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DEVELOPING A ROADMAP FOR METAVERSE STANDARDIZATION: ECONOMIC PRIORITIES AND EFFECTS

The article examines how to select economic priorities for metaverse standardization when virtual platforms interact. The study aims to identify areas in which a verifiable link can be established between technical requirements and participants' costs, and to propose a procedure for assessing expected effects. The ITU standardization roadmap and gap analysis, ISO/IEC and W3C documents, and scientific publications on the development of virtual services were analyzed. The study used comparative document analysis and grouped requirements by their economic mechanisms. Materials from research project AP23489090 provided the basis for the study.

Six areas of standardization were identified: platform interoperability, data exchange, digital identity, security, digital content, and service accessibility. For each area, the subject of the requirements, the mechanism through which costs may change, and the expected outcome of implementation were specified. The study distinguishes technical testing, such as transferring a three-dimensional object between platforms, from economic assessment, which requires accounting for configuration time and the costs of correcting errors. A four-stage roadmap was proposed: selecting applicable documents, drafting requirements, conducting voluntary pilot tests, and preparing and revising recommendations. An assessment framework was developed for three channels: integration costs, data transfer costs, and costs related to access verification and security. The findings can be used to prepare draft requirements and test protocols; quantitative assessment of the effects is planned for the pilot implementation stage.

Keywords: transaction costs, technological fragmentation, cross-platform portability, rights to virtual assets, institutional coordination, switching costs, user trust.

Кілт сөздер: транзакциялық шығындар, технологиялық бөлішектену, платформалар арасындағы тасымалданымдылық, виртуалды активтерге құқықтар, институционалдық үйлестіру, ауысу шығындары, пайдаланушылардың сенімі.

Ключевые слова: транзакционные издержки, технологическая фрагментация, межплатформенная переносимость, права на виртуальные активы, институциональная координация, издержки переключения, доверие пользователей.

Introduction. When connecting a single virtual service to two platforms, a developer may need to configure object transfer and access verification twice, increasing the time and cost of integration. The glTF 2.0 format for three-dimensional objects is specified in ISO/IEC 12113:2022. W3C published a model for verifiable digital credentials in 2025. These documents provide a technical basis for exchange but do not establish the savings for a specific platform. The study therefore examines which requirements should be tested first and how to compare configuration hours, data transfer costs, and losses from incidents before and after their application.

The study aims to identify economic priorities for metaverse standardization and propose a procedure for assessing expected effects when virtual platforms interact. Three tasks were set to achieve this aim:

- identify areas of standardization related to integration costs, data transfer, and security;
- compare international requirements with verifiable outcomes of their application;
- develop stages for a pilot assessment of technical and economic indicators.

The study materials comprised ITU technical reports on the standardization roadmap and gaps, ISO/IEC and W3C documents, and materials from research project AP23489090. Comparative document analysis and the grouping of requirements by economic mechanism were used. To support reproducibility, each area was matched with an aspect to be tested, pilot participants, and cost indicators before and after the requirements are applied. The project's expert interviews and questionnaires form the research basis of the study. Statistical testing of the economic effects is planned after data from the pilot platforms become available.

Literature review. Mordor Intelligence and Bloomberg Intelligence estimate the size of the metaverse market, but differences in their methods limit the use of these forecasts to calculate the effects of standardization [1, 2]. Kozinets R.V. studies user experience in virtual environments, while Kurmanov N.A. et al. examine the technology's economic potential in Kazakhstan [3, 4]. Alioth S. et al. investigate financial applications. Kurmanov N.A. et al. describe prospects for the economy and society without measuring the cost of interaction between platforms [5, 6]. Iqbal M. et al. discuss financial use cases, while Kabdullina G.K. et al. compare market forecasts and stages of metaverse development [7, 8]. Kurmanov N.A. et al. proposed an institutional and economic model of standardization [9]. The International Energy Agency's energy scenario provides external context but does not assess platform costs [10]. ITU documents set out a roadmap and identify gaps in standardization [11, 12]. Object formats, digital credentials, and accessibility are addressed in ISO/IEC and W3C documents [13-15]. Meeting technical requirements, however, does not yet demonstrate cost reductions. The order of implementation and the measurement of its effects remain unresolved. Pilot tests should compare integration time, data transfer costs, and losses from incidents before and after the requirements are applied.

The main part. The economic significance of standards depends on the costs incurred when virtual platforms interact and digital services are used. The ITU FGMV-51 roadmap identifies interoperability, data sharing, security, and accessibility as priority areas [11]. Table 1 presents six areas and their associated economic mechanisms.

Table – 1

Areas of metaverse standardization and their economic significance*

Area	Subject of standardization	Economic mechanism	Expected outcome
Platform interoperability	Common requirements for interaction between virtual environments	Lower integration costs	Broader access to platforms for companies
Data exchange and transfer	Data transfer formats and rules	Lower platform switching costs	Reduced dependence on a single provider
Digital identity	Identity verification and access management	Lower costs of verifying users	More reliable interaction between participants
Data protection and security	Requirements for data processing and transaction security	Lower likelihood of losses and expenses	Greater user trust
Digital content and assets	Rules for recording, transferring, and verifying rights	Less uncertainty in transactions	Increased exchange of digital products
Service accessibility	Requirements for the use of virtual services by different groups	A larger potential audience	Broader user reach

*compiled according to sources [11, 12].

As shown in Table 1, platform interoperability primarily affects developers' costs. Interfaces and data exchange often have to be configured twice when one virtual service is deployed on two platforms. Common requirements reduce repeated work and make it easier to enter an additional platform. Data exchange has a different implication. Users can retain their profiles and created materials when changing providers without entering the same information again. The ITU FGMV-52 report reviews existing solutions and gaps in standardization. Integration costs and switching costs should therefore be assessed separately [12].

A technical basis for transferring three-dimensional objects already exists. The glTF 2.0 format is specified in the international standard ISO/IEC 12113:2022 [13]. A common format makes it easier to load the same model into different environments. Transferring a file, however, does not confirm the buyer's right to continue using the object. Separate rules for recording and verifying rights are needed for transactions involving digital assets. Digital identity addresses a related issue. The W3C Verifiable

Credentials Data Model 2.0, adopted in 2025, specifies a model for exchanging verifiable digital credentials [14]. Whether access verification costs decline depends on platforms adopting a common procedure for processing these credentials.

Security requirements aim to reduce losses from data breaches, access errors, and disputed transactions. Implementing safeguards also creates configuration and maintenance costs. The economic effect is therefore assessed by comparing these costs with the losses avoided. Service accessibility affects user reach. For example, WCAG 2.2 added nine accessibility criteria for digital interfaces [15]. Navigation and forms of interaction in three-dimensional environments will also need to be tested for virtual services. The outcomes presented in Table 1 describe expected mechanisms. Materials from research project AP23489090 include 25 expert interviews and 257 questionnaires. The project does not contain a comparison of platform costs before and after the application of standards; the magnitude of the economic effect has not yet been measured.

These areas form the basis of the proposed metaverse standardization roadmap for Kazakhstan. Table 2 presents the sequence of activities, participants, and verifiable outcomes.

Table – 2

Proposed roadmap for metaverse standardization*

Stage	Main activities	Participants	Verifiable outcome	Economic rationale
1. Preparation	Compare documents with the needs of Kazakhstani platforms and select priorities	Researchers, standardization bodies, developers, businesses	List of applicable documents and issues requiring further work	Concentrating resources on the most significant tasks
2. Development of requirements	Prepare draft requirements for interoperability, data exchange, identity, and security	Standardization bodies, developers, data protection experts	Draft requirements and test criteria	Lower integration and user verification costs
3. Pilot testing	Test the requirements on voluntary pilot platforms and refine them based on the results	Platform developers, service providers, users	Test reports and revised requirements	Assessment of implementation costs and practical interoperability
4. Application and review	Propose procedures for applying and regularly updating the agreed requirements	Authorized organizations, industry associations	Recommendations for application and a set of monitoring indicators	Conditions for expanding services and reducing technological fragmentation

**compiled by the authors.*

As shown in Table 2, the roadmap comprises four main stages. During the first stage, researchers, developers, and standardization bodies compare international documents with the needs of Kazakhstani platforms. The outcome is a list of requirements suitable for application and issues requiring separate development. The priorities of ITU FGMV-51 are considered when selecting requirements. The 2024 ITU FGMV-51 roadmap assigns high priority to interoperability and data sharing [11]. At the second stage, draft requirements and test criteria are prepared for the four areas listed in Table 2. The format of three-dimensional objects is proposed to be aligned with ISO/IEC 12113:2022. The procedure for verifying digital credentials is aligned with the 2025 W3C model [13, 14]. At the third stage, pilot platforms test the transfer of one object between two environments, the retention of profile data, and the time needed to connect a service. Configuration and error correction costs are recorded in working hours and tenge.

The pilot results inform recommendations on applying and revising the requirements. The economic assessment compares connection time, data transfer costs, and the cost of incidents before and after testing. Successful object transfer alone does not demonstrate savings. Table 2 sets out the sequence of testing, while the project's effects have yet to be calculated. Figure 1 presents the mechanism linking technical outcomes to economic results.

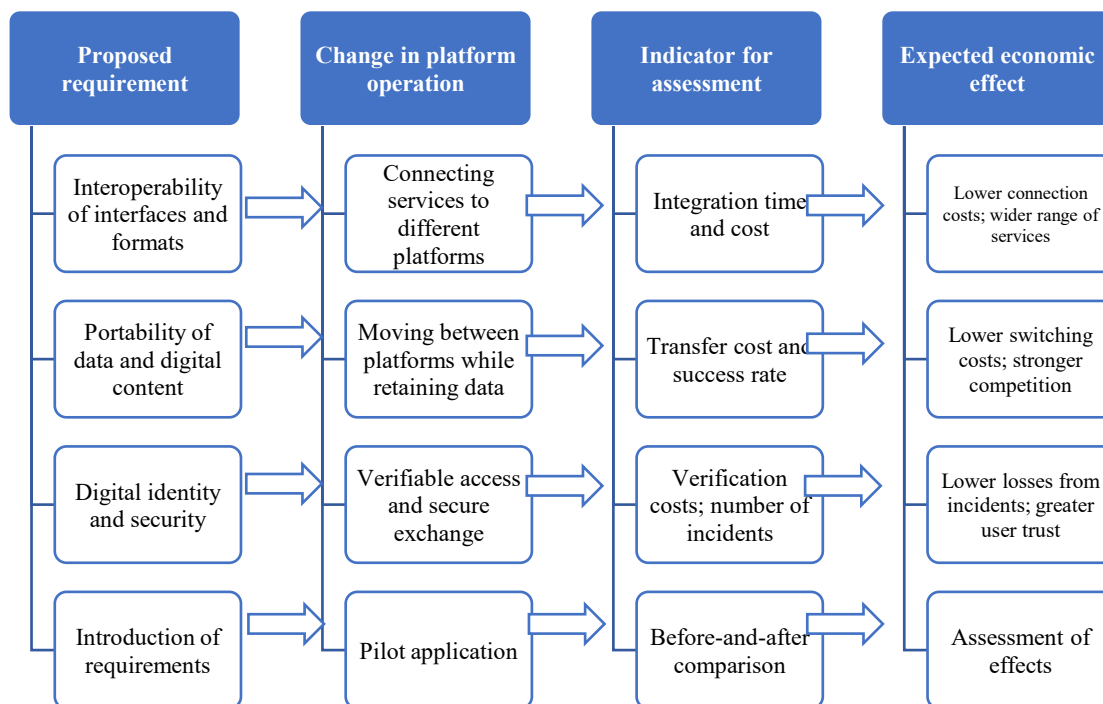


Figure – 1. **Mechanism through which economic effects arise after the introduction of standards***

**compiled by the authors*

Figure 1 links three groups of requirements to changes in platform operation, measurable costs, and expected economic outcomes. The first channel tests the connection of one service to two platforms. Fewer configuration hours and lower expenses in tenge indicate a reduction in integration costs. The compatible format for three-dimensional objects specified in ISO/IEC 12113:2022 provides a specific object for testing transfer between environments [13].

The second channel considers two transfer outcomes: whether a digital object opens successfully and whether the required profile data are retained. Switching costs are calculated from the time spent on transfer, reconfiguration, and recovery of lost data. Lower costs reduce users' dependence on their previous platform. The third channel compares the cost of verifying one user and the number of incidents before and after identity and security requirements are applied. The economic outcome is determined by comparing the cost of implementing safeguards with the value of losses prevented.

For all three channels, Figure 1 provides for a comparison of indicators before and after pilot implementation. Quantitative assessment of savings and changes in the number of incidents is planned for the pilot implementation stage.

Conclusion. The article proposes a four-stage roadmap for metaverse standardization. The stages comprise the selection of requirements, development of drafts, pilot testing, and review based on the results of application. Six areas of standardization are linked to specific economic mechanisms. Platform interoperability is associated with the cost of connecting a service. Data transfer is associated with the cost of changing providers. Identity and security are associated with access verification costs and losses from incidents.

The novelty of the proposed approach lies in distinguishing a technical outcome from an economic effect. Successful transfer of a three-dimensional object confirms format compatibility. A reduction in costs, however, can be established only by comparing the time and cost of operations before and after the requirements are applied. A three-channel assessment framework was developed for this purpose. Materials from project AP23489090, including 25 expert interviews and 257 questionnaires, form the research basis of the study but do not replace data on platforms' actual costs.

The roadmap can be used to prepare draft requirements and organize voluntary tests involving developers, service providers, and standardization bodies in Kazakhstan. Further research will measure integration and data transfer costs, account for security expenditures, and assess losses from incidents on

pilot platforms. These measurements will help refine priorities for implementing the requirements and test the expected economic effects.

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МЕТАВЕРСТІ СТАНДАРТТАУДЫҢ ЖОЛ КАРТАСЫН ӘЗІРЛЕУ: ЭКОНОМИКАЛЫҚ БАСЫМДЫҚТАР МЕН ӘСЕРЛЕР

Аңдатпа

Мақалада виртуалды платформалардың өзара әрекеттесуі жағдайында метаверсті стандарттаудың экономикалық басымдықтарын таңдау мәселесі қарастырылған. Зерттеудің мақсаты - техникалық талаптар мен қатысушылардың шығындары арасындағы тексеруге болатын байланысты анықтау мүмкіндігі бар бағыттарды айқындау және күтілетін әсерлерді бағалау тәртібін ұсыну. ITU ұйымының жол картасы мен стандарттаудағы олқылықтарға шолуы, ISO/IEC және W3C құжаттары, сондай-ақ виртуалды қызметтердің дамуы туралы ғылыми жарияланымдар талданған. Құжаттарды салыстырмалы талдау және талаптарды экономикалық тетіктер бойынша топтастыру әдістері қолданылған. AP23489090 зерттеу жобасының материалдары жұмыстың зерттеу негізін құрады.

Стандарттаудың алты бағыты анықталған: платформалардың үйлесімділігі, деректер алмасу, цифрлық бірегейлік, қауіпсіздік, цифрлық контент және қызметтердің қолжетімділігі. Әр бағыт бойынша талаптардың нысаны, шығындардың өзгеру тетігі және қолданудан күтілетін нәтиже айқындалған. Үш өлшемді объектіні платформалар арасында беру сияқты техникалық тексеру мен баптауға жұмсалған уақытты және қателерді түзету шығындарын есепке алуды қажет ететін экономикалық бағалаудың айырмашылығы көрсетілген. Төрт кезеңнен тұратын жол картасы ұсынылған: қолдануға болатын құжаттарды іріктеу, талаптар жобаларын әзірлеу, ерікті пилоттық сынақтар өткізу, ұсынымдарды дайындау және қайта қарау. Үш бағыт бойынша бағалау схемасы әзірленген: интеграция құны, деректерді көшіру шығындары, қолжетімділікті тексеру мен қауіпсіздікке жұмсалатын шығындар. Алынған нәтижелер талаптар жобалары мен сынақ хаттамаларын дайындауда қолданылуы мүмкін; әсерлерді сандық бағалау пилоттық қолдану кезеңінде көзделген.

Кабдуллина Г.К., Рахимбекова А.Е., Сатбаева А.Ж., Жангирова Р.Н.

РАЗРАБОТКА ДОРОЖНОЙ КАРТЫ СТАНДАРТИЗАЦИИ МЕТАВСЕЛЕННОЙ: ЭКОНОМИЧЕСКИЕ ПРИОРИТЕТЫ И ЭФФЕКТЫ

Аннотация

В статье рассмотрена проблема выбора экономических приоритетов стандартизации метавселенной при взаимодействии виртуальных платформ. Цель исследования - определить направления, для которых можно установить проверяемую связь между техническими требованиями и затратами участников, и предложить порядок оценки ожидаемых эффектов. Проанализированы дорожная карта и обзор пробелов стандартизации ITU, документы ISO/IEC и W3C, а также научные публикации о развитии виртуальных услуг. Использованы сравнительный анализ документов и группировка требований по экономическим механизмам. Материалы исследовательского проекта AP23489090 составили исследовательскую основу работы.

Выявлены шесть направлений стандартизации: совместимость платформ, обмен данными, цифровая идентичность, безопасность, цифровой контент и доступность сервисов. Определены предмет требований, механизм изменения затрат и ожидаемый результат применения для каждого направления. Показано различие между технической проверкой, например передачей трёхмерного объекта между платформами, и экономической оценкой, для которой необходим учёт времени настройки и расходов на устранение ошибок. Предложена дорожная карта из четырёх этапов: отбор применимых документов, разработка проектов требований, добровольные пилотные испытания, подготовка и пересмотр рекомендаций. Разработана схема оценки по трём каналам: стоимость интеграции, затраты на перенос данных, расходы на проверку доступа и безопасность. Полученные результаты могут использоваться при подготовке проектов требований и протоколов испытаний; количественная оценка эффектов предусмотрена на этапе пилотного применения.

