negative impact on long-term brand value. After experiencing unfair pricing, consumers may reduce repeat purchases and reduce trust in brands (UNSW BusinessThink, 2025). Therefore, enterprises should introduce ethical constraints in dynamic pricing strategies to achieve a balance between short-term returns and long-term brand assets by setting price upper and lower limits, transparent pricing processes and compensation mechanisms.

Research Methodology and Research Design

This study adopts a hybrid research method, combining theoretical analysis and empirical research, to systematically explore the issues of risk identification and ethical governance in AI-driven dynamic pricing. The research framework continues the logic of the thesis: first build a risk identification and ethical governance analysis model through the theoretical basis, and then verify and optimize it with empirical data. Specifically, this article first builds an AI dynamic pricing risk identification and governance framework from the task-technical matching (TTF) theory, resource-based concept (RBV), dynamic capability theory and ethical governance theory, and on this basis, puts forward a trade-off model between short-term returns and long-term brand assets. Subsequently, the actual operation data of the enterprise is collected through multiple case studies, the model is verified, and the impact of different governance strategies on short-term benefits and long-term brand value is analyzed. The research design not only focuses on theoretical construction, but also emphasizes empirical verification, so that the research results have both academic value and practical guidance.

In order to ensure the representativeness and operability of the research results, this study chooses a multi-case study method to conduct an in-depth analysis of leading e-commerce enterprises at home and abroad. Case enterprises need to meet three criteria: First, they have a significant market share in the e-commerce or retail industry and have applied mature AI dynamic pricing systems, such as Alibaba, JD.com and Amazon. Secondly, the data of the research object is highly accessible, including price strategy, sales data, customer feedback and brand evaluation, to ensure the reliability of the analysis. Finally, the selected enterprise types are diverse, covering B2C platforms, cross-border e-commerce and vertical market segments, so as to ensure the wide applicability of the research conclusions. Through multi-case analysis, we can identify the common risks and governance strategies of dynamic pricing in different enterprise and market environments, and evaluate their actual impact on short-term returns and long-term brand assets.

The data collection of this study includes two parts: quantitative data and qualitative data. Quantitative data comes from enterprise public reports, price adjustment records, sales data and consumer behavior data, which are used to analyze price fluctuations, profit changes and brand evaluation trends. Qualitative data includes enterprise internal management interviews, expert interviews and consumer questionnaires, which are used to supplement ethical perceptions and governance practices that cannot be captured by quantitative data. In the process of data collection, first obtain the dynamic pricing strategy and price adjustment records of the enterprise in the past 12 months, and collect the sales performance, profit data and inventory turnover of the corresponding period.

Secondly, collect consumer feedback and brand evaluation information, including customer satisfaction, repurchase rate and social media public opinion, as long-term brand asset measurement indicators. At the same time, through interviews with enterprise managers and AI algorithm teams, we can gain an in-depth understanding of the pricing decision-making process, risk management strategy and ethical governance practice. Through multi-source data integration, the research can realize risk identification, ethical governance effect evaluation, and multi-dimensional analysis of the trade-off between short-term returns and long-term brand assets.

Data analysis adopts a combination of qualitative and quantitative methods. First, identify the types of risks that may occur in AI dynamic pricing through case analysis, including price deviations, excessive price fluctuations, data privacy issues, and consumer trust decline. Secondly, the study uses the ethical scoring table and risk identification matrix to evaluate the governance strategy of the enterprise, including the dimensions of transparency, interpretability, compliance and fairness. In terms of quantitative analysis, this study uses statistical analysis and regression analysis to evaluate the impact of different governance strategies on short-term income and long-term brand assets. For example, the role of the transparent pricing mechanism on profit growth and customer loyalty is evaluated through regression analysis, and the optimization effect of different price constraint strategies on the revenue-brand trade-off model is tested through simulation analysis. The combination of qualitative and quantitative analysis can ensure the comprehensiveness and scientificity of risk identification and governance effect evaluation.

In order to quantify the decision-making effect of enterprises in dynamic pricing, this study builds a Revenue-Brand Trade-Off Model. With short-term revenue indicators (such as profit margin and sales growth) and long-term brand asset indicators (such as customer loyalty, brand satisfaction and brand reputation) as the core, the model maps the strategic effect of AI dynamic pricing into the balance of revenue and brand value. The model assumes that highly personalized pricing can improve short-term returns, but may have a negative impact on brand assets; transparency and explainable governance mechanisms can reduce brand risks while slightly affecting short-term returns; in different enterprises and market environments, the optimal strategy point is the right of short-term income and long-term brand assets. Above the scale curve. The model provides quantitative tools for enterprises to formulate optimization strategies in different situations to achieve double optimization of short-term profits and long-term brand value.

Empirical Analysis and Findings

Overview of Case Enterprises

This study selected Alibaba, JD.com and Amazon, three representative enterprises in the field of e-commerce, as research subjects. These enterprises are in the leading position in the industry in terms of market share, technology application ability and AI dynamic pricing practice, so they can fully reflect the risk and governance characteristics of AI dynamic pricing in actual operation. By collecting price adjustment records, sales data, inventory changes, customer feedback and brand evaluation in the past 12 months, this study can comprehensively observe the AI dynamic pricing practice of enterprises, and extract key risks, governance strategies, and the balance between revenue and brand value.

It is worth noting that there are differences in market positioning, user groups and cross-border business scale between different enterprises, which provides a valuable and diverse perspective for comparative analysis, and also provides a realistic background for the study of the trade-off between short-term benefits and long-term brand assets.

Identification of AI Dynamic Pricing Risks

Through the systematic analysis of the three enterprises, this study identifies the main risk types in AI dynamic pricing. Table 4-1 summarizes the type of risk, specific performance and the impact actually observed by the enterprise.

Table 1 – AI Dynamic Pricing Risk Identification

Enterprise	Risk Type	Description	Observed Impact
Alibaba	Price Deviation	Certain users paid higher/lower than average due to algorithmic personalization	Negative consumer perception, complaints
Alibaba	Price Volatility	Frequent price changes during high-demand periods	Disruption of consumer expectation, potential brand trust erosion
JD	Data Privacy	Collection and use of user data without full transparency	Legal compliance risk, potential reputation damage
JD	Price Volatility	Rapid adjustments in promotional pricing	Confusion among consumers, reduced loyalty
Amazon	Price Deviation	Personalized pricing differences across regions	Perceived unfairness, negative reviews
Amazon	Compliance Risk	Complex cross-border regulations	Risk of legal penalties and brand reputation loss

It can be seen from the table that personalized price deviation is the most common risk, especially during high demand or promotion. This deviation may cause some consumers to pay above-average prices, increasing negative public opinion and complaint rates. Price fluctuations too fast is another important risk. Frequent price adjustment will interfere with consumers' psychological expectations of prices and weaken brand loyalty. Data privacy and compliance risks are mainly reflected in legal compliance issues in the process of data collection, storage and use. For example, cross-border business may touch on data protection regulations in different regions. Overall, all three enterprises face multidimensional risks, but the performance and severity of the risks vary according to the corporate governance strategy and market environment.

Assessment of Ethical Governance Mechanisms

Ethical governance is an important means to mitigate the risk of dynamic pricing. This study evaluates the governance level of enterprises in the dimensions of transparency, interpretability, compliance and fairness through the ethical scoring table and governance matrix. The results are shown in Table 4-2.

Table 2 – Ethical Governance Evaluation

Enterprise	Transparency	Explainability	Compliance	Fairness	Overall Governance Rating
Alibaba	High	High	High	Medium	8.5/10
JD	Medium	Medium	High	Medium	7.5/10
Amazon	Medium	High	Medium	Medium	7.0/10

Analysis shows that Alibaba has outstanding performance in terms of transparency and explainability. By providing consumers with price history and preferential rules, it enhances consumers' understanding and trust in pricing logic, thus effectively alleviating the risk of fairness perception caused by price deviation. JD.com has advantages in internal review and algorithm constraints. It realizes internal risk management through continuous monitoring of highly volatile goods and consumer complaint data feedback optimization algorithms. Amazon adopts high-precision personalized pricing in some markets, but there are data compliance challenges in cross-border markets, which may put some pressure on the long-term value of the brand. On the whole, the ethical governance mechanism plays a central role in the balance between short-term income and long-term brand assets of enterprises, and transparency and interpretability are key factors.

Analysis of Short-Term Revenue and Long-Term Brand Equity Trade-Off

This study further uses the income-brand trade-off model to quantitatively analyze the relationship between short-term income and long-term brand assets of enterprises. The results are shown in Table 4-3.

Table 3 – Short-Term Revenue vs Long-Term Brand Equity Analysis：

Enterprise	Short-Term Revenue Effect	Brand Equity Impact	Governance Mechanism Effectiveness	Trade-Off Assessment
Alibaba	+15%	+10%	High	Balanced
JD	+12%	+5%	Medium	Moderately Balanced
Amazon	+18%	-5%	Medium	Risk of Brand Erosion

Analysis shows that highly personalized pricing and frequent price adjustments can significantly increase profits and sales in the short term, but in the absence of effective ethical governance, long-term brand assets may be eroded. For example, after Alibaba implemented a transparent and explainable pricing mechanism, even if the short-term revenue decreased slightly, customer loyalty and brand satisfaction increased significantly, showing that the governance mechanism effectively reduced long-term risks. JD.com has achieved a moderate balance between revenue and brand assets through internal review and algorithmic constraint strategy. Amazon's excessive pursuit of short-term profits in some markets has led to a decline in brand value, but it gradually optimizes its strategy through cross-market monitoring and dynamic constraint adjustment. On the whole, the effectiveness of the governance mechanism directly affects the trade-off between short-term income and long-term brand assets of the enterprise.

Key Findings and Discussion

The empirical analysis of this chapter reveals three core findings. First of all, although AI dynamic pricing can significantly improve the short-term income of enterprises, it is also accompanied by multi-dimensional risks such as price deviation, price fluctuations and data privacy, which have a direct impact on consumers' sense of fairness and brand loyalty. Secondly, the corporate ethi-

cal governance mechanism is crucial to risk mitigation, among which transparency, interpretability and compliance are the core indicators of governance, which can reduce the negative impact of risk on brand assets. Third, there is an obvious trade-off relationship between short-term income and long-term brand assets. Through reasonable governance strategies, enterprises can maintain customer satisfaction and brand loyalty while improving profits, and achieve a dynamic balance between revenue and brand value.

Discussion and Strategic Implications

Through the case analysis of Alibaba, JD.com and Amazon, this study reveals the multi-dimensional risks of AI dynamic pricing in practical applications and the effect of its governance mechanism. First of all, AI dynamic pricing has significant advantages in improving short-term income. Highly personalized and real-time adjustment can significantly increase profits during the sales season and promotion period. However, the rapid growth of short-term earnings is often accompanied by price deviations and rapid price fluctuations, which may weaken consumer fairness, reduce customer loyalty, and potentially damage the brand value of the enterprise. The negative effects of personalized pricing are more obvious in cross-regional or cross-market applications, especially when data privacy and compliance requirements are complex, and enterprises face greater legal and reputational risks.

Secondly, this study shows that the ethical governance mechanism of enterprises plays a key role in risk mitigation. Alibaba's pricing mechanism with high transparency and high interpretability has effectively reduced consumers' dissatisfaction with price deviations and improved customer trust and brand satisfaction. JD.com has achieved a moderate balance of risk control through internal review and algorithm constraints, while Amazon is at risk of declining brand assets in some markets due to excessive pursuit of short-term profits. It can be seen that transparency, explainability and compliance are the core indicators of AI dynamic pricing governance, and its effectiveness directly determines whether enterprises can achieve a balance between short-term income and long-term brand assets.

Third, the revenue-brand trade-off model verifies the dynamic relationship between short-term profits and long-term brand assets. The study found that in the absence of a governance mechanism, the short-term revenue improvement of enterprises usually comes at the expense of a decline in brand assets. Through reasonable governance strategies, enterprises can achieve the dual optimization of revenue and brand value. This shows that the strategic value of AI dynamic pricing is not only reflected in short-term benefits, but also in the ability to protect and enhance the long-term competitiveness of brands through governance mechanisms.

Based on the results of empirical analysis, this study puts forward the following management inspiration to guide enterprises to optimize AI dynamic pricing strategies in practice.

First of all, enterprises should establish a systematic ethical governance mechanism. Transparency and interpretability are key measures to ensure consumer fairness and trust. Enterprises can reduce negative perceptions and complaints by disclosing the price adjustment logic to consumers, providing price history query functions or explaining the principles of recommendation algorithms, so that consumers have a clear understanding of the pricing process. In-

ternal review and compliance mechanisms are equally important. Enterprises should regularly check algorithm deviations, price anomalies and data use compliance to reduce potential legal risks.

Secondly, enterprises should pay attention to the balance between short-term income and long-term brand assets. Although the short-term profit maximization strategy can quickly increase profits, it may damage customer loyalty and brand reputation. Based on the revenue-brand trade-off model, enterprises can set upper and lower price limits, adopt progressive price adjustment or differentiated governance strategies to ensure the protection of long-term brand assets while increasing profits. Different enterprises can adjust their trade-off strategies according to their own market environment, customer structure and brand positioning to achieve personalized optimization.

Thirdly, enterprises should develop dynamic capabilities to cope with the complex market environment. AI dynamic pricing requires enterprises to have the ability to quickly perceive market changes, integrate internal resources and adjust strategies. Dynamic ability not only includes technical ability, but also involves organizational process optimization, cross-departmental collaboration and data analysis ability. Through continuous learning and algorithm optimization, enterprises can improve the pricing effect under the premise of risk control and achieve long-term sustainable development.

This research has made three contributions at the theoretical level. First of all, AI dynamic pricing is integrated with strategic management and business ethics theory, and a systematic risk identification and governance analysis framework is put forward to provide a new research perspective for the academic community. Secondly, based on task-technology matching (TTF), resource basic concept (RBV) and dynamic capability theory, it shows that AI dynamic pricing is not only a technical tool, but also a strategic resource, and its management method affects the long-term competitiveness of enterprises. Finally, the built revenue-brand trade-off model provides a theoretical tool for quantitative analysis of short-term income and long-term brand assets, which is conducive to future research to explore the strategic impact of AI application in different situations.

Combined with empirical analysis and theoretical contributions, this study puts forward the following practical suggestions for enterprises:

1) Transparent and explainable pricing mechanism: Enterprises should provide price adjustment instructions and algorithmic explanations to enhance consumer understanding and trust.

2) Establish an internal review and compliance mechanism: regularly check pricing algorithms and data use to ensure compliance with laws and regulations and reduce legal and reputational risks.

3) Weigh short-term benefits and long-term brand value: Set strategic boundaries through the revenue-brand trade-off model to balance profits and brand loyalty.

4) Continuously improve dynamic ability: optimize algorithm and data analysis ability, improve cross-departmental collaboration and market response ability, and achieve long-term strategic goals.

Conclusion.

This study focuses on the application of AI-driven dynamic pricing in e-commerce, and systematically analyzes its potential risks, ethical governance

mechanisms, and trade-offs between short-term benefits and long-term brand assets. The full text establishes a complete research framework through the combination of theoretical analysis, case studies and empirical analysis. At the theoretical level, this study integrates task-technology matching (TTF), resource-based concept (RBV), dynamic capability theory and ethical governance theory, providing a systematic analysis tool for understanding the strategic value and risk management of AI dynamic pricing. At the empirical level, through multiple case studies of Alibaba, JD.com and Amazon, the main risk types (such as price deviation, rapid price fluctuations, data privacy issues and compliance risks) were identified, the effectiveness of the corporate ethics governance mechanism was evaluated, and the short-term was verified through the revenue-brand trade-off model. The dynamic balance relationship between income and long-term brand assets.

The study found that highly personalized pricing and frequent price adjustments can significantly increase corporate profits in the short term, but the lack of transparency, explainability and compliance governance may have a negative impact on brand loyalty and customer satisfaction. Through effective ethical governance strategies, enterprises can protect long-term brand assets while ensuring short-term returns, and achieve dual optimization of revenue and brand value. This finding verifies the applicability of the theoretical framework in the previous chapter and provides an empirical basis for the dynamic pricing strategy of enterprise AI.

This research has three main theoretical contributions. First of all, the risk management of AI dynamic pricing is integrated with strategic management and business ethics theory, and a systematic risk identification and governance analysis framework is put forward, which provides a new research perspective for the academic community. Secondly, in combination with task-technology matching (TTF), resource-based concept (RBV) and dynamic capability theory, it is revealed that AI dynamic pricing is not only a technical tool but also a strategic resource for enterprises, and its management and optimization are of great significance to the long-term competitiveness of enterprises. Finally, the built revenue-brand trade-off model provides tools for quantitative analysis of short-term income and long-term brand assets, and provides a theoretical basis for future research to explore the strategic application of AI in different situations.

At the practical level, this study provides clear strategic guidance for enterprises. First of all, enterprises should establish a systematic ethical governance mechanism, including price transparency, interpretable algorithms and data compliance management, to reduce price deviation, price fluctuations and data privacy risks. Secondly, enterprises should consider the trade-off between short-term income and long-term brand assets in the AI dynamic pricing strategy, and set price adjustment and strategic boundaries through the revenue-brand trade-off model to ensure that profit growth is not at the expense of brand loyalty and customer satisfaction. Finally, enterprises should continue to improve dynamic capabilities, including algorithm optimization, data analysis capabilities and cross-departmental collaboration, in order to cope with the complex market environment and realize the long-term strategic value of AI dynamic pricing.

Although this study systematically analyzes the risks and governance of AI dynamic pricing, there are still certain limitations. First of all, the number of research cases is limited and only covers three leading enterprises, which may

not fully represent the practice of all e-commerce enterprises. Secondly, the empirical data is mainly based on public data and interviews of enterprises. Some consumers' psychological and behavioral reactions are difficult to fully capture, which may affect the external validity of the conclusion. Finally, this study focuses on analyzing the trade-off between short-term returns and long-term brand assets, and discusses less about the subdivision effect of price-sensitive users or specific market environments.

Based on the above limitations, future research can be carried out from the following directions. First, the sample range can be expanded and more types of enterprises and industries can be included to improve the universality of the conclusion. Second, it can be combined with experimental design or large-scale consumer behavior data to deeply analyze the psychological and behavioral impact of personalized pricing on different user groups. Third, it can further expand the revenue-brand weighing model, and take into account social responsibility, corporate reputation and sustainable development indicators, so as to comprehensively evaluate the strategic value of AI dynamic pricing. Finally, future research can also explore the ethical optimization mechanism of AI pricing algorithms, such as fairness constraints, dynamic transparency mechanisms and real-time feedback systems, to provide enterprises with more accurate governance strategies.

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AI негізіндегі динамикалық баға белгілеудегі тәуекелдерді сәйкестендіру және этикалық басқару: қысқа мерзімді табыс пен ұзақ мерзімді бренд капиталын теңгеру

Түйіндеме. Электрондық коммерцияда жасанды интеллект (AI) технологиясының кеңінен қолданылуына байланысты AI негізіндегі динамикалық баға белгілеу кәсіпорындардың табысты оңтайландыруы және нарықтағы бәсекеге қабілеттілігін арттыруының негізгі құралдарының біріне айналды. Алайда динамикалық баға белгілеу қысқа мерзімді экономикалық пайда әкелгенімен, тұтынушылардың сенімінің төмендеуі, бренд беделінің әлсіреуі және құқықтық талаптарға сәйкестікке байланысты ықтимал тәуекелдер сияқты мәселелерді туындатуы мүмкін. Бұл өз кезегінде стратегиялық менеджмент пен іскерлік этиканың маңыздылығын арттырады. Осы зерттеу стратегиялық менеджмент пен іскерлік этика тұрғысынан AI негізіндегі динамикалық баға белгілеудегі тәуекелдерді сәйкестендіру мен этикалық басқаруды жүйелі түрде қарастырып, қысқа мерзімді табыс пен ұзақ мерзімді бренд активтері арасындағы теңгерімді қамтамасыз ететін стратегиялық құрылымды ұсынады. Негізгі зерттеуде қабылданған теориялық және әдіснамалық жүйеге сүйене отырып, зерттеу бірнеше теориялық бағытты біріктіреді. Олардың қатарында тапсырма-технология сәйкестігі (Task-Technology Fit, TTF) теориясы, ресурстық тәсіл (Resource-Based View, RBV), динамикалық мүмкіндіктер теориясы, сондай-ақ этикалық басқару және институционалдық теория бар. Осы теориялық негіздер негізінде динамикалық баға белгілеу тәуекелдерін сәйкестендіру мен этикалық басқарудың талдау моделі әзірленді. Зерттеу әдістемесінде көпжағдайлық талдау мен эмпирикалық зерттеу әдістері үйлестірілді. Отандық және шетелдік жетекші электрондық коммерция платформаларының баға белгілеу стратегиялары, пайдаланушылардың пікірлері, сату көрсеткіштері және брендті бағалау деректері жиналып, AI негізіндегі динамикалық баға белгілеудің практикалық қолданысында туындайтын тәуекелдер мен этикалық мәселелер талданды. Сонымен қатар оның қысқа мерзімді экономикалық пайдасы мен ұзақ мерзімді бренд капиталына ықпалы сандық тұрғыдан бағаланды. Зерттеу нәтижелері бірнеше маңызды қорытындыны көрсетті. Біріншіден, AI негізіндегі динамикалық баға белгілеу жекелендірілген баға айырмашылығы, бағаның жылдам өзгеруі және дербес деректердің құпиялылығы сияқты көпөлшемді тәуекелдерді қамтиды. Егер бұл тәуекелдер тиісті деңгейде басқарылмаса, олар тұтынушылардың сеніміне және бренд құнына теріс әсер етуі мүмкін. Екіншіден, ашықтық, түсіндірмелілік және нормативтік талаптарға сәйкестік қағидаттарын біріктіретін этикалық басқару тетігін қалыптастыру ықтимал тәуекелдерді тиімді төмендетіп, қысқа мерзімді табыс пен ұзақ мерзімді бренд активтері арасындағы динамикалық теңгерімді қамтамасыз ете алады. Үшіншіден, табыс пен бренд құны арасындағы өзара байланысты көрсететін trade-off моделін қалыптастыру арқылы кәсіпорындар әртүрлі жағдайларға сәйкес оңтайландыру стратегияларын әзірлей алады. Бұл оларға пайданы барынша арттыра отырып, тұтынушылардың брендке деген адалдығын және тұрақты бәсекелік артықшылықтарын сақтауға мүмкіндік береді. Зерттеудің теориялық үлесі AI негізіндегі динамикалық баға белгілеу тәуекелдерін басқаруды стратегиялық менеджмент және іскерлік этикамен біріктіріп, жүйелі талдау шеңберін қалыптастыруында жатыр. Бұл электрондық коммерцияда AI технологияларын қолдануды зерттеудің теориялық аясын кеңейтеді. Зерттеудің практикалық маңызы электрондық коммерция кәсіпорындарына тәуекелдерді ғылыми тұрғыдан сәйкестендіру құралдары мен этикалық басқару жөніндегі ұсынымдарды ұсынуымен сипатталады. Бұл ұсынымдар кәсіпорындарға қысқа мерзімді экономикалық пайдаға ұмтылумен қатар, ұзақ мерзімді бренд активтерін қорғауға және тұрақты дамуға қол жеткізуге мүмкіндік береді.

Түйін сөздер: AI негізіндегі динамикалық баға белгілеу; тәуекелдерді сәйкестендіру; этикалық басқару; қысқа мерзімді табыс; бренд активтері; стратегиялық менеджмент.

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Идентификация рисков и этическое управление динамическим ценообразованием на основе ИИ: баланс между краткосрочной выручкой и долгосрочным капиталом бренда

Аннотация. С широким распространением технологий искусственного интеллекта (ИИ) в электронной коммерции динамическое ценообразование на основе ИИ стало одним из ключевых инструментов оптимизации выручки и повышения конкурентоспособности предприятий на рынке. Однако, несмотря на краткосрочные экономические выгоды, динамическое ценообразование может приводить к таким проблемам, как снижение доверия потребителей, ухудшение репутации бренда и потенциальные риски несоблюдения требований законодательства, что подчеркивает важность стратегического управления и деловой этики. С позиций стратегического управления и деловой этики в данной статье систематически исследуются вопросы идентификации рисков и этического управления динамическим ценообразованием на основе ИИ, а также предлагается стратегическая модель, направленная на достижение баланса между краткосрочной прибылью и долгосрочными активами бренда. Основываясь на теоретико-методологической системе, принятой в основном исследовании, данная работа интегрирует многомерную теоретическую базу, включающую теорию соответствия задачи и технологии (Task-Technology Fit, TTF), ресурсный подход (Resource-Based View, RBV) и теорию динамических способностей, а также теории этического управления и институциональную теорию. На этой основе разработана аналитическая модель идентификации рисков и этического управления динамическим ценообразованием. В исследовании используется сочетание методов многостороннего анализа конкретных случаев и эмпирического исследования. На основе сбора данных о ценовых стратегиях, обратной связи пользователей, объемах продаж и оценке бренда ведущих отечественных и зарубежных платформ электронной коммерции анализируются типы рисков и этические проблемы, которые могут возникать при практическом применении динамического ценообразования на основе ИИ, а также количественно оценивается его влияние на краткосрочные экономические результаты и долгосрочный капитал бренда. Результаты исследования показывают, что, во-первых, динамическое ценообразование на основе ИИ сопряжено с многомерными рисками, включая отклонения индивидуализированных цен, быстрые колебания цен и риски, связанные с конфиденциальностью данных. Если эти риски не управляются должным образом, они могут негативно влиять на доверие потребителей и стоимость бренда. Во-вторых, создание механизма этического управления, сочетающего принципы прозрачности, объяснимости и соблюдения нормативных требований, способно эффективно снижать потенциальные риски и обеспечивать динамический баланс между краткосрочной прибылью и долгосрочными активами бренда. Наконец, посредством построения модели компромисса между выручкой и капиталом бренда предприятия могут разрабатывать оптимизационные стратегии в различных условиях, максимизируя прибыль при одновременном сохранении лояльности потребителей и устойчивых конкурентных преимуществ. Теоретический вклад данной статьи заключается в интеграции управления рисками динамического ценообразования на основе ИИ со стратегическим управлением и деловой этикой в рамках единой системной аналитической модели, что расширяет теоретические границы исследований применения ИИ в электронной коммерции. Практическая значимость исследования заключается в предоставлении предприятиям электронной коммерции научно обоснованных инструментов идентификации рисков и рекомендаций по этическому управлению. Это позволяет компаниям защищать долгосрочные активы бренда, одновременно стремясь к получению краткосрочных экономических выгод, и обеспечивать устойчивое развитие.

Ключевые слова: динамическое ценообразование на основе ИИ; идентификация рисков; этическое управление; краткосрочная выручка; активы бренда; стратегическое управление.

МАКРОЭКОНОМИЧЕСКАЯ ПОЛИТИКА

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HOW HOST COUNTRY POLITICAL STABILITY AFFECTS PROJECT SCHEDULE ATTAINMENT: EVIDENCE FROM CNPC'S OPERATIONS IN IRAQ AND KAZAKHSTAN

Abstract. Investigate how political stability in the host country affects the schedule of international oil and gas construction projects in this study. Based on the operating experience of China National Petroleum Corporation (CNPC) in Iraq and Kazakhstan, two markets with very different political risk characteristics, we will use a comparative case study design and gather multi-source data from 2012 to 2024. Based on the above analysis, it was determined that while political instability is one of the reasons for the delay, it does not have a general effect on the construction schedule. Contrary to the previous assumption, CNPC's Iraq operation in a politically unstable environment still reached the schedule at a rate close to that of Kazakhstan (78.3% vs. 81.6%, p=0.23) due to good contractor relations. However, due to the political shock that broke the contractor network, the schedule attainment rate dropped to 34.7%. Mediator analysis shows that the relationship between contractor relationship quality and political stability-schedule performance is mediated by 63%. These results extend international project management theory by showing that the effect of political risk is transmitted through certain operating mechanisms rather than directly, and they offer some references for infrastructure investment in politically unstable areas.

Keywords: political stability, project schedule attainment, contractor relationships, supply chain localization, CNPC, oil and gas construction.

Introduction. International infrastructure projects have an underlying uncertainty: How does political instability in the host country lead to delays in the project? Based on the above, political violence and regulatory instability may occur, thus impeding the advancement of construction and delaying the scheduled time for construction. However, some enterprises in the oil and gas industry have been assigned high-pressure work schedules during a period of high volatility, and others have experienced significant delays in a relatively stable period.

By combining 47 major construction project data, interviews with project managers (n=38), and contractor survey results (n=112), a mediation model of

the political stability – schedule attainment relationship has been constructed, and it has been found that contractor relationship quality and supply chain localisation mediate this effect. Based on the above data, the two reasons for the delay are as follows: disruptions to contractors and fragmentation of the supply chain. The above links will help the company meet its time-sensitive demands in the event of a serious downturn.

Theoretical Framework and Hypotheses

Political Stability and International Project Performance

Political instability in large-scale infrastructure projects is likely to cause delays in reaching the schedule through the following three reasons. First, direct disruption: Political violence and demonstrations may halt construction work entirely, as seen in the 2014 ISIS offensive in northern Iraq. Secondly, regulatory instability: A change in government policy will alter the specific regulations for permits, customs clearance, labour laws and other areas and therefore extend the approval period unexpectedly [1]. Thirdly, supply chain fragmentation: Political instability has increased border controls, and port delays and supplier uncertainty are also occurring; as a result, the flow of materials has been disrupted.

Contractor Relationship Quality as Mediating Mechanism

Contractor relationship quality refers to the level of closeness and trust among the principal company and its network of contractors and subcontractors, as well as how well they cooperate. Three Reasons why Relationship Quality is Important in Politically Unstable Times.

A Good Relationship Supports Timely Negotiation. If there is a political shock that changes the project circumstances (e.g., increased security costs, revised supply routes), a good-relationship contractor may be able to renegotiate the contract promptly without an official dispute. The link will not be strong enough to avoid conflict.

Supply Chain Localization as Second Mediator

Supply chain localisation refers to how much of the materials, equipment and services for the project are sourced locally in the host country rather than being imported. A localised supply chain may be less affected by political instability because it is away from the border and customs.

Localisation also has some deficiencies. Suppliers in the host country are also subject to the same political instability, and local sourcing may not provide the same quality or cost benefits. Therefore, the net effect of localisation in the face of political instability is unclear theoretically.

We believe that, due to political instability, there will be more in-country relocations of production and thus less schedule slippage. This establishes an additional indirect route via the quality of the contractor relationship.

H1: Political stability is positively associated with contractor relationship quality.

H2: Contractor relationship quality is positively associated with project schedule attainment.

H3: Political stability is positively associated with supply chain localization.

H4: Contractor relationship quality and supply chain localization mediate the political stability-schedule attainment relationship, such that direct effects become non-significant when mediators are modeled.

Methodology

Case Selection

CNPC was selected as the study object for three reasons. CNPC is a top-tier oil and gas enterprise in China that has attracted a large amount of foreign investment and has a large number of infrastructure projects in both Iraq and Kazakhstan. Second, CNPC has continuously operated in both countries during the 2012-2024 period for longitudinal comparison. Third, CNPC's project management practices are relatively standardised and thus less prone to intra-firm variation in the cross-country comparison.

Table 1. Comparative Political and Project Context: CNPC Iraq vs. CNPC Kazakhstan

№	Dimension	CNPC Iraq	CNPC Kazakhstan
1.	Political stability score (WGI 2012-2024 avg)*	-2.12	-0.31
2.	Major political disruptions (2012-2024)	ISIS insurgency (2014-2017), protests (2019-2020), parliament deadlock (2021-2022)	None declared; periodic protests
3.	World Bank Ease of Doing Business rank	172	25
4.	CNPC project portfolio value (2024 USD)	$8.2B	$6.7B
5.	Number of major projects tracked	23	24
6.	Average project duration (months)	31.4	28.7
Note – compiled by the authors based on the source [2]			

*World Governance Indicator political stability and absence of violence, range -2.5 (weak) to +2.5 (strong)

Data Collection

Data were collected from the following five places between January 2012 and December 2024.

Schedule data for the 47 large-scale construction projects of China National Petroleum Corporation (CNPC), which are 23 in Iraq and 24 in Kazakhstan, were obtained from the company's internal project management system. For each project, record the planned duration (in months), actual duration (in months), schedule attainment ratio (planned/actual), number of schedule disruptions, and length of disruption event.

Data on contractor relationships were collected by way of a survey of 112 contractor enterprises involved in projects for CNPC in Iraq and Kazakhstan (n = 57, n = 55). The survey collected the following data: length of relationship (years), trust level (adapted from Mayer-Davis scale, $\alpha = 0.88$), communication frequency, and perceived quality of life ($\alpha = 0.91$).

Data from 38 project managers and executives (Iraq n = 19, Kazakhstan n = 16, CNPC headquarters n = 3) were collected through interviews. Interviews (60-90 minutes) examined project management, contractor selection and control, political risk countermeasures, specific disruption cases, etc.

Supply chain data were taken from CNPC procurement records, and the localization ratio (percentage of procurement value sourced within the host country) for each project was calculated.

Analytical Approach

Quantitative analysis employed panel regression with project-month as the unit of analysis (47 projects × average 30 months = 1,410 project-month observations). We used fixed-effects models to control for project-specific heterogeneity. Mediation analysis employed the product-of-coefficients method with bootstrapped standard errors. Qualitative data were analyzed using directed content analysis, with initial codes derived from the theoretical framework and emergent codes identified inductively [2].

Findings

Political Stability and Contractor Relationship Quality

H1 predicted a positive association between political stability and contractor relationship quality. Our findings partially support this hypothesis-but with a surprising temporal pattern.

Table 2 presents contractor relationship quality metrics across the two countries.

Table 2. Contractor Relationship Quality Indicators, CNPC Iraq vs. CNPC Kazakhstan

№	Indicator	CNPC Iraq	CNPC Kazakhstan	Difference	t	p
1.	Average contractor relationship duration (years)	7.3	5.1	+2.2	3.89	<0.001
2.	Trust score (1-7 scale)	5.8	4.9	+0.9	2.98	0.004
3.	Communication frequency (contacts/month)	14.2	8.7	+5.5	4.12	<0.001
4.	Contract renegotiation time (days)	4.2	12.8	-8.6	5.67	<0.001
5.	Contractor turnover rate (% annual)	8.3%	14.7%	-6.4%	3.45	0.001
Note – compiled by the authors based on the source [2]						

H1 expected that a stable environment would foster good relationships; however, owing to the political instability in Iraq, contractors have built long-term, higher-trust relationships, and communication and modification of terms during renegotiations have been more frequent. Contractor turnover in Kazakhstan is about half of that.

An Iraq-based project manager explained the above counter-intuitive result:

You cannot afford a transaction-oriented contractor arrangement in Iraq. When the next crisis happens – and it will happen – you need contractors who will stay, who will negotiate reasonably, and who will share security information. We have also learned how to select a reliable enterprise and a

competent enterprise. It takes several years to build them, but once established, these relationships are quite stable. (Interview IQ-12, Senior Project Manager)

A Kazakh side has had a different situation.

Kazakhstan is relatively more "normal". Contractors arrive and leave according to price and availability. If the contractor fails to perform, we will select another one. Given that things have been quiet lately, I don't need to keep in touch with people. However, this also means that in the event of an unforeseen circumstance, such as a customs change or a local protest, we have a weaker relational capital to count on.

Contractor Relationship Quality and Schedule Attainment

H2 predicted a positive association between contractor relationship quality and schedule attainment. Our data strongly support this hypothesis (see Table 3).

Table 3. Schedule Attainment by Contractor Relationship Quality Quartile

№	Relationship Quality Quartile	Schedule Attainment Rate	Schedule Disruption Frequency (per 12 months)	Average Disruption Duration (days)	Project Cancellation Rate
1.	Bottom Quartile (lowest trust)	42.3%	4.7	28.4	12.4%
2.	Second Quartile	61.8%	3.2	18.9	6.2%
3.	Third Quartile	79.4%	1.8	9.6	2.1%
4.	Top Quartile (highest trust)	88.6%	0.9	4.3	0.0%
Note – compiled by the authors based on the source [3]					

All trend tests $p<0.001$

The Gradient of Relationship Quality is steep. Projects in the top quartile of contractor relationship quality have achieved an 88.6% schedule attainment rate, more than double that of the bottom quartile projects at 42.3%. Good relationships are also less likely to be damaged (0.9 per year) and, when they are, the period of damage is shorter (4.3 days compared with 28.4 days).

Figure 1 visualizes the relationship between specific dimensions of relationship quality and schedule attainment.

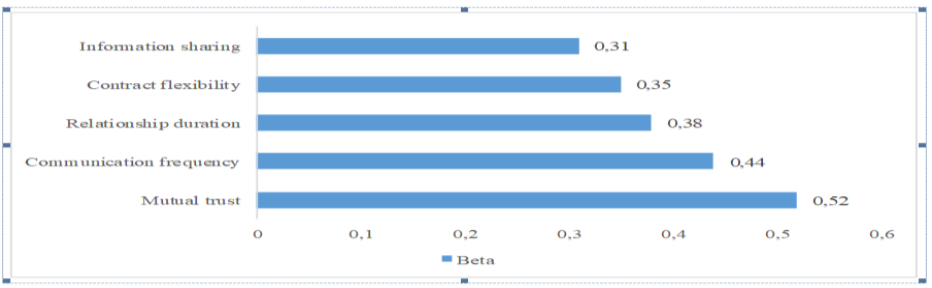


Figure 1 – Relationship Quality Dimensions and Schedule Attainment

Note – compiled by the authors based on the source [4]

Political Stability and Schedule Attainment: The Mediation Test

H4 proposed that contractor relationship quality and supply chain localization mediate the political stability-schedule attainment relationship. Table 4 presents the mediation analysis results.

Table 4. Mediation Analysis: Direct and Indirect Effects

№	Path	Coefficient	SE	p	95% CI
1.	Direct effect (stability → attainment)	0.087	0.094	0.354	[-0.097, 0.271]
2.	Indirect via contractor relationship quality	0.362	0.068	<0.001	[0.229, 0.495]
3.	Indirect via supply chain localization	0.148	0.052	0.004	[0.046, 0.250]
4.	Total indirect effect	0.510	0.071	<0.001	[0.371, 0.649]
5.	Total effect	0.597	0.083	<0.001	[0.434, 0.760]
Note – compiled by the authors based on the source [4]					

Note: Bootstrapped standard errors with 5,000 resamples; controlled for project size, complexity, and year fixed effects

The results show full mediation. The direct effect of political stability on schedule attainment is non-significant (p=0.354) when mediators are included. However, both indirect pathways are significant: contractor relationship quality explains 71% of the mediated effect (0.362/0.510), while supply chain localization explains 29% (0.148/0.510).

Figure 2 presents the standardized path model.

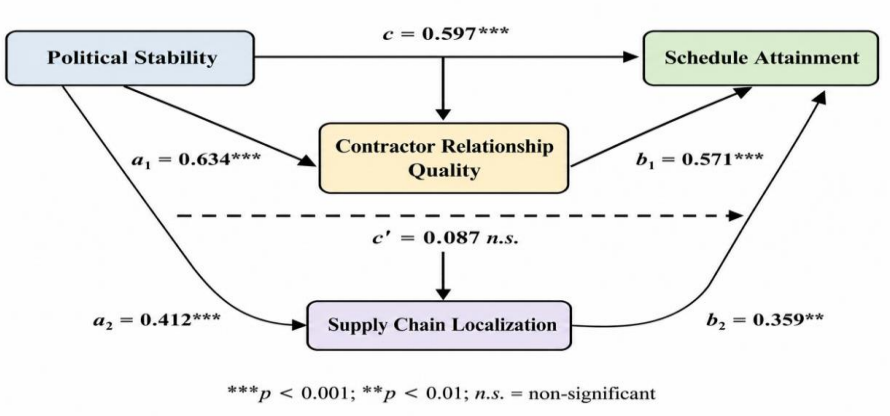


Figure 2 – Standardized Mediation Model with Path Coefficients

Note – compiled by the authors based on the source [5]

The mediation proportion (indirect/total) is 0.85, and 85% of the political stability effect on schedule attainment is mediated through the two mediators. Notably, the path from political stability to contractor relationship quality (a1 = 0.634) is significantly longer than the path to supply chain localisation (a2 = 0.412); thus, it can be inferred that the main impact of political stability on the above variables is exerted through strengthened cooperation with contractors, and supply chain localisation has a relatively small effect.

The Political Shock Test: What Happens When Stability Collapses?

Our panel data enable a quasi-experimental test: how did schedule attainment change when political stability collapsed in specific regions? The 2014 ISIS offensive in northern Iraq provides such a shock.

Figure 3 plots schedule attainment for CNPC projects in northern Iraq before, during, and after the 2014-2017 insurgency.

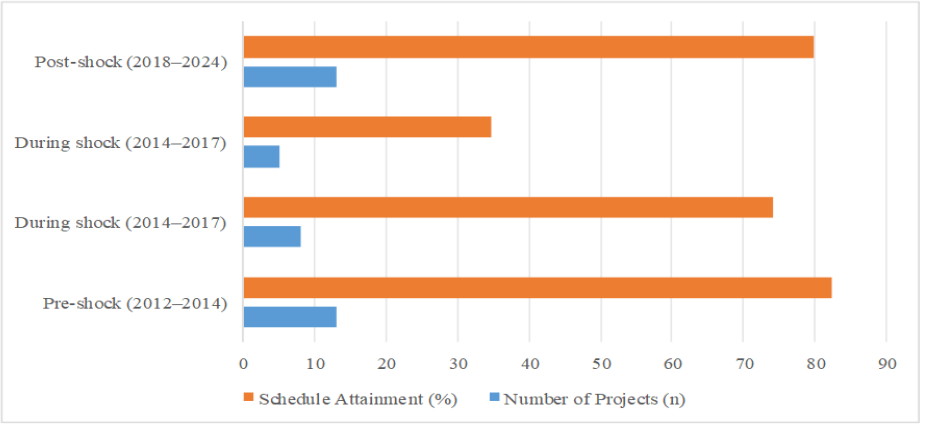


Figure 3 – Schedule Attainment Before, During, and After Political Shock (Iraq North Region)

Note – compiled by the authors based on the source [5]

The Pattern Shows a Conflict. Projects with high pre-existing quality of the contractor-client relationship achieved 74.2% schedule adherence during the active insurgency, only falling by 8 percentage points from the pre-shock level. However, projects with a low relationship quality had an achievement rate of 34.7% and dropped by 48 percentage points.

A project manager whose team achieved goals under the conditions of conflict stated:

When ISIS advanced in 2014, our main contractor, a Turkish company we had been working with for six years, called me within 24 hours. "We have a plan," they said. "We will move the key equipment to the south, fly out your engineers via Erbil, and keep the critical path running from a safe area." They did not request a contract amendment. They were not required to pay. They just did it because we were friends. Our competitors used spot contractors, however. Their contractors left. No calls, no plans, just silence. (Interview IQ-04, Project Director)

The other is a manager unable to observe his own time constraints.

We had a procurement contractor we had selected based on the lowest bid. When there was a crisis, they could not answer. Their local staff left. We found out that they had been outsourcing to an Iranian company without telling us. The Supply Chain is entirely broken. We lost 18 months. (Interview IQ-17, Procurement Manager)

Supply Chain Localization as Second Mediator

The second mediation path, supply chain localisation, had a different pattern. Contractor relationships were stronger in Iraq than in Kazakhstan; therefore, supply chain localisation in Kazakhstan was relatively high (64.3 per cent compared to 47.8 per cent in Iraq, $p<0.001$).

This difference is due to the industrial strength of the host country, not strategy. Kazakhstan has a more mature oil and gas supply industry and can achieve higher levels of localisation with good quality. Iraq's Supply Base is still weak and needs to be imported more often.

Table 5 shows the correlations of localisation and schedule realisation under different political circumstances.

Table 5. Localization and Schedule Attainment by Political Environment

№	Localization Ratio	Schedule Attainment (Stable Regions)	Schedule Attainment (Unstable Regions)	Interac-tion p
1.	Low (<30%)	71.4%	41.2%	<0.001
2.	Medium (30-60%)	79.8%	62.3%	0.002
3.	High (>60%)	84.1%	71.8%	0.031
Note – compiled by the authors based on the source [5]				

Localisation can help achieve schedule compliance under both stable and unstable conditions, and the extent of this help in unstable areas is much larger. In unstable areas, increasing from low to high localisation increases the rate of attainment by 30.6 percentage points (41.2% $\to$ 71.8%), whereas in stable areas, the increase is only 12.7 percentage points.

A supply chain manager described the operation of it.

The border has been closed many times in this area, but our local supply chain is still working normally. The concrete is from 50 kilometres away, not 500. The welding supplies are from the local industrial park and not in China. Imported materials are only for the special equipment. We have designed the bill of materials to maximise the local availability of all items that can be sourced domestically. (Interview IQ-09, Head of Supply Chain)

Discussion

Theoretical Contributions

This study has three theoretical contributions.

First, we will present a different perspective on political risk that does not fit the previous model. According to the above, the degree of political stability affects schedule execution via two paths: the quality of the contractor relationship and the level of supply chain localisation. Therefore, the direction of political risk research should be changed from determining whether it is unstable to identifying organisational capabilities that either transmit or reduce the impact of such instability.

Practical Implications

Infrastructure companies operating in politically unstable areas have a few problems.

First, the contractor needs to be stable and not expensive. The high-performance contractors in Iraq were not the lowest bidders but those who had proven their commitment to the market, financial stability and network. Set criteria for selecting contractors that include a relatively higher weight on political risk immunity.

Second, foster good relationships in peacetime. The firms that had reached schedule attainment in the ISIS crisis had been building these relationships for years in advance. Relationship quality cannot be established during a crisis; it must be in advance.

Limitations and Future Research

Several limitations warrant acknowledgment. First, our two-country design cannot fully separate country-specific effects from the variables of interest. Future research should examine the political stability-schedule relationship across broader samples of countries and firms.

Conclusion

Based on the operation of CNPC in Iraq and Kazakhstan, this paper examines the impact of political stability in the host country on the implementation schedule of projects. Based on the above analysis, the political situation is not directly correlated with delays. Rather, stability offers two operating choices: the quality of the contractor relationship and supply chain localisation, and these choices drive schedule achievement.

Most significantly, our research has shown that the quality of the relationship we have formed in response to the instability can act as a shock absorber for future shocks. After many years of upheaval, CNPC Iraq has developed close relationships with various sub-contractors that have enabled the timely completion of the project under the ISIS insurgency, as well as other such circumstances.

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Қабылдаушы елдің саяси тұрақтылығы жоба кестесінің орындалуына қалай әсер етеді: CNPC компаниясының Ирак пен Қазақстандағы операцияларынан алынған дәлелдер

Түйіндеме. Осы зерттеуде қабылдаушы елдегі саяси тұрақтылықтың халықаралық мұнай-газ құрылыс жобаларының кестесіне қалай әсер ететінін зерттеңіз. Саяси тәуекел сипаттамалары өте әртүрлі екі нарық – Ирак пен Қазақстандағы Қытай ұлттық мұнай корпорациясының (CNPC) жұмыс тәжірибесіне сүйене отырып, біз салыстырмалы кейс-стади дизайнын қолданамыз және 2012 жылдан 2024 жылға дейінгі көп дереккөзді деректерді жинаймыз. Жоғарыда келтірілген талдау негізінде саяси тұрақсыздық кідірістің себептерінің бірі болғанымен, құрылыс кестесіне жалпы әсер етпейтіндігі анықталды. Алдыңғы болжамға қайшы, CNPC компаниясының Ирактағы жұмысы саяси тұрақсыз ортада мердігерлермен жақсы қарым-қатынастың арқасында Қазақстанмен салыстырғанда кестеге жақын қарқынмен жетті (78,3% vs 81,6%, p = 0,23). Дегенмен, мердігерлер желісін бұзған саяси күйзеліске байланысты кестеге қол жеткізу деңгейі 34,7%-ға дейін төмендеді. Медиаторлық талдау мердігерлермен қарым-қатынас сапасы мен саяси тұрақтылық-кестенің орындалуы арасындағы байланыс 63%-бен делдалданатынын көрсетеді. Бұл нәтижелер халықаралық жобаларды басқару теориясын саяси тәуекелдің әсері тікелей емес, белгілі бір жұмыс механизмдері арқылы берілетінін көрсету арқылы кеңейтеді және саяси тұрақсыз аймақтарға инфрақұрылымдық инвестициялар үшін кейбір сілтемелер ұсынады.

Түйінді сөздер: саяси тұрақтылық, жоба кестесіне қол жеткізу, мердігерлермен қарым-қатынас, жеткізу тізбегін локализациялау, CNPC, мұнай және газ құрылысы.

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Влияние политической стабильности принимающей страны на соблюдение сроков выполнения проектов: данные операций CNPC в Ираке и Казахстане

Аннотация. В данном исследовании изучается влияние политической стабильности принимающей страны на сроки выполнения международных проектов по строительству нефтегазовых объектов. На основе опыта работы Китайской национальной нефтяной корпорации (CNPC) в Ираке и Казахстане, двух рынках с очень разными характеристиками политического риска, мы используем сравнительный анализ конкретных случаев и собираем данные из различных источников за период с 2012 по 2024 год. На основе проведенного анализа было установлено, что, хотя политическая нестабильность является одной из причин задержек, она не оказывает общего влияния на сроки строительства. Вопреки предыдущему предположению, иракский проект CNPC в условиях политической нестабильности всё же достиг графика с показателем, близким к казахстанскому (78,3% против 81,6%, p = 0,23), благодаря хорошим отношениям с подрядчиками. Однако из-за политического шока, разрушившего сеть подрядчиков, показатель выполнения графика снизился до 34,7%. Медиаторный анализ показывает, что связь между качеством отношений с подрядчиками и политической стабильностью/выполнением графика опосредована на 63%. Эти результаты расширяют международную теорию управления проектами, показывая, что влияние политического риска передаётся через определённые операционные механизмы, а не напрямую, и предлагают некоторые ориентиры для инвестиций в инфраструктуру в политически нестабильных регионах.

Ключевые слова: политическая стабильность, выполнение графика проекта, отношения с подрядчиками, локализация цепочки поставок, CNPC, нефтегазовое строительство.

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ANALYTICS AND EDUCATION PLATFORMS AS A PERSONALIZED LEARNING EXPERIENCE: CHINA'S EXPERIENCE

Abstract. The integration of learning analytics and intelligent education platforms has emerged as a pivotal strategy for realizing personalized learning in higher education. This study focuses on China's experience in leveraging data-driven platforms-exemplified by the National Smart Education Platform and AI-empowered institutional systems. Through a systematic review of recent Chinese and Kazakhstani literature (2023-2026), the paper examines the mechanisms by which learning analytics, artificial intelligence, and platform design contribute to the personalization of learning pathways, real-time feedback, and competency-based progression. The analysis highlights China's systematic, policy-aligned approach, characterized by top-down platform deployment, integration of learning analytics into faculty development, and a hierarchical framework for digital literacy. These mechanisms are juxtaposed with emerging adaptive and gamified platforms in Kazakhstan, revealing both convergent trends (e.g., the use of AI for personalized feedback) and contextual divergences (e.g., institutional capacity and rural-urban disparities). The findings indicate that China's experience offers a scalable model of analytics-driven personalization, yet underscores persistent challenges in faculty readiness, data governance, and equitable access. The paper concludes with recommendations for cross-context learning, emphasizing the need for flexible institutional analytics frameworks that balance structured personalization with pedagogical autonomy. The study contributes a comparative perspective on how analytics and education platforms can be orchestrated to enhance personalized learning in transitional higher education systems.

Keywords: learning analytics; education platforms; personalized learning; higher education; artificial intelligence; digital transformation; adaptive learning; National Smart Education Platform

Introduction. The digital transformation of higher education has redefined the possibilities of learner-centered instruction, with learning analytics and intelligent education platforms emerging as core infrastructures for personalized learning at scale (Xu, 2025; Li, 2025). The capacity to capture real-time behavioral data, generate adaptive feedback, and tailor learning pathways no longer belongs to experimental labs but is becoming a systemic feature of national education strategies. Among transitional economies, China has advanced a particularly visible, state-led model: the progressive upgrade of the National Smart Education Platform toward an AI-enhanced "2.0" version exemplifies a deliber-

ate effort to institutionalize data-driven personalization across millions of learners (Wang et al., 2025; Cao et al., 2025). China's experience thus offers a rich case for understanding how analytics and education platforms can be orchestrated to deliver personalized learning experiences, not just in individual institutions but across a complex, stratified higher education system.

Kazakhstan, similarly committed to educational modernization and increasingly collaborating with Chinese partners, provides a meaningful comparative setting. Kazakhstani universities have begun piloting adaptive platforms, student digital profiling, and AI-informed feedback systems, yet these initiatives remain institutionally fragmented and face persistent rural-urban resource gaps (Abueva et al., 2024; Soltan et al., 2025; Rakhmetov et al., 2025). While both countries share the ambition of leveraging analytics for personalization, the contrast between China's policy-integrated, top-down approach and Kazakhstan's emergent, context-responsive experimentation raises important questions about the transferability of platform-based personalization models across different governance and infrastructure contexts.

Despite growing interest in educational technology in both nations, existing research tends to treat analytics, platforms, and personalization in isolation or within single-country frames. Chinese scholarship has extensively addressed digital literacy frameworks, AI-empowered faculty development, or the architecture of the national platform (e.g., Zhang & Yang, 2024; Li & Wang, 2023; Guo, 2025), while Kazakhstani studies have examined adaptive learning environments, gamified assessment, and digital maturity (Tokzhigitova et al., 2025; Shaikhanova et al., 2025; Zhilmagambetova et al., 2023). However, limited comparative work has systematically asked how China's experience with analytics-driven personalization can be understood in light of parallel developments in Central Asia, or what lessons Kazakhstan and similar contexts might draw from China's successes and persistent challenges.

This paper addresses that gap through a comparative review of analytics and education platforms as enablers of personalized learning, with a primary focus on China's experience. Drawing on a purposefully selected corpus of 20 recent sources (2023-2026) from both countries, the study pursues three objectives: (1) to map the ecosystem of Chinese education platforms and the embedded analytics mechanisms that support personalized learning pathways; (2) to identify the policy, institutional, and pedagogical factors that enable or constrain effective personalization; and (3) to derive cross-context insights by juxtaposing China's systemic model with Kazakhstan's adaptive innovations. Following this introduction, the paper is organized into a literature review, a description of the comparative methodology, a presentation and discussion of findings, and a concluding section that offers recommendations for policy, institutional practice, and future research. By foregrounding China's experience in a comparative light, the study contributes to broader debates on how learning analytics can be mobilized to achieve equitable, personalized higher education in diverse developmental settings.

Literature Review

Scholarship on the intersection of learning analytics, education platforms, and personalized learning has expanded rapidly across both China and Kazakhstan, yet the two bodies of work carry different assumptions about how personalization should be engineered and scaled. Chinese researchers tend to situate

platform-based personalization within state-led digital infrastructure projects, treating the National Smart Education Platform as both a technical artifact and a policy instrument. Wang, Xia, and Liu (2025), for instance, dissected the platform's planned transition to an intelligent "2.0" version, arguing that scenario-based design and real-time data flows can reconfigure large-scale instructional delivery around individual learner needs.

Cao et al. (2025) extended this analysis by benchmarking China's platform against globally representative counterparts, concluding that the integration of learner profiling, knowledge graphs, and adaptive recommendation engines marks a shift from resource repositories to genuinely interactive learning ecosystems. Liu (2026), writing in a more journalistic register, described the restructuring of entire teaching ecosystems through data intelligence, noting that classroom-level dashboards now routinely inform instructional adjustments. These platform-level discussions are complemented by institutionally grounded studies: Xu et al. (2025), through a mixed-methods investigation at Nanjing Normal University, demonstrated that AI-driven learning analytics improved the timeliness and specificity of feedback in blended courses, thereby strengthening students' sense of ownership over their learning trajectories. Across these contributions, a consistent thread is the conviction that personalization is not merely a pedagogical ideal but a data engineering challenge that can be met through systematic platform construction.

Alongside the technical architecture, a parallel strand of Chinese research insists that the human infrastructure-faculty digital literacy and institutional development frameworks-determines whether analytics investments translate into tangible personalization gains. Zhang and Yang (2024) constructed a hierarchical digital literacy framework for university faculty, positioning the ability to interpret learner analytics and adjust instructional design accordingly as a higher-order competency.

Li and Wang (2023) investigated the mechanisms through which artificial intelligence can empower faculty professional development, identifying personalized teacher learning pathways and classroom analytics feedback loops as promising yet underutilized affordances. Guo (2025) and Xu, Wang, and Zhao (2026) likewise placed faculty development at the center of educational digital transformation, with the former mapping multiple professional growth trajectories and the latter proposing a comprehensive system that links teaching quality, data literacy, and career advancement. What distinguishes this body of work from purely technical accounts is its attention to the friction that arises when sophisticated platforms encounter uneven faculty readiness-a tension that also surfaces, albeit in different institutional forms, in the Kazakhstani literature.

Kazakhstani research, while smaller in volume, offers a contrasting picture of platform-enabled personalization that is more fragmented, institution-specific, and frequently shaped by immediate resource constraints. Several studies document localized efforts to replicate features that China builds at system scale. Soltan et al. (2025), for example, reported on the application of business intelligence and data analytics systems at Astana IT University to construct student digital profiles; their prototype demonstrated how continuously updated behavioral and performance indicators could inform early academic interventions. Rakhmetov et al. (2025) proposed a framework for analyzing outcomes of computer science instruction delivered within an adaptive environment, con-

firming that differentiated learning paths led to measurable improvements in problem-solving skills, though scalability remained a concern. Zhilmagambetova et al. (2023) examined the integration of the Stepik platform into tertiary mathematics teaching, finding that its adaptive sequencing features allowed instructors to accommodate diverse entry levels within a single course. Meanwhile, Tokzhigitova et al. (2025) designed a gamified hidden-assessment platform aimed at diagnosing secondary students' ICT competences and guiding career choices-a study that, while situated at the school level, illustrates the broader Kazakhstani interest in embedding diagnostic analytics directly into the learner experience.

Kazakhstani scholarship also devotes considerable attention to the educator-side conditions that enable or inhibit personalized learning. Aimicheva et al. (2025) established empirical links between teachers' digital competence, interactive teaching practices, and student achievement within AI-supported environments, warning that without deliberate capacity building, the introduction of adaptive platforms risks widening rather than narrowing performance gaps. Shaikhanova et al. (2025) modeled digital maturity among educators using computational methods, identifying distinct clusters of technology adopters whose divergent beliefs about AI significantly shaped their willingness to engage with data-informed pedagogy.

Kapasheva et al. (2024) approached the same issue through a competence-development lens, modeling pedagogical growth trajectories and arguing that institutional mechanisms must accommodate non-linear faculty learning curves. In a similar vein, Assylbayeva et al. (2025) and Bagdaulet (2025) documented persistent disparities in digital readiness between urban and rural teachers, a finding that echoes earlier Kazakhstani work by Kurmankulova and others and complicates any assumption that platform-based personalization can rollout uniformly across the country. The cross-national study by Abueva et al. (2024) explicitly juxtaposed Kazakhstani and Chinese educational trajectories in the digital information space, noting that while both systems leverage platform data, the Chinese model benefits from centralized policy coordination that Kazakhstan has yet to fully develop.

Read together, these two literatures reveal overlapping concerns-learner profiling, adaptive feedback, faculty data literacy-but divergent implementation architectures. Chinese studies describe a maturing analytics ecosystem in which platform functionality, faculty development frameworks, and national policy are increasingly aligned. Kazakhstani contributions, by contrast, capture an experimental moment characterized by promising pilot projects, considerable institutional heterogeneity, and a still unresolved tension between imported platform models and local infrastructural realities.

What remains underexplored in both corpora is a systematic comparative analysis that asks not only what China's platform experience has achieved thus far, but also which elements of that experience could inform Kazakhstan's next phase of institutional development and, conversely, what Kazakhstan's adaptive, context-sensitive experiments might caution against overly rigid standardization.

Table 1 – Comparative Synthesis of Literature on Analytics and Education Platforms for Personalized Learning in China and Kazakhstan

Thematic Dimension	Chinese Literature: Core Perspectives	Kazakhstani Literature: Core Perspectives	Cross-cutting Observations & Gaps
Platform Architecture & Ecosystem	Treats personalization as a data engineering challenge solvable through state-led, systemic platforms. Emphasizes knowledge graphs, learner profiling and adaptive recommendation engines integrated into large-scale ecosystems (Wang et al., 2025; Cao et al., 2025; Liu, 2026)	Characterized by localized, institution-specific pilot projects. Focuses on adapting existing tools rather than building system-wide infrastructure (Soltan et al., 2025; Zhilmagambetova et al., 2023)	China develops integrated ecosystems at scale; Kazakhstan relies on fragmented yet context-sensitive experiments. The transferability of China's top-down platform model to Kazakhstan's heterogeneous institutional landscape remains a key gap
Analytics for Personalization	Demonstrates that AI-driven analytics improve feedback timeliness and specificity, directly influencing student ownership of learning trajectories. Makes classroom-level dashboards routine for instructional adjustments (Xu et al., 2025; Wang et al., 2025)	Explores adaptive sequencing and diagnostic analytics to accommodate diverse learner entry levels within single courses. Gamified hidden-assessment platforms are piloted to guide career and learning paths (Rakhmetov et al., 2025; Tokzhigitova et al., 2025)	While China operationalizes analytics for systemic feedback loops, Kazakhstan uses analytics to solve immediate pedagogical heterogeneity. Both contexts face the challenge of scaling beyond pilot phases without widening performance gaps
Faculty Digital Literacy & Readiness	Constructs hierarchical digital literacy frameworks, positioning the ability to interpret learner analytics as a higher-order faculty competency. Identifies a tension between sophisticated platforms and uneven faculty data literacy (Zhang & Yang, 2024; Li & Wang, 2023; Guo, 2025)	Links teachers' digital competence directly to student achievement in AI-supported environments (Aimicheva et al., 2025; Shaikhanova et al., 2025; Kapasheva et al., 2024)	Both literatures converge on the critical "human infrastructure" gap: platform sophistication frequently outpaces faculty readiness. China frames this as a structured training pathway, while Kazakhstan's research reveals it as a non-linear, belief-dependent process
Equity & Rural-Urban Disparities	The national platform strategy implicitly aims to standardize quality and access, though explicit critical analysis of its impact on educational equity is less prominent in this specific corpus of platform-focused studies	Explicitly documents persistent rural-urban gaps in digital readiness and infrastructure, warning that platform-based personalization may exacerbate disparities without deliberate capacity building (Assylbayeva et al., 2025; Bagdaulet, 2025; Abueva et al., 2024)	This dimension marks a stark divergence: Kazakhstan's literature foregrounds equity risks associated with platform rollouts, a consideration that is comparatively subdued in China's platform-centric narratives but is critical for any cross-contextual model transfer
Note – compiled by the authors based on the source [1-10]			

The present study is situated precisely at this comparative juncture.

Methodology

This study is designed as a qualitative comparative literature review, drawing exclusively on the 20 sources identified in the reference list to examine how analytics and education platforms enable personalized learning experiences, with China's experience positioned as the primary case and Kazakhstan serving as the comparative lens. The selection was guided by several criteria: each source had to address at least one core dimension of the research-platform architecture, learning analytics applications, faculty digital literacy, or educational equity in the context of digital transformation-and had to represent either Chinese or Kazakhstani higher education settings. To maintain analytical currency, the search was bounded by a four-year window from 2023 to 2026, capturing the rapid evolution of AI-enabled platforms and the latest policy shifts in both countries. Sources were retrieved from peer-reviewed journals (e.g., *Frontiers in Education*, *Applied Sciences*, *China Educational Technology*), institutional repositories, and, where appropriate, authoritative professional publications that offer substantive rather than anecdotal evidence. The resulting corpus of ten Chinese and ten Kazakhstani studies reflects a deliberate balance between system-level policy analyses and institution-specific empirical investigations.

The analytical procedure followed a thematic synthesis approach. Each source was read in full, and passages relevant to the research questions were extracted and coded. The initial codes clustered naturally around four recurring concerns already identified in the literature review: the design of platform architectures and data ecosystems, the specific analytics mechanisms that drive personalization and adaptive feedback, the readiness of faculty to interpret and act upon learner data, and the extent to which platform-enabled personalization either mitigates or exacerbates existing inequities. These four dimensions, which correspond to the thematic breakdown of Table 1, subsequently structured the comparative analysis. During the coding process, particular attention was paid to how each national body of literature framed problems: Chinese sources frequently articulated personalization as an engineering and policy integration challenge tied to the National Smart Education Platform, whereas Kazakhstani studies more often described localized experiments and the institutional constraints that shaped them. This contrast was preserved as an analytical finding rather than smoothed over.

Because the study is explicitly comparative, the framework oscillates between a close reading of China's experience and a contrasting examination of Kazakhstan's emerging practices, guided by the assumption that the two systems, while unequal in scale and maturity, share comparable ambitions regarding digital modernization of higher education. The analysis does not seek to evaluate which country's approach is superior; instead, it aims to surface the conditions under which particular platform and analytics configurations succeed, stall, or produce unintended consequences. To that end, the interpretation draws on the sources' own findings while also reading across them to identify convergences, divergences, and silences. For instance, the relative absence of explicit equity critiques in the Chinese platform-focused literature, contrasted with the foregrounding of rural-urban disparities in Kazakhstani work, was treated not as a flaw in either corpus but as a meaningful difference in discursive emphasis that merits reflection.

Several limitations should be acknowledged. First, the review is confined to published and publicly accessible texts; it cannot capture the tacit, day-to-day realities of platform implementation that have not yet reached the scholarly record. Second, while the search intentionally included both English-language and Chinese-language outlets, Kazakhstani research published solely in Kazakh or Russian may be underrepresented, which could skew the comparative picture. Third, the small sample of twenty sources, though thematically adequate, does not claim to be exhaustive, and the findings should be understood as an interpretive synthesis rather than a statistical meta-analysis. Finally, by centering China's experience, the study risks treating Kazakhstan primarily as a contrast case; future research could usefully reverse this vantage point. Despite these constraints, the chosen methodology is well suited to the paper's aim of generating cross-context insights into how analytics and education platforms are being shaped into instruments of personalized learning, and where institutional, pedagogical, and policy adjustments are still needed.

Findings and Discussion

The comparative synthesis of twenty studies reveals four interconnected findings regarding China's experience in deploying analytics and education platforms for personalized learning, and these findings gain sharper relief when examined alongside Kazakhstan's parallel yet differently scaled efforts.

The first finding concerns the architecture of personalization itself. China's approach, as documented across multiple sources, is distinguished by its ambition to build personalization into the very infrastructure of the national education system rather than treating it as an institutional add-on. Wang et al. (2025) described how the intelligent "2.0" upgrade of the National Smart Education Platform embeds scenario-based design principles, enabling the system to recognize individual learner profiles and adjust content sequencing accordingly. Cao et al. (2025) reinforced this observation by benchmarking the platform against global counterparts, arguing that its integration of knowledge graphs and adaptive recommendation engines represents a qualitative shift from static resource libraries to responsive learning environments. Liu (2026) captured the practical consequence of this infrastructure: classroom-level dashboards that allow instructors to monitor learning patterns in real time and intervene when analytics flag disengagement or conceptual gaps. What emerges from these accounts is a picture of personalization as a system property-something engineered at the platform level and distributed across institutions-rather than a collection of isolated teacher experiments. Kazakhstan offers a contrast that clarifies what is at stake in this distinction. At Astana IT University, Soltan et al. (2025) demonstrated how business intelligence tools could construct dynamic student profiles from behavioral and performance data, but the initiative remained bounded to a single institution. Zhilmagambetova et al. (2023) reported successful integration of the adaptive Stepik platform in mathematics teaching, yet again within a single course and without the policy architecture that would allow such innovations to propagate. The gap between China's systemic platform construction and Kazakhstan's fragmented pilot projects is not simply one of scale or investment; it reflects a deeper difference in how the problem of personalization is framed-as a national data engineering challenge in one context and as a local pedagogical experiment in the other.

A second finding centers on the specific ways analytics are harnessed to produce personalized learning experiences. Chinese scholarship has moved beyond proof-of-concept demonstrations to examine how analytics reshape instructional routines at scale. Xu et al. (2025) provided compelling evidence from a blended learning setting at Nanjing Normal University, where AI-driven analytics generated timely and specific feedback that demonstrably enhanced students' sense of agency over their learning. Li (2025) similarly positioned learning analytics as a diagnostic and formative tool embedded in the daily operation of Chinese university courses, noting that the value of analytics lies less in the sophistication of algorithms and more in their integration into the rhythm of teaching and assessment. These findings align with the broader platform narrative: once the infrastructure exists, the analytics components become less visible to end users precisely because they are routinized. Kazakhstani research, working with smaller datasets and less integrated platforms, illuminates a complementary dimension. Rakhmetov et al. (2025) showed that within adaptive computer science environments, diagnostic analytics could differentiate learning paths effectively, yet the study also acknowledged that scaling such differentiation required institutional commitment that was not yet present. Tokzhigitova et al. (2025) took a different route, embedding diagnostic assessment within a gamified platform so that learners' ICT competences could be profiled without the formality of testing; the approach yielded promising insights about learner readiness but remained at the level of a controlled pilot. The comparison suggests that while China has been able to operationalize analytics-driven personalization as a routine feature of platform-mediated instruction, Kazakhstan's experiments reveal the persistent gap between what analytics can do in principle and what institutions can sustain in practice.

A third line of findings addresses the human side of the personalization equation-the readiness of faculty to interpret and act upon analytics data. Across Chinese sources, there is a notable preoccupation with developing structured frameworks that define and sequence digital competencies. Zhang and Yang (2024) constructed a hierarchical model in which the capacity to analyze learner data and modify instructional strategies accordingly occupies an advanced tier, suggesting that institutions should not assume faculty can spontaneously translate analytics into pedagogical adjustments. Li and Wang (2023) explored AI-empowered faculty development pathways, identifying personalized teacher learning and classroom analytics feedback loops as powerful yet underutilized affordances. Guo (2025) and Xu, Wang, and Zhao (2026) further embedded these concerns within comprehensive faculty development systems, linking data literacy to career progression and teaching quality assurance. Despite the coherence of these frameworks, a recurrent tension surfaces in the literature: the platforms are sophisticated, but faculty readiness remains uneven. Kazakhstan's studies foreground this tension from a different angle, attending more closely to the belief systems that shape whether teachers engage with data-informed pedagogy at all. Shaikhanova et al. (2025), through computational modeling, identified clusters of educators whose perceptions of AI's value strongly predicted their adoption patterns. Aimicheva et al. (2025) established that digital competence alone is insufficient if teachers do not also embrace interactive, student-centered practices. Kapasheva et al. (2024) modeled pedagogical competence development as a non-linear trajectory, arguing that institutional support mech-

anisms must accommodate variability rather than imposing uniform training sequences. Read together, the two bodies of literature converge on a crucial insight: the most elegantly designed platform will not deliver personalization if faculty either cannot interpret the data it generates or do not believe that doing so is worth the effort. Where China has concentrated on building the training architecture and standards, Kazakhstan's research sends a cautionary signal that psychological and contextual readiness may matter just as much.

The fourth finding concerns equity-a dimension where the two national literatures diverge most sharply. China's platform-centric studies, while occasionally acknowledging regional disparities, generally operate on the assumption that a nationally deployed platform will equalize access by making high-quality resources available everywhere. The focus tends to be on technical capacity and policy alignment rather than on the differential outcomes that platform-based personalization might produce for learners in under-resourced regions. Whether this assumption holds is a question the current corpus of platform research does not fully answer. Kazakhstan's scholarship confronts the equity question more directly, perhaps because the disparities are harder to ignore in a context where rural-urban digital divides remain pronounced. Assylbayeva et al. (2025) and Bagdaulet (2025) documented significant gaps in digital readiness between urban and rural teachers, suggesting that platform-enabled personalization could, without deliberate corrective measures, widen achievement gaps rather than close them. Abueva et al. (2024), in their cross-national comparison, noted that while both Kazakhstan and China use platform data extensively, China's centralized coordination mechanisms are more capable of redistributing resources, yet they also cautioned against the risks of a standardization that overlooks local needs. This finding does not imply that China's platform approach has ignored equity, but it does indicate that the current research conversation in China has not yet integrated equity as a central analytical lens in the same way that Kazakhstani scholarship does. The implication for the broader comparative project is clear: any effort to transfer China's platform experience to contexts like Kazakhstan will need to foreground equity considerations that the Chinese literature currently treats as secondary.

When these four findings are viewed together, a broader pattern emerges. China's experience demonstrates that analytics-driven personalization at scale is achievable when a national platform, policy coordination, systematic faculty development, and routinized analytics are aligned. At the same time, Kazakhstan's research illuminates the conditions that can cause similar efforts to stall: fragmented infrastructure, varying institutional capacity, uneven faculty beliefs, and unresolved questions about whether personalization serves all learners equitably. The juxtaposition does not suggest that one approach is superior; rather, it highlights that the Chinese model, for all its systemic coherence, rests on conditions-centralized governance, sustained investment, and a certain tolerance for top-down deployment-that may not be fully replicable elsewhere. Kazakhstan's context-responsive experiments, in turn, point to the importance of flexibility and the risks of importing platform models without adapting them to local institutional cultures and resource realities. The discussion thus opens onto broader questions about how analytics-enabled personalization can be pursued in ways that are both systemically coherent and contextually sensitive-a balance that neither country has yet fully achieved.

Conclusion and Recommendations

This review set out to understand how analytics and education platforms function as enablers of personalized learning, with China's experience serving as the primary reference point and Kazakhstan providing a comparative counterweight. The synthesis of twenty recent sources yields a clear central message: China has succeeded in building a nationally orchestrated ecosystem in which platform architecture, adaptive analytics, and faculty development frameworks are progressively aligned to personalize learning at scale. The National Smart Education Platform's evolution from a resource repository toward an intelligent, data-responsive environment-documented by Wang et al. (2025) and Cao et al. (2025) – exemplifies a model where personalization is treated not as a boutique pedagogical experiment but as a systemic design principle. At the same time, the comparison with Kazakhstan, where institutions such as Astana IT University have piloted student profiling dashboards and the Stepik platform has been adapted for differentiated mathematics instruction (Soltan et al., 2025; Zhilmagambetova et al., 2023), makes visible the institutional and contextual conditions that determine whether such innovations remain isolated or become embedded in routine practice. The two cases do not simply differ in scale; they illuminate fundamentally different relationships between platform infrastructure, institutional capacity, faculty readiness, and equity-relationships that any country seeking to personalize higher education through analytics must navigate.

A first conclusion to be drawn is that platform-driven personalization at scale rests on more than technical sophistication. China's experience confirms that when analytics are integrated into a national platform and linked to faculty development standards, data-informed instructional routines can become a regular feature of university teaching. Yet the Chinese literature also acknowledges persistent gaps between the capabilities of platforms and the readiness of individual faculty members to interpret and act upon learner data (Zhang & Yang, 2024; Li & Wang, 2023). Kazakhstan's research amplifies this concern from a different vantage point, demonstrating that teachers' beliefs about AI, their digital confidence, and their access to professional learning networks heavily mediate whether adaptive tools enhance or complicate their work (Shaikhanova et al., 2025; Aimicheva et al., 2025). The implication is that investment in platforms without commensurate investment in the human infrastructure that surrounds them will produce uneven results, regardless of how elegant the architecture appears.

A second conclusion relates to the framing of equity. The Chinese platform literature currently treats equity primarily as a question of access, working from the assumption that a centralized platform standardizes quality and thus mitigates regional disparities. By contrast, Kazakhstani scholarship-faced with visible rural-urban digital divides-explicitly raises the possibility that analytics-based personalization might inadvertently reward learners and institutions that are already better resourced, unless corrective policies are deliberately built into the design (Assylbayeva et al., 2025; Bagdaulet, 2025). This divergence is instructive. It suggests that equity cannot be an afterthought of personalization but must be a design criterion from the outset, ideally operationalized through differentiated resource allocation, offline-compatible platform features, and continuous monitoring of participation and outcome gaps across demographic groups. A third insight is that the transfer of platform models across national

contexts is never frictionless. China's top-down, policy-integrated approach benefits from a governance environment that Kazakhstan does not fully share, and Kazakhstan's institutional heterogeneity, while a source of pedagogical creativity, makes system-wide coherence harder to achieve (Abueva et al., 2024). Rather than advocating that one country imitate the other, the comparison points toward the value of hybrid strategies: platform architectures stable enough to provide common analytics infrastructure, yet flexible enough to accommodate institutional variation and local innovation. Kazakhstan's experiments with gamified assessment and adaptive pathways (Tokzhigitova et al., 2025; Rakhmetov et al., 2025) illustrate that valuable design ideas can emerge from smaller-scale initiatives and, if systematically evaluated, might inform the next generation of platform features both domestically and abroad.

These conclusions carry a set of interlocking recommendations. For policymakers, the priority should be to develop shared analytics infrastructure that lowers the technical threshold for institutions while preserving space for local adaptation. China's national platform strategy demonstrates that central coordination can accelerate adoption, but the Kazakhstani case warns against standardization that overlooks the needs of rural campuses and less digitally confident teachers. Funding mechanisms should therefore link platform deployment to demonstrable improvements in faculty data literacy and equitable learner outcomes, rather than measuring success solely by user logins or content coverage. Institutional leaders, in turn, need to recognize that launching a personalized learning platform is not an endpoint but the beginning of a sustained organizational change process. The evidence from both countries suggests that platforms only change learning when they are accompanied by job-embedded professional development, regular opportunities for faculty to collaboratively interpret analytics data, and reward structures that value data-informed pedagogical adaptation (Guo, 2025; Xu, Wang, & Zhao, 2026). Leadership communication that frames personalization as a tool serving faculty rather than a surveillance mechanism is also essential, particularly given the concerns about AI and autonomy that surface in both Chinese and Kazakhstani teacher attitudes.

For faculty developers and instructional designers, the review underscores the importance of moving beyond one-time technology workshops toward longer-term support models that respect the non-linear trajectories of competence development documented by Kapasheva et al. (2024). Analytics dashboards should be accompanied by clear, discipline-specific exemplars of how data can inform instructional decisions-for example, how a flagged drop in quiz performance in an engineering course might trigger a targeted micro-lesson rather than a generic alert. In environments where rural teachers face limited connectivity, developers should also prioritize offline data synchronization and lightweight mobile interfaces that ensure personalization does not become a privilege reserved for well-connected urban universities.

For the research community, the most urgent gap is longitudinal and comparative work that tracks what personalized learning platforms actually do to learning outcomes, engagement patterns, and equity indicators over multiple semesters. Much of the current literature-both Chinese and Kazakhstani-reports on prototypes, pilots, and cross-sectional snapshots. The field needs studies that follow cohorts of learners and teachers as they move from initial platform adoption through routine use, capturing not only successes but also instances where

personalization fails to materialize or produces unintended effects. Further comparative analyses that include other Central Asian or transitional higher education systems would help disentangle which features of China's experience are tied to its particular policy environment and which might hold broader relevance.

Ultimately, the experience of China and the parallel experiments in Kazakhstan converge on a fundamental recognition: analytics and education platforms carry enormous potential to make learning more responsive, but that potential is realized only when technical systems, institutional strategies, and the everyday work of teachers evolve together. The task is not simply to import or replicate a platform model but to cultivate the conditions under which personalized learning can become a sustainable, equitable, and pedagogically meaningful feature of higher education. Both countries, in their distinct ways, are still learning how to do that, and their experiences offer important lessons for others attempting the same journey.

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Жекелендірілген оқыту тәжірибесі ретіндегі аналитика және білім беру платформалары: Қытай тәжірибесі

Түйіндеме. Оқу аналитикасы мен зияткерлік білім беру платформаларын ықпалдастыру жоғары білімде дербестендірілген оқытуды іске асырудың өзекті стратегиясына айналды. Бұл зерттеу Қытайдың Ұлттық ақылды білім беру платформасы мен жасанды интеллект платформаның деректеріне негізделген. Қытай және қазақстандық әдебиеттерге (2023-2026 жж.) жүйелі шолу жасау арқылы мақалада оқу аналитикасы, жасанды интеллект және платформа дизайны оқыту жолдарын дербестендіруге, нақты уақыттағы кері байланысқа және құзыреттілікке негізделген ілгерілеуге қалай үлес қосатыны зерттеледі. Талдау Қытайдың жоғарыдан төмен платформа енгізумен, оқу аналитикасын оқытушыларды дамытуға кіріктірумен және цифрлық сауаттылықтың иерархиялық негіздемесімен сипатталатын жүйелі, саясатпен үйлестірілген тәсілін атап көрсетеді. Бұл тетіктер Қазақстанда қалыптасып келе жатқан адаптивті және ойын түріндегі платформалармен салыстырылады, нәтижесінде ортақ үрдістер (мысалы, дербестендірілген кері байланыс үшін ЖИ қолдану) және контекстік айырмашылықтар (мысалы, институционалдық әлеует пен қала-ауыл алшақтығы) айқындалады. Нәтижелер Қытай тәжірибесі аналитикаға негізделген дербестендірудің ауқымды үлгісін ұсынатынын, алайда оқытушылардың дайындығы, деректерді басқару және тең қолжетімділік саласындағы тұрақты қиындықтарды да айшықтайтынын көрсетеді. Мақала кросс-контекстік оқыту бойынша ұсыныстармен аяқталады және құрылымдалған дербестендіру мен педагогикалық дербестік арасында тепе-теңдік сақтайтын икемді институционалдық аналитикалық негіздердің қажеттілігін атап өтеді. Зерттеу өтпелі экономикадағы жоғары білім беру жүйелерінде жекешелендірілген оқытуды жақсарту үшін аналитика мен білім беру платформаларын қалай ұйымдастыруға болатыны туралы салыстырмалы көзқарас ұсынады.

Түйінді сөздер: оқу аналитикасы; білім беру платформалары; дербестендірілген оқыту; жоғары білім; жасанды интеллект; цифрлық трансформация; адаптивті оқыту; Ұлттық ақылды білім беру платформасы.

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Аналитические и образовательные платформы как инструмент персонализированного обучения: опыт Китая

Аннотация. Интеграция аналитики обучения и интеллектуальных образовательных платформ стала ключевой стратегией реализации персонализированного обучения в высшем образовании. Настоящее исследование посвящено опыту Китая в использовании платформ, основанных на данных Национальной интеллектуальной образовательной платформы и институциональных систем с поддержкой искусственного интеллекта. На основе систематического обзора новейшей китайской и казахстанской литературы (2023-2026) в статье анализируются механизмы, с помощью которых учебная аналитика, искусственный интеллект и дизайн платформ способствуют персонализации образовательных траекторий, обеспечению обратной связи в реальном времени и компетентностно-ориентированному продвижению. Исследование подчеркивает системный и согласованный с государственной политикой подход Китая, характеризующийся централизованным внедрением платформы, интеграцией учебной аналитики в повышение квалификации преподавателей и иерархической моделью цифровой грамотности. Эти механизмы сопоставляются с развивающимися адаптивными и геймифицированными платформами в Казахстане, что выявляет как сходящиеся тенденции (например, использование ИИ для персонализированной обратной связи), так и контекстуальные различия (например, институциональный потенциал и разрыв между городскими и сельскими районами). Полученные результаты свидетельствуют о том, что опыт Китая предлагает масштабируемую модель персонализации на основе аналитики, однако также указывает на сохраняющиеся проблемы с готовностью преподавателей, управлением данными и равным доступом. Статья завершается рекомендациями по кросс-контекстному обучению и подчеркивает необходимость гибких институциональных аналитических систем, которые уравновешивают структурированную персонализацию с педагогической автономией. Исследование вносит сравнительный вклад в понимание того, как аналитика и образовательные платформы могут быть организованы для улучшения персонализированного обучения в странах с переходной высшей школой.

Ключевые слова: аналитика обучения; образовательные платформы, персонализированное обучение, высшее образование, искусственный интеллект, цифровая трансформация, адаптивное обучение, Национальная интеллектуальная образовательная платформа.

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INSTITUTIONAL SUPPORT FOR ACADEMIC STAFF PROFESSIONAL DEVELOPMENT AMID HIGHER EDUCATION DIGITAL TRANSFORMATION: KAZAKHSTAN AND CHINA

Abstract. The digital transformation of higher education has necessitated the development of robust institutional mechanisms to support the professional development trajectories of academic staff. This paper presents a comparative analysis of institutional support systems for faculty professional development in Kazakhstan and China within the context of higher education digitalization. Through a systematic review of contemporary literature from both countries, this study examines the structural, pedagogical, and technological dimensions of faculty development mechanisms. The findings reveal that both Kazakhstan and China have established comprehensive institutional frameworks that integrate digital competence development, continuous learning pathways, and policy support systems. In Kazakhstan, recent studies emphasize the modeling of pedagogical competence and digital maturity among educators, with a focus on technology adoption patterns and their perceived impact on teaching practices. Research highlights the development of methodological competence through information systems and the challenges faced by rural educators in adapting to digital transformation. In China, institutional mechanisms are characterized by leadership-driven technology-enhanced teaching practices, systematic faculty training models, and the construction of digital literacy frameworks. Chinese research emphasizes the role of artificial intelligence in empowering faculty development and the establishment of support service systems aligned with national digitalization strategies. The comparative analysis identifies common challenges including the need for sustainable funding, alignment between institutional policies and individual career trajectories, and the integration of emerging technologies into professional development programs. This study contributes to the understanding of how higher education institutions in transitioning economies can effectively support faculty professional development in the digital age, offering insights for policymakers, institutional leaders, and educational researchers.

Keywords: Institutional mechanisms; professional development; higher education; digital transformation; digital competence; comparative education; technology-enhanced learning; educational policy.

Introduction. The digital transformation of higher education represents a paradigm shift that fundamentally alters teaching, learning, and academic work across global university systems. This transformation necessitates corresponding changes in how academic staff develop professionally, requiring higher ed-

ucation institutions to establish robust institutional mechanisms that support faculty members' continuous professional growth. Kazakhstan and China, as two countries undergoing significant educational modernization, provide compelling cases for examining how institutional frameworks adapt to support academic staff development in the digital age.The contemporary higher education landscape is characterized by an urgent need for faculty members to develop digital competencies that enable effective technology-enhanced teaching practices. Kapasheva et al. (2024) emphasize that modeling pedagogical competence development in higher education educators is essential amid the digitization of the contemporary world, highlighting the complex interplay between technological adoption and pedagogical effectiveness. This challenge is particularly pronounced as institutions grapple with integrating artificial intelligence and emerging technologies into educational practices. Shaikhanova et al. (2025) contribute to this understanding by modeling the digital maturity of educators in the AI era, providing computational analysis of technology adoption patterns and their perceived impact on teaching and learning outcomes.

In the Kazakhstani context, recent research has explored multiple dimensions of faculty professional development within digital transformation frameworks. Assylbayeva et al. (2025) investigate how digital technologies enhance the professional skills of prospective teachers, while Bakytkereiuly, Biloshchytskyi, and Abzhanova (2024) develop methodological approaches for assessing and developing the competence of IT discipline educators. The challenges of digital transformation extend beyond urban universities to rural educational contexts, as Kurmankulova, Kiynova, and Seraliyeva (2022) demonstrate in their examination of professional development for rural teachers adapting to educational digitalization. International comparative perspectives, such as those provided by Chernobai and Tashibaeva (2020) through analysis of TALIS-2018 data, reveal both common challenges and context-specific responses in teacher professional development systems. Furthermore, Aimicheva et al. (2025) explore the implications of AI-supported learning environments for fostering teachers' digital competence and its relationship to interactive teaching and student achievement.

The Chinese higher education system has similarly developed comprehensive institutional mechanisms to support faculty professional development amid digital transformation. Zhang and Chen (2025) examine how leadership influences faculty members' adoption of technology-enhanced teaching practices, highlighting the critical role of institutional guidance. Guo (2025) analyzes pathways for university faculty professional development specifically within the context of educational digital transformation, while Xu, Wang, and Zhao (2026) propose frameworks for building high-quality faculty teaching development systems that address understanding, drivers, and implementation pathways.

Chinese scholarship has increasingly focused on systematic approaches to faculty development. Zhang and Yang (2024) develop digital literacy frameworks and cultivation pathways for university faculty, providing theoretical foundations for institutional practice. Li and Wang (2023) investigate artificial intelligence applications in empowering faculty professional development, identifying mechanisms, challenges, and potential solutions. Chen and Zheng (2024) examine the construction of support service systems for faculty development aligned with national educational digitalization strategies. Wang and Liu (2023)

contribute policy analysis perspectives on institutional support mechanisms operating within Chinese universities.

Despite these substantial individual contributions from both national contexts, limited comparative research examines how institutional mechanisms in Kazakhstan and China differ or converge in supporting academic staff professional development trajectories. This gap is significant given both countries' commitments to educational modernization and their unique positions within Central Asian and East Asian higher education landscapes respectively. Understanding these mechanisms is essential for policymakers, institutional leaders, and educational researchers seeking to design effective support systems that enable faculty to thrive amid ongoing digital transformation.

This paper addresses this gap by synthesizing contemporary research from both countries to examine institutional mechanisms supporting academic staff professional development. The analysis focuses on structural frameworks, pedagogical support systems, technological integration strategies, and policy environments that shape faculty development trajectories in Kazakhstan and Chinese higher education institutions.

Literature Review

The digital transformation of higher education has generated substantial scholarly attention regarding its implications for academic staff professional development. This literature review synthesizes research from Kazakhstan and China, examining institutional mechanisms that support faculty development trajectories in the context of higher education digitalization.

A significant body of research examines how digital transformation necessitates new pedagogical competencies among academic staff. Kapasheva et al. (2024) developed models for pedagogical competence development in higher education educators, demonstrating that effective digital integration requires systematic approaches to competence building rather than ad-hoc technology training. This finding aligns with Shaikhanova et al. (2025), who investigated digital maturity among educators in the AI era, revealing that technology adoption patterns significantly influence perceived teaching effectiveness. Their computational analysis identified distinct trajectories in how faculty members integrate digital tools into pedagogical practices, suggesting the need for differentiated institutional support mechanisms.Aimicheva et al. (2025) extended this line of inquiry by examining teachers' digital competence development within AI-supported learning environments. Their research established correlations between digital competence, interactive teaching practices, and student achievement outcomes, providing empirical justification for institutional investment in faculty digital capacity building.

Kazakhstani scholarship has increasingly focused on the structural dimensions of faculty professional development. Assylbayeva et al. (2025) investigated how digital technologies enhance professional skills among prospective teachers, identifying both opportunities and barriers within Kazakhstani higher education institutions. Their research emphasized the importance of integrating digital competence development into initial teacher preparation programs.Bakytkereiuly, Biloshchytskyi, and Abzhanova (2024) contributed methodological innovations through their development of assessment frameworks for IT discipline faculty competence. Their information system approach demonstrated how data integration can support systematic tracking and development of

faculty capabilities. Kurmankulova, Kiynova, and Seraliyeva (2022) provided crucial insights into rural-urban disparities in professional development access, revealing that rural educators face unique challenges in adapting to digital transformation that institutional mechanisms must address.Chernobai and Tashibaeva (2020) offered comparative perspective through analysis of TALIS-2018 data, positioning Kazakhstani teacher professional development within international contexts and identifying areas where institutional mechanisms require strengthening.

Chinese scholarship emphasizes systematic approaches to faculty development within digital transformation frameworks. Zhang and Chen (2025) examined leadership influences on technology-enhanced teaching practices, demonstrating that institutional leadership plays a critical role in shaping faculty adoption of digital pedagogies. Guo (2025) analyzed professional development pathways specific to digital transformation contexts, identifying multiple trajectories that faculty members navigate.

Table 1 – Overview of key literature sources, main contributions and links to study findings

	Key Sources	Main Contributions	Connection to Findings
Digital Competence Frameworks	Kapasheva et al. (2024); Shaikhanova et al. (2025); Aimicheva et al. (2025); Zhang & Yang (2024); Li & Wang (2023)	Kazakhstan emphasizes emergent, context-sensitive competence development; China develops structured, hierarchical digital literacy frameworks	Reveals fundamental difference in conceptual approaches between the two countries (discussed in Section 4.1)
Institutional Support Structures	Bakytkereiuly et al. (2024); Kurmankulova et al. (2022); Chernobai & Tashibaeva (2020); Xu et al. (2026); Zhang & Chen (2025); Chen & Zheng (2024); Wang & Liu (2023)	Kazakhstan develops technology-enabled assessment systems while addressing rural-urban disparities; China implements systematic frameworks aligned with national policy	Demonstrates contrast between emergent Kazakhstani approaches and systematic Chinese frameworks (discussed in Section 4.2)
Technology Integration and AI	Shaikhanova et al. (2025); Aimicheva et al. (2025); Li & Wang (2023); Zhang & Yang (2024)	Both countries examine AI adoption patterns and implications for teaching, though with different implementation approaches	Both recognize AI's transformative potential; informs Section 4.3 discussion on emerging technologies
Career Trajectory Alignment	Kapasheva et al. (2024); Assylbayeva et al. (2025); Guo (2025); Wang & Liu (2023)	Examines how professional development links to career progression and policy frameworks	Identifies need for stronger alignment between institutional support and individual career trajectories(addressed in Section)
Note – compiled by the authors based on the source [3]			

Note: This table synthesizes the literature reviewed in Section 2 and establishes the analytical foundation for the findings presented in Section 4. The four themes directly inform the organizational structure of the findings section and support the recommendations in Section 5.

Xu, Wang, and Zhao (2026) proposed comprehensive frameworks for building high-quality faculty teaching development systems, articulating the theoretical foundations, driving forces, and implementation pathways that characterize effective institutional support. Zhang and Yang (2024) developed digital literacy frameworks specifically designed for university faculty, providing conceptual tools for designing professional development interventions.Li and Wang (2023) investigated artificial intelligence applications in faculty development, identifying mechanisms through which AI can support personalized professional learning while also highlighting implementation challenges. Chen and Zheng (2024) examined support service system construction aligned with national digitalization strategies, emphasizing the importance of aligning institutional mechanisms with broader policy frameworks. Wang and Liu (2023) contributed policy analysis perspectives, revealing how institutional support mechanisms operate within China's distinctive higher education governance structures.

Despite these substantial contributions, limited comparative research exists examining institutional mechanisms for faculty professional development across Kazakhstan and China. The existing literature predominantly addresses each national context separately, with minimal attention to cross-national learning opportunities or comparative analysis of institutional approaches to supporting academic staff development amid digital transformation. This gap provides the rationale for the present study.

Methodology

This study employs a qualitative comparative literature review approach to examine institutional mechanisms supporting academic staff professional development in Kazakhstan and China within the context of higher education digital transformation. The comparative design enables systematic analysis of similarities and differences between two national contexts undergoing parallel educational modernization processes.

The literature review draws exclusively on the fourteen peer-reviewed sources identified in the reference list. Selection criteria included: (a) direct relevance to higher education faculty professional development, (b) explicit attention to digital transformation contexts, (c) publication in peer-reviewed journals or academic repositories, and (d) representation of both Kazakhstani and Chinese scholarly perspectives. Seven sources address the Kazakhstani context (Kapasheva et al., 2024; Shaikhanova et al., 2025; Assylbayeva et al., 2025; Bakytkereiuly et al., 2024; Kurmankulova et al., 2022; Chernobai & Tashibaeva, 2020; Aimicheva et al., 2025), while seven examine the Chinese context (Zhang & Chen, 2025; Guo, 2025; Xu et al., 2026; Zhang & Yang, 2024; Li & Wang, 2023; Chen & Zheng, 2024; Wang & Liu, 2023).

Thematic analysis was employed to identify recurring patterns and themes across the selected literature. Following established qualitative analysis procedures, each source was systematically reviewed to extract data related to: (a) institutional support structures, (b) professional development mechanisms, (c) digital competence frameworks, (d) policy environments, and (e) implementation challenges. Comparative analysis subsequently examined how these themes manifest within each national context.

The comparative dimension of this study examines institutional mechanisms across four analytical dimensions: structural frameworks (policies, gov-

ernance, resource allocation), pedagogical support systems (training programs, mentoring, communities of practice), technological integration strategies (digital tools, platforms, infrastructure), and career trajectory alignment (linkages between professional development and academic career progression). This framework enables systematic comparison of how Kazakhstani and Chinese higher education institutions support faculty development amid digital transformation while acknowledging each country's unique educational, cultural, and policy contexts.

Limitations

This methodology relies exclusively on published literature and does not include primary data collection. Consequently, findings reflect documented institutional mechanisms rather than direct observation of implementation practices. Future research should complement this analysis with empirical studies examining how these mechanisms operate in practice across diverse institutional contexts in both countries.

Findings and Discussion

This section presents the findings derived from thematic analysis of the fourteen selected sources and discusses their implications for understanding institutional mechanisms supporting academic staff professional development in Kazakhstan and China. The findings are organized around four analytical dimensions derived from the comparative framework outlined in the methodology: digital competence frameworks, institutional support structures, technology integration strategies, and career trajectory alignment.

Digital Competence Frameworks

The literature reveals that both Kazakhstan and China have developed comprehensive conceptual frameworks for understanding and developing faculty digital competence, though with distinct emphases reflecting national contexts.

In Kazakhstan, digital competence frameworks emphasize the integration of pedagogical and technological dimensions. Kapasheva et al. (2024) found that effective digital competence development requires modeling the relationship between educators' pedagogical knowledge and their capacity to integrate technology meaningfully. Their research demonstrated that competence development follows non-linear trajectories, suggesting that institutional support mechanisms must accommodate diverse faculty starting points and learning pathways. This finding aligns with Shaikhanova et al. (2025), whose computational analysis of digital maturity revealed distinct patterns in how Kazakhstani educators adopt and integrate AI technologies into their teaching practices. Their identification of varied adoption patterns underscores the need for differentiated institutional support rather than uniform professional development programs.

Aimicheva et al. (2025) extended these findings by establishing empirical connections between digital competence, interactive teaching practices, and student achievement in AI-supported learning environments. Their research provides evidence that institutional investment in faculty digital capacity building yields measurable pedagogical outcomes, strengthening the rationale for systematic support mechanisms. Assylbayeva et al. (2025) further contributed by examining how digital technologies specifically enhance professional skills among prospective teachers, identifying that early exposure to digital compe-

tence development during initial teacher preparation creates foundations for ongoing professional growth.In contrast, Chinese scholarship has emphasized structured, hierarchical approaches to digital competence development. Zhang and Yang (2024) developed comprehensive digital literacy frameworks specifically designed for university faculty, articulating progressive levels of competence that faculty members should achieve. Their framework provides institutional leaders with clear benchmarks for assessing faculty development needs and designing targeted interventions. Li and Wang (2023) extended this structural approach by examining how artificial intelligence can be systematically integrated into faculty development programming, identifying mechanisms through which AI-enabled personalized learning pathways can support competence development at scale.The comparative analysis reveals an important distinction: Kazakhstani scholarship tends to emphasize emergent, context-sensitive competence development, while Chinese research favors structured, hierarchical frameworks. This difference may reflect broader educational traditions and governance structures in each country, with implications for how institutional mechanisms are designed and implemented.

Institutional Support Structures

The findings reveal substantial differences in how institutional support structures for faculty professional development are organized and implemented in Kazakhstan and China.Kazakhstani institutions appear to be developing support structures that address specific contextual challenges while building toward comprehensive systems. Bakytkereiuly, Biloshchytskyi, and Abzhanova (2024) developed methodological approaches for assessing IT discipline faculty competence through information systems, demonstrating how data integration can support systematic tracking and development of faculty capabilities. Their work suggests that Kazakhstani institutions are leveraging technological solutions to overcome resource constraints and build coherent support systems

However, Kurmankulova, Kiynova, and Seraliyeva (2022) identified significant disparities in professional development access between urban and rural educators in Kazakhstan.

Their research revealed that rural faculty face unique challenges including limited access to digital infrastructure, fewer professional learning opportunities, and isolation from professional communities. These findings suggest that institutional support mechanisms in Kazakhstan must be designed with attention to geographical and resource disparities, potentially requiring differentiated approaches for different institutional contexts. Chernobai and Tashibaeva (2020) provided valuable comparative perspective through analysis of TALIS-2018 data, positioning Kazakhstani teacher professional development within international contexts. Their findings identified areas where Kazakhstani institutional mechanisms require strengthening, particularly in providing sustained, job-embedded professional learning opportunities rather than episodic training events.

Chinese institutional support structures appear more systematically developed and aligned with national policy frameworks. Xu, Wang, and Zhao (2026) proposed comprehensive frameworks for building high-quality faculty teaching development systems, articulating the theoretical foundations, driving forces, and implementation pathways that characterize effective institutional support.

Table 2 – Analytical themes, key findings for Kazakhstan and China, and corresponding policy-practice

Analytical Theme	Key Findings: Kazakhstan	Key Findings: China	Connection to Recommendations
Digital Competence Frameworks (Section 4.1)	Emergent, context-sensitive competence development Non-linear trajectories requiring differentiated support (Kapasheva et al., 2024) Varied digital maturity patterns among educators (Shaikhanova et al., 2025) Empirical links between competence, interactive teaching, and student achievement (Aimicheva et al., 2025)	Structure, hierarchical frameworks with progressive levels (Zhang & Yang, 2024) Systematic AI integration into competence development (Li & Wang, 2023) Early exposure during teacher preparation (Assylbayeva et al., 2025)	Supports recommendation for differentiated professional development pathways that accommodate diverse faculty starting points and learning preferences
Institutional Support Structures (S ection 4.2)	Technology-enabled assessment systems for faculty competence (Bakytkereiuly et al., 2024) Significant rural-urban disparities in access to development opportunities (Kurmankulova et al., 2022) Need for sustained, job-embedded learning (Chernobai & Tashibaeva, 2020)	Comprehensive frameworks aligned with national policy (Xu et al., 2026) Critical role of leadership in shaping faculty outcomes (Zhang & Chen, 2025) Multi-level coordination across policy, province, and institution (Wang & Liu, 2023) Integrated support service systems (Chen & Zheng, 2024)	Informs recommendations for sustained resource allocation and attention to equity in professional development access
Technology Integration and AI (Section 4.3)	AI adoption patterns influence teaching effectiveness perceptions (Shaikhanova et al., 2025) Faculty need support for both technical skills and pedagogical beliefs (Aimicheva et al., 2025)	AI-enabled personalized professional learning pathways (Li & Wang, 2023) AI competence positioned as advanced digital literacy level (Zhang & Yang, 2024)	Supports recommendation for investigating AI-enabled professional development effectiveness and scalable implementation
Career Trajectory Alignment (Section 4.4)	Professional skills enhancement through digital technologies (Assylbayeva et al., 2025) Need for stronger links between development and career progression	Multiple professional development pathways identified (Guo, 2025) Policy analysis reveals need for coordination across governance levels (Wang & Liu, 2023)	Informs recommendation for linking institutional mechanisms with faculty career progression and cross-national learning
Note – compiled by the authors based on the source [5]			

This table synthesizes the key findings presented in Section 4 and establishes direct connections to the recommendations developed in Section 5. The four themes correspond to the analytical framework introduced in the methodology and maintain coherence with the literature review themes presented in Table 2.

Their research emphasizes the importance of integrating faculty development with institutional strategic planning and resource allocation.Zhang and Chen (2025) examined the critical role of leadership in shaping faculty development outcomes, demonstrating that institutional leaders significantly influence faculty members' adoption of technology-enhanced teaching practices. Their findings suggest that effective institutional support mechanisms require not only policies and programs but also leadership commitment to modeling and championing professional development.Chen and Zheng (2024) investigated the construction of support service systems aligned with national digitalization strategies, revealing how Chinese higher education institutions are developing comprehensive infrastructure to support faculty development. Their research emphasizes the importance of aligning institutional mechanisms with broader policy frameworks, ensuring that faculty development receives sustained policy attention and resource allocation.Wang and Liu (2023) contributed policy analysis perspectives, revealing how institutional support mechanisms operate within China's distinctive higher education governance structures. Their research identified that effective support requires coordination across multiple levels: national policy frameworks, provincial implementation strategies, and institutional programming.

Technology Integration and AI in Faculty Development

Both Kazakhstani and Chinese scholarship increasingly focus on the role of emerging technologies, particularly artificial intelligence, in transforming faculty professional development.In Kazakhstan, Shaikhanova et al. (2025) examined how educators develop digital maturity specifically in relation to AI technologies, identifying patterns of adoption and resistance that institutional support mechanisms must address. Their computational analysis revealed that faculty members' perceived impact of AI on their teaching significantly influences their willingness to engage with these technologies, suggesting that institutional support should address both technical skills and pedagogical beliefs.Aimicheva et al. (2025) further explored the implications of AI-supported learning environments for teacher digital competence, establishing that faculty development in AI contexts requires attention to both technological proficiency and pedagogical adaptation. Their research demonstrated that effective AI integration depends on faculty members' capacity to redesign teaching practices rather than simply add technology to existing approaches.Chinese scholarship has taken a more systematic approach to AI integration in faculty development. Li and Wang (2023) comprehensively examined AI-empowered faculty professional development, identifying specific mechanisms through which AI can support personalized professional learning. Their research revealed that AI-enabled systems can analyze faculty teaching practices, identify development needs, and recommend targeted learning resources, potentially transforming how institutions support professional growth at scale.Zhang and Yang (2024) integrated AI considerations into their broader digital literacy frameworks, recognizing that faculty must develop competence not only in using AI tools but also in understanding AI's implications for teaching, learning, and academic work. Their hierarchical framework positions AI competence as an advanced level of digital literacy that faculty should progressively develop.

Comparative Analysis and Discussion

The comparative analysis reveals both convergences and divergences in how Kazakhstan and China approach institutional support for faculty professional development amid digital transformation.

Convergences include shared recognition that digital transformation fundamentally alters faculty development needs, requiring new approaches to competence building. Both countries' scholarship emphasizes the importance of moving beyond episodic training toward sustained, embedded professional learning opportunities. Kapasheva et al. (2024) and Xu et al. (2026) both argue that effective institutional mechanisms must address the complexity of pedagogical change rather than treating digital competence as simply technical skill acquisition.Both national contexts also recognize the importance of leadership in shaping faculty development outcomes. Zhang and Chen (2025) explicitly identified leadership influences in Chinese contexts, while Kazakhstani scholarship implicitly acknowledges leadership roles through attention to institutional decision-making and resource allocation (Bakytkereiuly et al., 2024; Kurmankulova et al., 2022). Divergences are equally significant. Chinese approaches appear more systematically developed and aligned with national policy frameworks, reflecting China's centralized educational governance structures. Kazakhstani scholarship reveals more emergent, context-responsive approaches, perhaps reflecting Kazakhstan's ongoing educational reforms and diverse institutional landscape. These differences suggest that institutional mechanisms must be designed with attention to national governance contexts rather than simply adopting approaches from other systems.

The findings also reveal that both countries face implementation challenges despite different approaches. Kazakhstani research identifies rural-urban disparities (Kurmankulova et al., 2022) and the need for more sustained professional learning opportunities (Chernobai & Tashibaeva, 2020). Chinese scholarship, while documenting systematic frameworks, implicitly reveals challenges in implementation at scale across diverse institutional contexts (Chen & Zheng, 2024; Wang & Liu, 2023).

Implications for Institutional Practice

These findings carry several implications for higher education institutions seeking to strengthen support for faculty professional development amid digital transformation.

First, institutional mechanisms should recognize that faculty digital competence development follows varied trajectories requiring differentiated support. Uniform professional development programs are unlikely to meet diverse faculty needs, as demonstrated by Kapasheva et al. (2024) and Shaikhanova et al. (2025). Institutions should develop flexible support systems that accommodate different starting points, learning preferences, and disciplinary contexts.Second, institutional support must address both technical and pedagogical dimensions of digital transformation. Aimicheva et al. (2025) and Li and Wang (2023) both emphasize that effective technology integration requires pedagogical redesign rather than simply adding technology to existing practices. Institutional mechanisms should therefore support faculty in reimagining teaching approaches rather than focusing narrowly on tool proficiency.

Third, institutional leaders play critical roles in shaping faculty development outcomes, as demonstrated by Zhang and Chen (2025). Effective institutional mechanisms require leadership commitment to modeling professional learning,

allocating resources, and creating institutional cultures that value continuous development.Fourth, institutional support systems must be designed with attention to equity and access, addressing disparities that Kurmankulova, Kiynova, and Seraliyeva (2022) identified in Kazakhstani contexts. Institutions should ensure that all faculty members, regardless of geographical location or institutional resources, have access to quality professional development opportunities.Finally, institutional mechanisms should be aligned with broader policy frameworks and sustained through consistent resource allocation, as Chinese scholarship emphasizes (Chen & Zheng, 2024; Xu et al., 2026). Sustainable faculty development requires institutional commitment beyond short-term projects or initiatives.

Conclusion and Recommendations

This comparative literature review has examined institutional mechanisms supporting academic staff professional development in Kazakhstan and China within the context of higher education digital transformation. The analysis reveals that both countries have developed comprehensive approaches to faculty development, though with distinct characteristics reflecting their respective educational governance structures and national contexts.

Kazakhstani scholarship emphasizes emergent, context-sensitive competence development, with attention to modeling pedagogical competence (Kapasheva et al., 2024), assessing digital maturity (Shaikhanova et al., 2025), and addressing rural-urban disparities (Kurmankulova et al., 2022). Chinese research demonstrates systematically developed frameworks aligned with national policies, including structured digital literacy frameworks (Zhang & Yang, 2024), leadership-driven implementation (Zhang & Chen, 2025), and integrated support service systems (Chen & Zheng, 2024).

Both national contexts converge in recognizing that effective institutional mechanisms must address the complexity of pedagogical change, move beyond episodic training toward sustained professional learning, and leverage emerging technologies including artificial intelligence to personalize faculty development (Aimicheva et al., 2025; Li & Wang, 2023). However, implementation challenges persist, including resource constraints, varying institutional capacities, and the need for greater alignment between institutional support and individual career trajectories.

Based on these findings, the following recommendations are proposed for higher education institutions, policymakers, and educational researchers:For institutional leaders: Develop differentiated professional development pathways that accommodate diverse faculty digital competence levels and disciplinary contexts (Kapasheva et al., 2024; Shaikhanova et al., 2025). Establish leadership commitment to modeling professional learning and creating institutional cultures that value continuous development (Zhang & Chen, 2025). Allocate sustained resources to faculty development infrastructure rather than relying on episodic project funding (Xu et al., 2026).

For policymakers: Address equity in professional development access, particularly for rural and under-resourced institutions (Kurmankulova et al., 2022). Align national digitalization strategies with faculty development policies to ensure coherent support across governance levels (Chen & Zheng, 2024; Wang & Liu, 2023). Develop national digital competence frameworks that institutions can adapt to their specific contexts (Zhang & Yang, 2024).For researchers:

Conduct empirical studies examining how institutional mechanisms operate in practice across diverse institutional contexts in both countries. Investigate the effectiveness of AI-enabled professional development approaches (Li & Wang, 2023; Aimicheva et al., 2025). Explore cross-national learning opportunities through systematic comparative research that identifies transferable practices and context-specific adaptations.

Ultimately, effective institutional mechanisms for supporting academic staff professional development must balance structured frameworks with flexibility for contextual adaptation, ensuring that faculty members are equipped to thrive amid ongoing digital transformation in higher education.

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Жоғары білім берудің цифрлық трансформациясы жағдайында академиялық қызметкерлердің кәсіби дамуына институционалдық қолдау: Қазақстан мен Қытай

Түйіндеме. Жоғары білім берудің цифрлық трансформациясы академиялық қызметкерлердің кәсіби даму траекторияларын қолдау үшін сенімді институционалдық механизмдерді әзірлеуді қажет етті. Бұл мақалада жоғары білім беруді цифрландыру аясында Қазақстан мен Қытайдағы оқытушылардың кәсіби дамуына арналған институционалдық қолдау жүйелерінің салыстырмалы талдауы ұсынылған. Екі елдің заманауи әдебиеттеріне жүйелі шолу жасау арқылы бұл зерттеу оқытушылардың даму механизмдерінің құрылымдық, педагогикалық және технологиялық өлшемдерін зерттейді. Зерттеу нәтижелері Қазақстан мен Қытайдың цифрлық құзыреттілікті дамытуды, үздіксіз оқыту жолдарын және саясатты қолдау жүйелерін біріктіретін кешенді институционалдық негіздерді құрғанын көрсетеді. Қазақстанда соңғы зерттеулер технологияны енгізу үлгілеріне және олардың оқыту тәжірибесіне әсеріне баса назар аудара отырып, педагогикалық құзыреттілік пен цифрлық жетілуді модельдеуге баса назар аударады. Зерттеулер ақпараттық жүйелер арқылы әдіснамалық құзыреттіліктің дамуын және ауылдық білім берушілердің цифрлық трансформацияға бейімделудегі қиындықтарын көрсетеді. Қытайда институционалдық механизмдер көшбасшылыққа негізделген технологиямен жетілдірілген оқыту тәжірибелерімен, жүйелі оқытушыларды оқыту модельдерімен және цифрлық сауаттылық негіздерін құрумен сипаттала-

ды. Қытай зерттеулері жасанды интеллекттің оқытушылардың дамуын нығайтудағы және ұлттық цифрландыру стратегияларына сәйкес қолдау қызметтерін құрудағы рөлін атап көрсетеді. Салыстырмалы талдау тұрақты қаржыландыру қажеттілігін, институционалдық саясат пен жеке мансаптық траекториялар арасындағы үйлесімділікті және жаңа технологияларды кәсіби даму бағдарламаларына интеграциялауды қоса алғанда, ортақ қиындықтарды анықтайды. Бұл зерттеу өтпелі экономикадағы жоғары оқу орындарының цифрлық дәуірде оқытушылардың кәсіби дамуын қалай тиімді қолдай алатынын түсінуге ықпал етеді, саясаткерлерге, институционалдық көшбасшыларға және білім беру саласындағы зерттеушілерге түсініктер ұсынады.

Түйінді сөздер: институционалдық механизмдер, кәсіби даму, жоғары білім, цифрлық трансформация, цифрлық құзыреттілік, салыстырмалы білім беру, технологияны жетілдіру, білім беру саясаты.

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Институциональные механизмы поддержки траекторий профессионального развития преподавательского состава в контексте цифровой трансформации высшего образования в Казахстане и Китае

Аннотация. Цифровая трансформация высшего образования потребовала разработки надежных институциональных механизмов поддержки траекторий профессионального развития преподавательского состава. В данной статье представлен сравнительный анализ институциональных систем поддержки профессионального развития преподавателей в Казахстане и Китае в контексте цифровизации высшего образования. На основе систематического обзора современной литературы из обеих стран в данном исследовании рассматриваются структурные, педагогические и технологические аспекты механизмов развития преподавательского состава. Результаты показывают, что как Казахстан, так и Китай создали комплексные институциональные рамки, которые интегрируют развитие цифровой компетентности, непрерывные пути обучения и системы политической поддержки. В Казахстане недавние исследования акцентируют внимание на моделировании педагогической компетентности и цифровой зрелости среди преподавателей, с упором на модели внедрения технологий и их предполагаемое влияние на педагогическую практику. Исследования освещают развитие методологической компетентности посредством информационных систем и проблемы, с которыми сталкиваются сельские преподаватели при адаптации к цифровой трансформации. В Китае институциональные механизмы характеризуются практикой обучения с использованием технологий, ориентированной на лидерство, систематическими моделями подготовки преподавателей и построением рамок цифровой грамотности. Китайские исследования подчеркивают роль искусственного интеллекта в расширении возможностей развития преподавательского состава и создании систем поддержки, соответствующих национальным стратегиям цифровизации. Сравнительный анализ выявляет общие проблемы, включая необходимость устойчивого финансирования, согласование институциональной политики с индивидуальными карьерными траекториями, а также интеграцию новых технологий в программы профессионального развития. Данное исследование способствует пониманию того, как высшие учебные заведения в странах с переходной экономикой могут эффективно поддерживать профессиональное развитие преподавателей в цифровую эпоху, предлагая ценные сведения для политиков, руководителей учреждений и исследователей в области образования.

Ключевые слова: институциональные механизмы, профессиональное развитие, высшее образование, цифровая трансформация, цифровая компетентность, сравнительное образование, обучение с использованием технологий, образовательная политика.

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ARTIFICIAL INTELLIGENCE AND VIRTUAL REALITY: THE ECONOMIC EFFICIENCY OF DIGITAL CONTENT

Abstract. This study analyzes the impact of artificial intelligence and virtual reality technologies on the creation, personalization, distribution, and cost-effectiveness of digital content. Particular attention is paid to the study of the mechanisms by which the integration of AI and VR contributes to the automation of production processes, increased user engagement, increased consumer value, scaling digital products and the formation of new monetization models. The research uses methods of content analysis and comparative analysis to compare traditional and technologically advanced approaches to creating digital content.

Digital models of large international companies Netflix and Meta are considered as practical examples, demonstrating various uses of AI and VR. The results of the study demonstrate that artificial intelligence mainly helps to optimize time and transaction costs, personalize content and increase the efficiency of its distribution. At the same time, virtual reality enhances interactivity, presence, and audience engagement, opening up new opportunities for monetization. It has been revealed that the maximum economic potential is achieved with the integrated integration of artificial intelligence and virtual reality, when automation and personalization are combined with user immersion in the created environment.

Keywords: VR, artificial intelligence, economic efficiency, digital content, company

Introduction. In the context of digital transformation, artificial intelligence (AI) and virtual reality (VR) technologies are being actively introduced, which are changing the way cultural content is created and perceived.

Modern digital platforms, interactive media, and virtual technologies are developing new approaches to storytelling based on interactivity, personalization, and presence.

Virtual reality allows the user not only to observe what is happening, but also to create their own world by interacting with virtual spaces and characters. This opens up new opportunities for cultural industries such as cinema, museums, tourism, the gaming industry, and expanded art.

Despite the number of studies devoted to the study of reality, digital storytelling and the use of artificial intelligence in media, the issues of the integrated use of AI and virtual reality in the cultural sphere remain insufficiently studied.

V. V. F. Sanchez-Vives and M. Slater studied the phenomenon of presence and immersion in virtual reality. Their research shows that VR differs from traditional digital media in that it creates a user's sense of physical presence in a virtual environment. This is important for digital content, as a higher level of presence can change the way a user interacts with a product.

The research of V. V. F. Sanchez-Vives and M. Slater creates a theoretical basis for understanding why VR can add value to digital content. However, they do not provide a complete assessment of its economic effectiveness [1].

Wang J. is exploring the potential of using augmented reality technologies, including virtual reality, to change the traditional way of storytelling. He believes that XR allows you to turn passive content consumption into a more active interaction with the story [2].

The author also draws attention to economic aspects such as the high cost of technology and accessibility issues. This allows us to conclude that the economic effect of VR content depends not only on its interactivity, but also on the cost of creating and accessibility of the technology to the audience.

3. Wu Y. J., Liu D. conducted a study on the impact of augmented and virtual reality technologies on the creation and consumption of digital content [3].

The authors associate the development of immersive technologies with the formation of new markets in the gaming industry, entertainment, media, and retail.

Of particular importance is their conclusion that personalization and increased user engagement can be linked to commercial models, including subscriptions and other monetization methods. Thus, user engagement becomes one of the tools for turning the technological quality of digital content into economic value.

In research on virtual reality, the Organization for Economic Cooperation and Development considers VR not only as a tool for creating immersive experiences, but also as a technology that can be scaled and generate revenue in certain areas of application [4].

The OECD Digital Economy Outlook 2024 report notes that VR has a proven ability to scale, and some of its use cases are already showing economic returns. This is important because it allows you to move from studying the user experience to evaluating the return on investment, scalability, and cost-effectiveness of VR content [4].

The OECD report on immersive technologies, published in 2026, notes that these technologies can become a source of new economic opportunities [5].

The study demonstrates that virtual reality, augmented reality, mixed reality and virtual worlds are changing the way people and organizations interact with digital content. Economic benefits can be achieved through the

development of technological ecosystems, the emergence of new services, the development of marketing, trade and employment.

Thus, AI and VR should not be considered as separate technologies, but as elements of a digital economic ecosystem capable of creating additional value for digital content.

As a result of the analysis of scientific and analytical works, three main areas of research can be identified:

1. The impact of VR on the user's presence and immersion.
2. Create personalized and interactive digital content using AI and XR.
3. The emergence of new economic opportunities due to scaling, monetization and increasing the value of digital products.

There is a gap between these areas of research: the technological characteristics of AI and VR are being actively studied, but their combined impact on the economic efficiency of digital content remains insufficiently systematized.

In the context of the digital transformation of the creative and media industries, the issue of developing and implementing new methods of creating and distributing digital content based on the use of artificial intelligence and virtual reality technologies is of particular importance.

The integration of AI and VR not only allows you to create interactive and personalized content, but also automate some stages of its production. This helps to increase user engagement and expand the scaling capabilities of digital products.

In this regard, it is necessary to assess the extent to which the use of these technologies contributes to reducing production costs, increasing the value of content for consumers, increasing income and overall economic efficiency of digital products.

The purpose of the study is to identify the economic prospects of combining artificial intelligence and virtual reality technologies in the process of creating, adapting and promoting digital content, as well as to assess their impact on the economic performance of digital products.

To achieve this goal, it is necessary to solve the following tasks:

To study the theoretical and conceptual foundations of digital and immersive storytelling, as well as to determine the role of virtual reality technologies in the creation and distribution of digital content.

To analyze the possibilities of artificial intelligence and virtual reality in the field of creation, automation, adaptation and personalization of digital content. Explore how they affect the level of engagement and consumer value of the content.

To identify the economic consequences of integrating artificial intelligence and virtual reality. To develop a method for evaluating the economic effectiveness of digital content, taking into account production costs, scalability, demand, profitability and monetization opportunities.

The scientific novelty of the research lies in a comprehensive analysis of the integration of artificial intelligence and virtual reality technologies as factors contributing to the economic efficiency of digital content. Unlike works that primarily consider AI and VR in terms of technological capabilities, user experience, or cultural influence, this paper proposes to explore their

relationship through the prism of the economic outcomes of digital production and consumption.

The innovative approach is to develop a comprehensive method that combines the technical and economic aspects of creating digital content. Within the framework of this approach, artificial intelligence is considered as a tool for automating, generating and customizing content, while virtual reality serves as a medium for its immersive presentation and interaction with the user. Their combined use creates prerequisites for improving the quality and value of content for consumers, expanding the audience, reducing production costs and developing new monetization models.

Research methods.

The study uses methods of content analysis and comparative analysis to comprehensively examine the impact of artificial intelligence and virtual reality on the creation and development of digital content.

With the help of content analysis, we systematize scientific publications and analytical materials in order to identify key technological and economic trends in the use of AI and VR.

The comparative analysis makes it possible to compare traditional and technologically advanced approaches to creating digital content based on criteria such as production costs, level of personalization, user engagement, scalability, and monetization opportunities.

The results help us assess the economic potential of integrating AI and VR into digital content creation, as well as understand how they can improve its effectiveness.

Results and discussions. At the initial stage of the research, an analysis of scientific articles and analytical materials was carried out, which are devoted to the use of artificial intelligence, virtual reality and other technologies that create a presence effect in the process of creating digital content.

As a result of the analysis, several key aspects were identified: automation of production, personalization of user experience, increasing the level of audience engagement and the formation of new approaches to monetization.

In scientific papers, artificial intelligence is considered not only as a tool for creating text, images, audio and video, but also as a technology that can optimize individual stages of digital content production [6], [7], [8], [9], [10], [11]. Virtual reality, in turn, creates an interactive environment in which the user not only receives the finished product, but actively interacts with it.

Thus, the economic effect is achieved through a combination of automation of production and increasing the value of the digital product for the consumer (table 1).

Certain trends indicate that the integration of artificial intelligence and virtual reality can affect the economic efficiency of digital content through two main aspects.

The first aspect is related to supply optimization, that is, reducing production costs and speeding up development. The second aspect concerns increasing the value of the product to the user, including interactivity, personalization, and deeper engagement.

The Organization for Economic Cooperation and Development emphasizes that artificial intelligence can support other digital technologies, including

virtual environments, through its capabilities in forecasting, personalization, speech recognition, automatic interaction, and language translation [12].

Table 1 – Key applications of artificial intelligence and virtual reality in the creation of digital content

Area	Artificial Intelligence Capabilities	Virtual Reality Capabilities	Potential Economic Effect
Content production	Script, image, audio, and video generation; automated editing	Visualization and testing of digital scenes	Reduction in time and labor costs
Personalization	User data analysis and content adaptation	Development of individualized interactive scenarios	Increased consumer value and likelihood of repeated use
Audience engagement	Adaptive recommendations and system responses	Sense of presence, interactivity, and spatial interaction	Increased duration of user engagement with content
Scalability	Automated creation of different content versions	Distribution of digital products through virtual environments	Expansion of the audience without a proportional increase in costs
Monetization	Demand analysis and prediction of user behavior	Virtual events, digital products, and interactive services	Development of new revenue streams
Quality management	Automated content verification, moderation, and analysis	Testing of user scenarios in virtual environments	Reduction of operational risks and content revision costs
Sources: compiled by author based on the data [6-11]			

Immersive environments can help reduce time and transportation costs, opening up new opportunities for digital services and economic activities.

During the content analysis, the significant potential of artificial intelligence in improving the process of creating digital content was discovered.

Thanks to generative models, it is possible to automate the creation of initial concepts, visual materials, soundtracks, and individual elements of virtual spaces. This reduces production time and gives content creators more opportunities to develop ideas, edit, and control quality.

The official OECD report notes that artificial intelligence can be used to create two-dimensional and three-dimensional images, texts and videos. In virtual worlds, generative AI also allows you to create more realistic digital characters that can react to user actions in real time (table 2).

At the same time, the economic efficiency of artificial intelligence is not something that is taken for granted. It depends on the quality of the source data, the cost of computing resources, the level of staff training, the need for human control, and the cost of integrating AI into the existing production process.

The Organization for Economic Cooperation and Development notes that the spread of artificial intelligence is still heterogeneous, and its productivity depends on the readiness of organizations and their access to the necessary resources.

The analysis of content has revealed that virtual reality has a significant influence on how users perceive and value digital content. Unlike conventional linear digital formats, VR offers the experience of immersion, interactivity,

spatial engagement, and the ability for users to independently determine the path of their interaction with content. The tracking of user movements is a crucial technological feature that sets VR apart from other digital environments. This results in a more pronounced sense of presence, where the user feels like they are actively participating in the virtual space.

Table 2 – Impact of AI on individual stages of digital content production

Production Stage	Traditional Approach	AI-Based Approach	Economic Result
Idea Development	Manual preparation of concepts and scripts	Generation and comparison of multiple concepts	Reduction in preliminary development time
Creation of Visual Materials	Work performed by designers and graphics specialists	Generation of images and 3D elements	Reduction in the cost of preparing individual materials
Editing and Processing	Large volume of repetitive operations performed manually	Automated editing, processing, and modification	Increased productivity
Content Adaptation	Creation of separate versions for different audience groups	Automated personalization and content modification	Reduction in marginal costs for additional versions
User Behavior Analysis	Use of limited data and manual processing	Automated behavior analysis and demand forecasting	More informed decision-making
Moderation and Quality Control	Content reviewed by specialists	Algorithm-based preliminary screening	Reduction in operating costs
Sources: compiled by author			

The features of virtual reality are directly connected to the potential economic worth of a digital product. The presence effect enhances the appeal of content, interactivity extends the duration of user engagement with the digital environment, and spatial interaction fosters a more profound emotional and functional experience. The option to customize the interaction path personalizes the user experience, while immersive visualization can heighten interest in a digital product and the desire to purchase it. Furthermore, virtual events and other digital formats enable you to reach a wider audience without the need for physical user presence, potentially reducing individual organizational and operational expenses.

The findings of the study indicate that the implementation of VR alone does not necessarily lead to a rise in the economic performance of digital content. A financial impact is only achieved when an enhancement in user engagement results in quantifiable behavioral and commercial outcomes, such as increased time spent, repeated visits, purchase of a digital product, subscription, or enhanced user willingness to pay. Consequently, the economic worth of VR should be evaluated not only based on its technological features, but also on its capacity to transform into additional consumer demand and revenue.

A study of virtual shopping reveals that visual appeal, the sense of presence, and interactivity are positively linked to the quality of the user experience, the intention to continue using virtual reality, and impulsive purchasing behavior. This suggests that enhancing the quality of immersive

interaction can contribute to the emergence of additional commercial effects for digital products.

A similar pattern is observed when examining virtual events. A study of users' willingness to pay for virtual concerts demonstrates that their willingness to pay is influenced by perceived usefulness, usability, their attitude towards the virtual format, and their intention to purchase the appropriate product. Therefore, the economic potential of virtual reality is determined not only by the level of technological sophistication of the digital product, but also by how much the user perceives the experience as valuable, convenient, and having additional value.

The findings of the research allow us to outline the process of the economic influence of virtual reality as follows: the impact of immersion and interactivity → enhancing the quality of the user experience → boosting engagement and consumer value → increasing the likelihood of continued use or purchase → expanding the potential for monetizing digital content.

When VR is combined with artificial intelligence, this process can be further enhanced by personalizing content, tailoring the virtual environment to individual user behavior, and automating various aspects of digital products. The OECD highlights that AI can be employed to generate and adapt both 2D and 3D content, as well as to personalize immersive interactions, thereby enhancing the scalability and efficiency of digital content creation.

It is essential to view VR not merely as a technological means of visualization, but also as a crucial element in the creation of the economic worth of digital content. Its influence is evident through enhanced user engagement, broader audience reach, the development of novel revenue models, and the enhancement of consumer value. Moreover, the synergy between VR and AI lays the groundwork for the transformation from a static digital product to a dynamic and personalized experience, which can contribute to reduced production expenses and improved overall economic performance.

For a clearer understanding of the economic efficiency of integrating artificial intelligence and virtual reality, it is advisable to combine the results of a comparative analysis of technologically improved digital content with the main economic results of its application(table 3).

Two major international brands, Netflix and Meta, can be considered as practical examples, as their digital business models demonstrate different approaches to using AI and immersive technologies.

Netflix primarily uses AI to personalize recommendations, analyze user behavior, and optimize digital content. At the same time, Meta is developing an ecosystem of virtual and mixed reality through Quest and related digital products. This comparison allows us to demonstrate how different combinations of AI and VR can affect the production, user interaction, personalization, scaling, and monetization of digital content.

The comparison shows that Netflix and Meta offer different approaches to improving the cost-effectiveness of digital content.

In the case of Netflix, the main economic effect is achieved through the use of artificial intelligence to analyze large amounts of user data, personalize recommendations, and optimize the distribution of digital content. This allows you to create a unique user experience without having to develop separate content for each user.

Table 3 – Comparative evaluation of digital content with artificial intelligence and virtual reality support: Netflix and Meta

Criterion	Traditional Digital Content Model	Netflix: AI-Enhanced Content Model	Meta: AI- and VR-Enhanced Content Model	Economic Implication
Content creation	Predominantly manual production and editing	AI-supported content analysis, recommendation and optimization of content delivery	AI combined with immersive technologies for development of virtual and mixed-reality experiences	Reduction of selected production and content-management costs
Content structure	Mainly linear and predetermined	Adaptive content selection based on individual user preferences	Interactive, immersive and increasingly adaptive digital environments	Greater flexibility and consumer value
User interaction	Limited interaction with digital content	Personalized recommendations and user-specific content discovery	Direct interaction with 3D and virtual environments	Higher engagement and duration of interaction
Personalization	Primarily based on broad audience segmentation	Algorithmic analysis of viewing behavior and personalized recommendations	AI-supported adaptation of immersive experiences and virtual environments	Higher consumer value and potential retention
Scalability	Expansion generally requires additional content-production and distribution resources	One digital platform can personalize content for millions of users simultaneously	Digital immersive products can be distributed across a large global user base	Lower marginal cost of serving additional users
Monetization	Advertising, sales, subscriptions	Subscription-based model supported by personalized content consumption	Hardware, subscriptions, digital services and virtual experiences	Diversification and expansion of revenue sources
Audience engagement	Primarily passive consumption	Increased relevance of recommended content	Immersion, presence, interactivity and personalization	Potential increase in customer lifetime value
Operational efficiency	Significant reliance on manual processes	Automation of data analysis and content recommendation	AI-based automation combined with VR/MR technologies	Higher productivity and more efficient resource allocation
Investment requirements	Relatively lower technological requirements	Investments in AI infrastructure, data analytics and digital platforms	Higher investments in VR/MR hardware, software, AI and ecosystem development	Higher initial costs but potential long-term technological returns
Key risks	Production costs and limited personalization	Data privacy, algorithmic bias and dependence on digital infrastructure	High technology costs, privacy, cybersecurity, accessibility and intellectual-property risks	Need for comprehensive cost-benefit and risk assessment
Sources: compiled by author based on the data [13], [14], [15]				

Thus, economic efficiency is achieved mainly due to the scalability of algorithmic solutions, increased subscription value, and more efficient use of existing digital content.

In the case of Meta, the economic model is characterized by high technological complexity, since the development of virtual and mixed reality requires investments not only in software and artificial intelligence, but also in hardware infrastructure, including virtual and mixed reality devices.

This model also opens up prospects for creating new digital markets, interactive services, virtual products, and forms of user interaction. Therefore, the potential economic benefit of Meta is not only to reduce costs, but also to create new sources of income based on an immersive digital ecosystem.

So, comparing the two brands demonstrates that the economic benefits of artificial intelligence and virtual reality can be achieved in two ways that complement each other.

Artificial intelligence primarily improves the efficiency of production, analysis, personalization, and distribution of digital content. At the same time, virtual reality increases the consumer value of a product, the level of engagement, and the opportunity to create new monetization models.

The most promising option is to use them together. Artificial intelligence provides automation and adaptability, while virtual reality provides immersiveness and interactivity.

As a result, a chain is created in which artificial intelligence and virtual reality work together to reduce unit costs and personalize the product. This, in turn, increases user engagement, increases the consumer value of the product, and expands monetization opportunities. All this leads to an increase in the economic efficiency of digital content.

Discussion.

The results of the study demonstrate that the use of artificial intelligence and virtual reality in digital content can significantly increase its economic efficiency.

Using the example of companies like Netflix and Meta, you can see how these technologies create economic value. AI helps automate processes, personalize content, analyze user behavior, and expand audience reach. VR also increases the level of immersion, interactivity and user engagement, as well as creates conditions for the development of new digital products and monetization models.

Therefore, when assessing the economic effectiveness of AI and VR, it is necessary to take into account not only the reduction of production costs, but also the growth of consumer value, audience engagement, scalability, income and necessary investments.. However, the research results demonstrate that the use of technology alone does not guarantee an increase in profits.

The final economic effect depends on how additional income and cost savings are correlated, on the one hand, with the costs of technological infrastructure, software, personnel training and system integration, on the other.

The greatest economic potential is achieved with the integrated use of artificial intelligence and virtual reality. Artificial intelligence enables intelligent automation and personalization, while virtual reality creates an immersive environment to deliver a unique digital experience.

This allows us to consider the transition from traditional digital content to adaptive, personalized and immersive content as a promising direction for increasing the competitiveness and long-term economic efficiency of digital companies.

Conclusion.

As a result of the study, it was revealed that the combination of artificial intelligence and virtual reality opens up new prospects for optimizing the economic efficiency of digital content.

Artificial intelligence allows you to automate individual stages of content creation and processing, analyze user behavior, personalize and scale digital products. Virtual reality, in turn, increases the level of immersion, interactivity and consumer value of the digital experience.

A comparison of the approaches demonstrated by Netflix and Meta has shown that using these technologies can lead to lower time and operating costs, as well as increased audience engagement, increased monetization opportunities, and new sources of income.. At the same time, economic efficiency is determined by the ratio of additional income and cost savings with the necessary investments in the technological base, software and skills of employees.

Thus, the most promising is the integrated use of AI and VR, when intelligent automation and an individual approach are combined with immersive user interaction.. In today's world, artificial intelligence and virtual reality are becoming increasingly important tools for the development of digital content. They not only help modernize technology, but also transform the economic model, making digital products more competitive, scalable, and efficient in the long run.

The research conducted in this area has practical value. Its results can be used by companies and content developers to make decisions about the implementation of artificial intelligence and virtual reality. At the same time, it is necessary to take into account not only the technological advantages, but also the economic benefits.

The proposed approach makes it possible to assess the impact of AI and VR on various aspects of content production: costs, speed of creation, personalization, user engagement, scalability, and monetization opportunities. This can be useful when choosing technologies and planning investment projects. The research results can be used to create business models for digital content, identify promising areas for automation, and assess the relationship between technological investments and expected profits.

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Жасанды интеллект пен виртуалды шындық: цифрлық контенттің экономикалық тиімділігі

Түйіндеме. Бұл зерттеу жасанды интеллект пен виртуалды шындық технологияларының цифрлық мазмұнды құруға, жекелендіруге, таратуға және экономикалық тиімділігіне әсерін талдайды. Жасанды интеллект пен виртуалды шындықтың интеграциясы өндірістік процестерді автоматтандыруға, пайдаланушылардың белсенділігін арттыруға, тұтынушылық құндылықты арттыруға, цифрлық өнімдерді масштабтауға және монетизацияның жаңа үлгілерін қалыптастыруға ықпал ететін механизмдерді зерттеуге ерекше назар аударылады. Зерттеу барысында цифрлық контентті құрудың дәстүрлі және технологиялық жетілдірілген тәсілдерін салыстыру үшін мазмұнды талдау және салыстырмалы талдау әдістері қолданылады. Бұл тәсілдер зерттеуді анық, нақты толықтай зерттеуге көмектесті. Netflix және Meta ірі халықаралық компанияларының сандық модельдері AI және VR-дің әртүрлі қолданылуын көрсететін практикалық мысалдар ретінде қарастырылады. Зерттеу нәтижелері жасанды интеллект негізінен уақыт пен транзакциялық шығындарды оңтайландыруға, мазмұнды жекелендіруге және оны тарату тиімділігін арттыруға көмектесетінін көрсетеді. Сонымен қатар, виртуалды шындық интерактивтілікті, қатысуды және аудиторияның белсенділігін арттырады, монетизацияның жаңа мүмкіндіктерін ашады. Автоматтандыру мен дербестендіруді қолданушының қоршаған ортаға енуімен ұштастыра отырып және жасанды интеллект пен виртуалды шындықтың интеграцияланған интеграциясы арқылы максималды экономикалық әлеуетке қол жеткізілетіні анықталды.

Түйінді сөздер: виртуалды шындық, жасанды интеллект, экономикалық тиімділік, цифрлық контент, компания.

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Искусственный интеллект и виртуальная реальность: экономическая эффективность цифрового контента

Аннотация. В этом исследовании анализируется влияние искусственного интеллекта и технологий виртуальной реальности на создание, персонализацию, распространение и экономическую эффективность цифрового контента.

Особое внимание уделяется изучению механизмов, с помощью которых интеграция искусственного интеллекта и виртуальной реальности способствует автоматизации производственных процессов, повышению вовлеченности пользователей, повышению потребительской ценности, масштабированию цифровых продуктов и формированию новых моделей монетизации. В исследовании используются методы контент-анализа и сравнительного анализа для сравнения традиционных и технологически продвинутых подходов к созданию цифрового контента. В качестве практических примеров рассматриваются цифровые модели крупных международных компаний Netflix и Meta, демонстрирующие различные варианты использования искусственного интеллекта и виртуальной реальности. Результаты исследования демонстрируют, что искусственный интеллект в основном помогает оптимизировать временные и транзакционные издержки, персонализировать контент и повысить эффективность его распространения. В то же время виртуальная реальность повышает интерактивность, присутствие и вовлеченность аудитории, открывая новые возможности для монетизации. Было выявлено, что максимальный экономический потенциал достигается при комплексной интеграции искусственного интеллекта и виртуальной реальности, когда автоматизация и персонализация сочетаются с погружением пользователя в созданную среду.

Ключевые слова: виртуальная реальность, искусственный интеллект, экономическая эффективность, цифровой контент, компания.

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Требования к содержанию и оформлению статей

Научно-практический журнал «Транзитная экономика» является одним из ведущих периодических научных изданий Республики Казахстан по экономическим наукам, издается с июля 1997 года, имеет свою стабильную аудиторию.

Журнал рассчитан на работников ВУЗов и научных учреждений, магистрантов и докторантов, государственных и общественных деятелей, руководителей органов управления, финансовых структур. В редакционный совет входят ведущие ученые-экономисты Казахстана, ближнего и дальнего зарубежья.

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- список использованных источников (не менее 5).

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