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ICT SKILLS DEVELOPMENT IN THE REPUBLIC OF KAZAKHSTAN

Insight Report with Recommendations

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IN THE REPUBLIC OF KAZAKHSTAN

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UNESCO Institute for Information Technologies in Education

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Executive Summary

The UNESCO Institute for Information Technologies in Education (UNESCO IITE) prepared an insight report examining the state of the art and perspectives of ICT skills development in the Republic of Kazakhstan within the project "Al Capacity Building in Arabic-Speaking Countries and Promoting ICT Education in Central Asia". The project is implemented to support digital transformation of national economies and strengthen the capacity of Kazakhstan and other Central Asia countries through ICT talent development for the achievement of the Sustainable Development Goal 4 "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all", redesigning higher education and TVET in line with labour market demands and further development of ICT skills strategy.

The study draws on comprehensive desk research, encompassing the collection of up-to-date statistical data and a thorough review of relevant documents and secondary information accessed from global and national resources. The data available from national ministries and agencies in charge of education, labour, innovation and ICT has been collected and analysed to investigate the local context and challenges. The report provides an overview of the country's ICT ecosystem and policy landscape, focusing on education and labour market.

The publication consists of an introduction, country overview, three chapters, conclusions and recommendations.

The Introduction outlines the scope, methodology and objectives of the research.

The Country Overview provides general information about the demographic, economic and social context of Kazakhstan.

The chapter "Policy and Governance Frameworks for Digital Transformation" highlights Kazakhstan's progress towards digital transformation achieved through the intensification of legislative activities which aim to encourage ICT integration across sectors, implementation of new technologies and development of digital competencies. It also explores e-government strategies and initiatives designed to create enabling environment for ICT talent cultivation.

The chapter "ICT Adoption and Digital Ecosystems for Sustainable Growth" describes the ICT infrastructure, outlines the evolution of the digital economy and analyses the digitalization of government and public services. In addition to examining the ICT industry development, the chapter provides examples of digitalization in different sectors of national economy, including digital finance and banking, corporate sector and e-commerce, which result in the change of labour market demands.

The chapter "Human Capital for Digital Economy: Knowledge, Skills and Employability" considers the issues related to ICT capacity building and human capital development from the perspective of higher education and TVET, ICT labour market and demand for ICT skills. The chapter includes the analysis of current trends and challenges in the labour market and reviews various educational initiatives and programmes implemented to enhance ICT skills indispensable in the ICT and AI era.

The Conclusions and Recommendations section summarizes the research findings and provides a cross-analysis of Kazakhstan rankings in a number of global indices. The chapter identifies the challenges faced by the country and proposes recommendations for implementing effective reforms in ICT skills development in Kazakhstan.

Annex to this document contributed by Huawei Technologies describes Huawei's philosophy and framework for developing ICT talent and explains why cultivating digital skills is seen as a long-term investment, central to innovation and economic progress, aligned with national visions.

Contents

Acronyms

AI	Artificial Intelligence
CIS	Commonwealth of Independent States
EGDI	United Nations E-Government Development Index
GDI	Global Digitalisation Index
GDP	Gross Domestic Product
HE	Higher Education
HEI	Higher Education Institution
ICESCO	Islamic World Educational, Scientific and Cultural Organization
ICT	Information and Communication Technology
IT	Information Technology
IoT	Internet of Things
ITU	International Telecommunication Union
LMS	Learning Management System
MDDIAI RK	Ministry of Digital Development, Innovations and Aerospace Industry of the Republic of Kazakhstan
MES RK	Ministry of Education and Science of the Republic of Kazakhstan
MOOC	Massive Open Online Course
MTC RK	Ministry of Transport and Communications of the Republic of Kazakhstan
NITEC	National Information Technologies JSC
OECD	Organization for Economic Co-operation and Development
RK	Republic of Kazakhstan
SDGs	Sustainable Development Goals
STEM	Science, Technology, Engineering and Mathematics
TVET	Technical and Vocational Education and Training
UIS	UNESCO Institute for Statistics
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO IITE	UNESCO Institute for Information Technologies in Education
WIPO	World Intellectual Property Organization

Introduction

In today's fast-changing world, technology continues to evolve and play a greater role in everyday live, digital skills are more important than ever to keep up with new technologies and unlock a vast array of opportunities. In the job market, the ability to effectively use digital devices and platforms becomes a requirement for professionals across the majority of industries. With the rise of technology and the digitalization of many aspects of business, employers are seeking candidates who possess a strong foundation in digital skills, including proficiency in using software and applications, data analysis, digital marketing, social media management, etc. The internet paired with such advancements as AI has reshaped the way businesses operate. The development of basic and advanced ICT skills driven by digital transformation is vital for professional growth.

This insight report is produced within the project "Al Capacity Building in Arabic-Speaking Countries and Promoting ICT Education in Central Asia" implemented by the UNESCO Institute for Information Technologies in Education in partnership with Huawei. The overall purpose of the project is to strengthen the national capacity development in several UNESCO Members States in terms of ICT-related skills to enhance the quality of learning and expand access to relevant career opportunities and contribute to the achievement of the Sustainable Development Goal 4 aiming to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all".

The insight report provides a comprehensive overview of Kazakhstan's socio-economic context and digital landscape, outlines the government commitments to the development of national economy and ICT industry, describes the status quo of the economy, ICT industry and digital infrastructure, elaborates on the relevance of education and training to labour market demands for ICT skills. In conclusion, the report outlines the current challenges and offers recommendations to advance sustainable development.

To ensure a comprehensive analysis of ICT skills development in Kazakhstan, this study relies on the desk research based on the collection and analysis of quantitative and qualitative data. The report data was extracted from international data sources: UNESCO Institute for Statistics (UIS), World Bank, ITU Datahub, databases of United Nations Conference on Trade and Development (UNCTAD), United Nations Development Programme (UNDP), United Nations Department of Economic and Social Affairs (UN DESA), World Development Indicators, etc. In addition, the data from international rankings, including E-Government Development Index, E-Participation Index, Government AI Readiness Index, Global Talent Competitiveness Index, Global Innovation Index, Network Readiness Index, Global Knowledge Index, IMD World Digital Competitiveness Index, Global Attractiveness Index, Global Sustainable Competitiveness Index, QS World University Rankings, Executive Opinion Survey by World Economic Forum, Huawei Global Digitalisation Index, were compared. The official statistical data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan and the Official Information Source of the Prime Minister of the Republic of Kazakhstan was widely used. National level policy documents published by the Ministry of Education and Science, the Ministry of Digital Development, Innovations and Aerospace Industry, the Ministry of Labour and Social Protection of Population and the Ministry of Transport and Communications of the Republic of Kazakhstan were analysed, as well as a wide range of research publications.

Country Overview

Kazakhstan, officially the Republic of Kazakhstan, is the ninth-largest country in the world: its land area covers 2,724,902.0 square kilometres. The country is mainly located in Central Asia (only about 5% is in Eastern Europe) and shares borders with Russia, China, Kyrgyzstan, Uzbekistan and Turkmenistan. Kazakhstan is a sparsely populated country with a population density of about 7.4 people per square kilometre (2022). According to the World Bank data,[1] in 2024, the total population of Kazakhstan was 20.59 million people; of them 58% lived in cities[2] and the annual population growth rate was 1.3%.

Table 1. Demographic indicators

	2019	2020	2021	2022	2023	2024
Population, total (million)	19.20	19.48	19.74	20.03	20.33	20.59
Population growth rate (annual %)	1.5	1.4	1.3	1.5	1.5	1.3
Urban population (% of total population)	58	58	58	58	58	58
Human sex ratio (m per 100 f)*			94.4			

Sources: World Bank Open Data; *United Nations Statistics Division

According to the Workforce Development Centre, by the end of 2023 the population structure was as follows: children under 18 years of age — 35.1%, wage earners — 34.0%, pensioners — 12.5%, individual entrepreneurs — 8.5%, students — 6.2% and persons with disabilities — 3.8%. The number of able-bodied individuals was close to 11 million people (5,476,147 men and 5,446,803 women), the number of active employment contracts was 5,647,235.[3]

Table 2. Labour market participation and unemployment

Indicator	2019	2020	2021	2022	2023	2024
Labour force participation, total (% of total population ages 15+)	72.7	71.2	71.9	71.8	71.4	70.7
Labour force participation rate (% of male population ages 15+)	78	76.4	77.1	77.2	76.6	75.9
Labour force participation rate (% of female population ages 15+)	68	66.5	67.3	67	66.6	66
Unemployment, total (% of total labour force)	4.8	4.9	5.5	4.9	4.8	4.8
Unemployment, male (% of male labour force)	4.3	4.4	5	4.3	4.2	4.2
Unemployment, female (% of female labour force)	5.3	5.4	6.1	5.5	5.5	5.4
Unemployment, youth total (% of total labour force ages 15-24)	3.8	3.8	4.2	3.8	3.8	3.8

Source: World Bank Open Data based on ILO data and estimates

1 World Bank. 2024. Open Data Country profile. Kazakhstan. https://data.worldbank.org/country/kazakhstan

2 According to the Bureau of National Statistics, as of July 1, 2025, the country's population amounted to 20,387,811 people, of them 10,423,863 females and 9,963,948 males; 12,899,438 resided in cities and 7,488,373 lived in rural areas. https://stat.gov.kz/ru/

3 Workforce Development Centre. 2023. Analytics. Comprehensive statistics and analysis of key indicators of the social and labour sphere in the Republic of Kazakhstan. https://erdo.enbek.kz/analitics

The World Bank states that over the past decade Kazakhstan has demonstrated fairly high labour force participation rate for both females and males (66% and 75.9%, accordingly).[4] The total unemployment had almost returned to the pre-pandemic level of 4.8% by 2024 (in 2021, the unemployment was 5.5%).[5] However, the female unemployment rate stayed slightly higher (5.4%)[6] than male (4.2%)[7] or total youth (ages 15-24) unemployment rates (3.8%).[8]

Kazakhstan is classified as an upper middle-income economy and ranks 49th globally in terms of gross domestic product (GDP)[9] amounting to 288.41 billion current USD.[10] Between 2013 and 2023, the GDP growth rate was heavily influenced by oil price fluctuations and external economic factors. From 6% in 2013 it dropped to -2.5% in 2020 due to the impact of the COVID-19 pandemic. In 2023, the growth recovered to 5.1%, yet inflation reached 7% exerting downward pressure on the living standards. In 2024, GDP growth was 4.8%. GDP per capita followed a similar trajectory, decreasing from 13,478.5 USD in 2013 to 7,475.6 USD in 2016, and eventually reached 14,005.3 USD in 2024.

Table 3. Gross domestic product of Kazakhstan

Indicator	2019	2020	2021	2022	2023	2024
Gross domestic product (billion, current USD)	181.67	171.08	197.11	225.5	261.84	288.41
GDP per capita (current USD, thousand)	9,457.1	8,781.5	9,983.6	11,255.3	12,879.4	14,005.3
GDP growth (annual %)	4.5	-2.5	4.3	3.2	5.1	4.8

Source: World Bank Open Data

The extraction of natural resources fuels the economic growth of the country, which continues to rely on hydrocarbon exports, despite the intense government efforts to reduce the dependence on natural resources and diversify the economy, particularly through the support to digital economy and technological innovations, development of high-technology sectors and expansion of the agro-industrial complex, manufacturing industry and service sector.

Kazakhstan is changing under the influence of rapid digital transformations and fast spread of ICT and AI in all spheres of human life. Today 99% of the population in Kazakhstan is covered by the internet and more than 90% of the public services are available online (Government of the Republic of Kazakhstan, 2023b). Kazakhstan's large and medium-

4 World Bank Open Data. 2024. Kazakhstan. Labour force participation rate, by sex (% of population ages 15+) (modelled ILO estimate). https://genderdata.worldbank.org/en/economies/kazakhstan

5 World Bank. 2024. Open Data. Unemployment, total (% of total labour force) (modelled ILO estimate) — Kazakhstan, Euro area. https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS?locations=KZ-XC

6 World Bank. 2024. Open Data. Unemployment, female (% of female labour force) (modelled ILO estimate) — Kazakhstan. https://data.worldbank.org/indicator/SL.UEM.TOTL.FE.ZS?locations=KZ

7 World Bank. 2024. Open Data. Unemployment, male (% of male labour force) (modelled ILO estimate) — Kazakhstan. https://data.worldbank.org/indicator/SL.UEM.TOTL.MA.ZS?locations=KZ

8 World Bank. 2024. Open Data. Unemployment, youth total (% of total labour force ages 15-24) (modelled ILO estimate) — Kazakhstan. https://data.worldbank.org/indicator/SL.UEM.1524.ZS?locations=KZ

9 World Bank. 2024. Data Catalogue. GDP ranking. https://datacatalog.worldbank.org/search/dataset/0038130

10 World Bank. 2024. Open Data. Data for Kazakhstan, Euro area. https://data.worldbank.org/?locations=KZ-XC

sized enterprises gradually switch to the use of the Industry 4.0 technologies in their work. E-commerce, crypto farming and smart factories are boosting. The first elements of the innovation ecosystem have been created, i.e. the innovation cluster “Innovation Technologies Park”, National Agency for the Development of Innovations “QazInnovations”, autonomous educational organization “Nazarbayev University”, Astana Hub International Technopark of IT startups.

Policy and Governance Frameworks for Digital Transformation

Kazakhstan has demonstrated progress towards digital transformation. The country has invested considerably in digital infrastructure, embracing new technologies such as AI, blockchain and the Internet of Things (IoT) to fundamentally change public administration and services delivery. The commitment to digitalization has been further accelerated by national strategies that prioritize ICT development and digital literacy (UN, 2024).

During the recent decades, a number of laws and legislative acts were endorsed to regulate various aspects related to the field of ICT, including personal data protection, copyright protection for software and databases, intellectual property, e-commerce, digital assets, cybersecurity, electronic signatures and documents, telecommunications and communication, software and hardware development, use and protection, access to information and internet resources, open data and open-source software, etc. Highlighted below are the most important laws presently in effect in the Republic of Kazakhstan:

- On Electronic Document and Electronic Digital Signature (No. 370 of January 7, 2003)
- On Communications (No. 567 of July 5, 2004)
- On State Services (No. 88-V of April 15, 2013)
- On Personal Data and their Protection (No. 94-V of May 21, 2013)
- On Access to Information (No. 401-V of November 16, 2015)
- On Informatization (No. 418-V ZRK of November 24, 2015)
- On Digital Assets in the Republic of Kazakhstan (No. 193-VII LRK of February 6, 2023)
- On Online Platforms and Online Advertising (No. 18-VIII of July 10, 2023)

The country's commitment to digital transformation, cross-sectoral ICT integration and the development of digital competencies has been articulated through a range of national concepts and programmes, including the Concept of Digital Transformation, Development of the Information and Communication Technology Sector and Cybersecurity for 2023–2029, the Cybersecurity Concept (Cyber Shield of Kazakhstan), the Concept for the Development of Higher Education and Science in the Republic of Kazakhstan for 2023–2029, the Concept for the Development of the Labour Market of the Republic of Kazakhstan for 2024–2029 and the Concept for Artificial Intelligence Development for 2024-2029.

Significant investments in digital transformation have been made through national programmes such as Digital Kazakhstan (successor of the Informational Kazakhstan programme) and Technological Breakthrough Through Digitalization, Science and Innovation. The COVID-19 pandemic further accelerated regulatory activities aimed to support digital transformation, driving innovation across the public sector. In 2023, the Accessible Internet programme was launched to enhance infrastructure development, focusing on the creation of data centres, the deployment of 5G network and the expansion of telecommunications infrastructure (IDC, 2023).

The Ministry of Digital Development, Innovations and Aerospace Industry (MDDIAI) is responsible for shaping and implementing national policy in the field of digital development. The Ministry coordinates policies in telecommunications and communication, e-government and public services, IT technologies and digital solutions, information security, AI, electronics, innovation, digital assets, etc. In particular, MDDIAI is engaged in the implementation of the e-Government programme and optimization of digital public services, enhancing data-driven decision-making by building a national AI system based on "Smart Data Ukimet", establishing the international Technopark "Astana Hub", etc. According to the Law "On the Budget of the Republic of Kazakhstan for 2024–2026" (No. 43-VIII ZRK of December 5, 2023), the budget of the Ministry amounted to approximately 231 million USD in 2025 and 225 million USD in 2026 (Parliament of the Republic of Kazakhstan, 2023d).

Designed by MDDIAI, the Concept of Digital Transformation, Development of the Information and Communication Technology Sector and Cybersecurity provides a strategic framework to enhance the digital landscape of Kazakhstan through the end of 2029. It aims to improve public services, accelerate the transformation of public administration and develop the economic sector to create a digitally advanced and inclusive society by leveraging technology and focusing on citizen-centred services (Government of the Republic of Kazakhstan, 2023b). Human capital development for the digital economy is recognized as a key priority, involving the enhancement of basic and advanced digital skills at all stages of education, specialised training in AI, big data, virtual reality and IoT, as well as the expansion of innovative coding schools. By 2027, MDDIAI plans to train 120,000 qualified professionals and create 125,000 new jobs in the ICT sector, fostering growth and innovation in the industry (MDDIAI RK, 2023).

Knowledge and skills are recognized as the main anchors of the modern education system and human capital development within the comprehensive framework of the Kazakhstan-2050 Strategy. It places strong emphasis on aligning higher education and vocational training with the evolving needs of the economy, fostering research and innovation in higher education institutions (HEIs) and promoting public-private partnerships to advance knowledge acquisition and skills development.

The principal executive authorities in charge of digital transformation in the field of education are the Ministry of Education and the Ministry of Science and Higher Education. The latter has elaborated the Concept for the Development of Higher Education and Science, which prioritizes the enhancement of digital competencies within lifelong learning pathways spanning formal, non-formal and informal settings. The digital literacy rate of the population aged 6–74 is viewed as one of the target indicators and projected to increase to 88.5% in 2029 (Government of the Republic of Kazakhstan, 2023a). The Concept sets forth priorities such as enhancing quality and expanding access, developing science and research capacity, enhancing infrastructure and digital architecture and strengthening internationalization.

The Kazakhstan e-Government was initiated by the Decree of the President of the Republic of Kazakhstan No. 1471 of November 10, 2004 "On the State Programme for the Establishment of 'Electronic Government' in the Republic of Kazakhstan". In 2006, the eGov.kz web portal was launched. Today, 93.3% of government services is accessible online, of them 86% can be reached from smartphones (Official Information Source of the Prime Minister of the Republic of Kazakhstan, 2024a). To actively engage with the

public, each government body has a blog and a social media account on platforms such as Facebook, Instagram, VK, X and YouTube.

The operator of the e-government infrastructure, National Information Technologies (NITEC), the largest IT company in Kazakhstan, was established by the government decree (No. 492 of April 4, 2000) to ensure the smooth operation of e-government systems (Government of the Republic of Kazakhstan, 2000). NITEC is also developing the National Artificial Intelligence Platform to create a unified AI ecosystem, automate data processing and enhance public administration, strengthening Kazakhstan's global position in AI.

E-government initiatives have significantly enhanced e-participation, public engagement and digital inclusion in Kazakhstan. In 2023, the Digital Family Card, a flagship GovTech project, was launched to equip decision-makers with real-time data on vulnerable groups and serve as a comprehensive social support system. By mapping over six million families, it provides the foundation of the Social Code, optimizing government spending and ensuring more targeted social assistance (UNDP, 2023; Parliament of the Republic of Kazakhstan, 2023b). Kazakhstan follows global trends to enhance e-participation through targeted technology investments and policy reforms aimed at fostering civic engagement in governance and bridging the digital divide.

ICT Adoption and Digital Ecosystems for Sustainable Growth

Over the past decades, Kazakhstan's commitment to economic diversification and digital transformation has driven continuous improvements in ICT infrastructure and connectivity. These gains position the country as a regional leader in Central Asia, among the top performers in the CIS and among landlocked developing and upper-middle-income countries; for several indicators, Kazakhstan now ranks on par with advanced economies.

The country has made significant strides in strengthening the communication infrastructure. The country has improved access to the internet in rural areas and government institutions, which has contributed to the development of IT literacy among citizens (Global CIO, 2024). Kazakhstan expanded the communication infrastructure through the fiber optic line project, connecting over 1,200 rural settlements and 3,700 state institutions to broadband internet. The installation of more than 20,000 kilometers of new lines greatly enhanced connectivity. The launch of 918 5G base stations in 20 cities and the provision of broadband internet to 4,800 rural areas, alongside new regulatory requirements, have improved service quality and reduced fraudulent activities (The Astana Times, 2024). The median mobile internet download speed in Kazakhstan increased by 18.20 Mbps (+51.3%) in the twelve months to January 2025. Meanwhile, the download speed of the typical fixed internet connection in Kazakhstan increased by 14.97 Mbps (+29.1%) during the same period (DataReportal, 2025).

The expansion of 3G and 4G networks and the rollout of 5G technology will further enhance the quality of communication services. Mobile Telecom Service and Kcell companies are deploying 5G networks: they have already installed 1,144 base stations in 20 cities and have committed to covering at least 75% of the population by the end of 2025 (Affandy, 2024). It is planned to achieve 75% coverage in Astana, Almaty and Shymkent, as well as 60% in regional centres by 2027 (Nakispekova, 2023).

Table 4. Indicators of connectivity and affordability of ICT (2024)

% of individuals using the Internet	93.4
Mobile-cellular subscriptions per 100 inhabitants	127
Fixed-telephone subscriptions per 100 inhabitants	11.9
Active mobile / fixed-broadband subscriptions per 100 inhabitants	119 / 15.3
% of population covered by a mobile-cellular network	98.2
% of population covered by at least a 3G / 4G / 5G mobile network	92.2 / 91.6 / 45.8
Mobile / fixed broadband internet basket as a % of GNI per capita	1.11 / 0.89
Mobile / fixed broadband internet traffic per subscription (GB)	242 / 2160

Source: ITU Data Hub

According to Speedtest Global Index, as of January 2025, Kazakhstan ranked 49th worldwide for mobile internet and climbed five places in the fixed broadband rankings, moving to 83rd position. This achievement has become possible through the implementation

of government programmes and the efforts of mobile operators. The National Programme "Accessible Internet" envisages further development of wireline and wireless communications with the focus on the construction of an extensive fibre optic network in remote and rural areas and further development of the 5G network.

The development of ICT infrastructure at educational institutions and organizations plays a pivotal role. Ensuring internet access for schools is a cornerstone of Kazakhstan's efforts to prepare youth for the digital economy. According to UIS, in 2023 the proportion of secondary schools with access to internet for pedagogical purposes marked a notable improvement up to 100% (UIS, 2024),[11] which enables the adoption of modern teaching methods, digital platforms and online courses, enriching the quality of education.

To promote nationwide technological progress and universal internet access, targeted initiatives have been launched in rural areas to narrow the digital divide. Digital learning centres have been established to provide access to modern technologies and resources. These efforts have delivered measurable results: 96.7% of rural households have internet access at home.[12]

Kazakhstan was home to 15.7 million social media user identities in January 2025, equating to 75.7% of the country's total population. Markedly, the number of internet users in Kazakhstan increased by 238 thousand (+1.3%) between January 2024 and January 2025. (DataReportal, 2025). The adoption of ICT and internet penetration intensifies the use of ICT in various spheres of human life, fosters the growth of e-gov services, fintech, e-commerce, automation of industries, e-learning and telemedicine.

IT market and ICT industry

As Kazakhstan pursues the strategy of economic diversification and digital transformation, the development of ICT industry has become a critical priority. In 2024, 16,683 IT-companies operated in Kazakhstan and employed more than 180,000 people (MDDIAI RK, 2024). The ICT market in Kazakhstan grew at a compound annual growth rate of 9.8% between 2018 and 2022 and reached 5,438 million USD in 2022. The main market segments driving this growth were cloud services (+39%), IT equipment (+18%) and software (+12%). In 2023, the market grew by 8.3% to 5,888 million USD. In 2023–2027, the growth is forecasted at the rate of 6.48%, primarily in the segments of cloud services, IT services and software. By 2027, the total volume of ICT market is projected to increase by 40% compared to 2022 and reach approximately 7,570 million USD (IDC, 2023). The volume of programming, consulting and other related services provided by IT companies during the first quarter of 2024 reached 149,12 million USD. Astana and Almaty are the largest economic and IT hubs, accounting for 41.5% and 49% of IT services, respectively. The number of companies engaged in software development and IT consulting services has increased 2.7 times in the last four years, according to Global CIO (Global CIO, 2023).

According to UNCTAD data, in 2023 the IT market in Kazakhstan was still at nascent stage and relatively small. The highest share of the IT market belongs to the IT equipment (46%), of which 96.2% refers to wholesale trade in computers and peripheral equipment, mainly produced abroad, and 3.8% is related to the manufacture of IT equipment (UN,

[11] UIS. 2024. Proportion of secondary schools with access to Internet for pedagogical purposes (%). https://databrowser.uis.unesco.org/

[12] ITU. 2023. ITU Data Hub. Kazakhstan. https://datahub.itu.int/data/?e=KAZ

2023).[13] Kazakhstan still relies on the import of telecommunications equipment, software, network management systems and cybersecurity solutions. Most IT companies are not export-oriented. Kazakhstan is expanding its presence in the international ICT services market with a focus on software development, data processing, cloud computing and cybersecurity. In 2023, the share of exports in ICT goods and services represented 1.01% and 6.61% of the country's total trade in goods and services, respectively.[14] Between 2019 and 2023, the import of ICT services increased from 265 million USD to 638 million USD, while the export of ICT services grew from 126 million USD to 680 million USD (2023).[15] Kazakhstan's IT services are exported to 86 countries, mainly to Russia, the UAE, the Netherlands, the UK, Germany, Uzbekistan and the USA. Kazakhstani IT hubs have been launched in the USA, Saudi Arabia and Singapore.

There are several technoparks in Kazakhstan. Since 2018, Astana Hub Technopark has fostered a startup ecosystem and cultivated a culture of innovation and entrepreneurship by providing tax incentives to IT enterprises and supporting innovative projects and initiatives. Its services include acceleration, technological business incubation, consulting, information, analytics, educational, marketing and other events designed to stimulate development of its participants. Key focus areas include fintech, GameDev, blockchain, EdTech and GovTech. According to the data of 2024, over 1,500 IT companies were residents at Astana Hub; at least 400 of them with foreign investment: their cumulative income exceeded 1.2 billion KZT and export of IT services was equivalent to 315 million USD or 60% of Kazakhstan export of IT services in 2023. The Alatau Park of Innovative Technologies focuses on smart industry and new materials; smart environment; new sources of energy and clean technologies; fintech, e-commerce and new media. The Tech Garden Innovative Cluster operates as a Special Economic Zone and serves as a test site for the digitalization of industry, through pilot projects, model factories and laboratories. It runs an international accelerator programme for start-ups in central Almaty called icoStartup.kz with three main tracks: Industry 4.0 (industrial IoT, robotics and autonomous systems, energy efficiency and conservation, additive manufacturing and smart logistics); smart cities (building information modelling, next generation network and data transfer, smart transportation, infrastructure and social technologies); and fintech (blockchain, e-commerce and digital technologies) (UNESCO, 2021b).

According to the Startup Central Eurasia Ecosystem Ranking 2022, Kazakhstan was 1st in Central Asia and 3rd in Central Eurasia (ITU, 2022). Below are several examples of startup products:

- Robo Wunderkind educational kits for children to learn basics of programming and robotics both in schools and at home.
- Matrix Mill focuses on computer vision and AR/VR technologies that allows machines to understand 3D images of their surroundings and enables digital objects to interact with the real world.

[13] UN. 2023. Kazakhstan: Common Country Analysis. https://kazakhstan.un.org/sites/default/files/2024-02/CCA%20Kazakhstan%202023.pdf

[14] UNCTAD. 2023. Data Hub. Share of ICT goods as percentage of total trade, annual. https://unctadstat.unctad.org/datacentre/dataviewer/US.IctGoodsShare

[15] UNCTAD. 2023. Data Hub. International trade in ICT services, value, shares and growth, annual. https://unctadstat.unctad.org/datacentre/dataviewer/US.TradeServICT

- Nommi portable Wi-Fi router with global roaming capabilities, which connects to a database of over 4.5 million Wi-Fi hotspots worldwide.
- ORBIPrime software helps businesses optimize workflow and improve the efficiency of document management processes.
- Clockster time and task management app helps users increase personal and team productivity by organizing work schedules and monitoring task completion.

Digitalization of government and public services

For two decades Kazakhstan has been working on the digitization of government services and has made substantial progress in the field. In 2024, Kazakhstan ranked 24th out of 193 countries on the United Nations E-Government Development Index (EGDI) — the 'very high EGDI' category — and held 10th position in the Online Service Index.

The eGov.kz portal, launched in 2006, streamlines and simplifies information and service delivery for citizens and businesses through a range of national information systems, registries, databases, platforms and applications. The portal provides online services for a range of sectors, including education, employment, healthcare, citizenship, migration and immigration, legal assistance, public safety, real estate, social security, taxation, transportation and communication, etc. (Official Information Source of the Prime Minister of the Republic of Kazakhstan, 2024a). By the end of 2025, AI-elements shall be imbedded in e-Government and Smart City projects.

Table 5. Elements of Kazakhstan e-government and e-participation system

Sector	Platform
Public services	eGov.kz — e-government platform providing access to public information and services for citizens
	open e-Gov — e-government platform encompassing components such as Open Data, Open Legal Acts, Open Budgets, Open Dialogue and Performance Evaluation of Government Agencies
	eGov Mobile — mobile application designed to deliver public and e-government services
Public engagement	eOtinish — public service management system enabling citizens to file electronic appeals and complaints to government agencies
Taxation	Salyq — online service providing a wide variety of services for individuals and entrepreneurs
	e-Salyq Azamat/ e-SalyqBusiness — mobile applications providing a wide variety of services for individuals and self-employed individuals/ entrepreneurs
	@SalyqBot — digital tax consultant in Telegram assisting citizens in tax and customs issues
Legal	eNotary — digital platform providing legal and notary services to citizens and facilitating the operation of and communication between notaries
	e-License — information system providing public licensing services and permitting activities

Sector	Platform
Healthcare	Damumed — online service and mobile app offering access to medical organizations and documents, scheduling doctor appointments and house calls
Education	Kundelik — digital learning environment platform
	Mektep.edu — online school management system
Employment	Enbek — digital ecosystem, including skills.enbek.kz, business.enbek.kz, hr.enbek.kz, career.enbek.kz, migration.enbek.kz
Procurement	Goszakup — platform providing access to e-services for government procurement as a buyer, organizer and/or supplier

Digital finance and banking

Being one of the fastest growing nationwide and the largest in Central Asia, the digital finance market in Kazakhstan is transforming towards digitalization and increasing accessibility of financial services for the population. One of the key trends in the Kazakhstan financial market is the growth of digital payments and e-commerce ecosystems. The National Bank of Kazakhstan is building the digital financial infrastructure with digital tenge as one of the main components. The digital tenge platform has been piloted with the first retail transactions in November 2023. The development and testing of the prototype are managed by the National Bank of Kazakhstan and National Payment Corporation, incompliance with the Roadmap of the Digital Tenge Implementation for 2023–2025.

Banks are actively cooperating with digital companies to shape ecosystems offering personalized services capable of solving a wide range of tasks. Halyk Bank continuously improves its digital ecosystem; more than eight million people use Halyk SuperApp, which ensures seamless access to government services. Kaspi Bank has revolutionized the financial sector in Kazakhstan by introducing an intuitive and user-friendly mobile Kaspi.kz application offering a full range of financial services and allowing customers to perform transactions such as money transfers, bill payments, account deposits, loans and investments, etc. using smartphones. Forte, Jusan, HomeCredit, Freedom and other financial institutions launched online and mobile banking systems.

The number of fintech startups continues to grow. BNPL (buy now, pay later) and neobanking are gaining popularity among consumers. In 2021, neobank Simply presented the first payment card integrated with mobile financial services.

Digitalization of corporate sector

Today innovative technologies are introduced and employed for digital transformation of various industries. Below are several examples from different industries:

- Oil and gas industry: digitalization is aimed at optimizing processes, ensuring safety and improving operational efficiency. The national company KazMunayGas expands automation of production processes and uses IT to mitigate the risks of accidents, reduce repair costs and increase the volumes of refined oil. The analytical system ABAI collects, processes, analyses and visualizes the data on exploration and extraction.

- Mining and metallurgical complex: a national project “Mining Industry 4.0” provides state support for digital transformation of the industry by nurturing data-driven self-service analytic competencies through uniting IT, mining and training of specialists in universities.
- Construction industry: several state projects have been implemented, among them Unified geoportal of infrastructure data; E-PSD, a unified digital platform for interaction of customers and expert organizations; IS Kazreestr system for automated collection, processing, storage and analysis of information in the field of state registration of shares; e-QURYLYS system for monitoring at all stages of the construction process; e-SHANYRAQ system to improve efficiency of housing and utilities entities, water and heat use, operation of elevators, etc. Construction companies use a wide range of software: platforms for data collection and analytics, software for design, metrology equipment and communication systems. The platform of BI Group offers a range of services, including online apartment purchase, a repair planner, a construction marketplace, cleaning services, food delivery and smart home solutions.
- Agricultural sector: the Ministry of Agriculture has developed E-APK programme to introduce effective and affordable tools for digitalization of processes to increase production and exports of processed agricultural products. The main technologies being implemented in the digitalization of agriculture are GPS navigation for agricultural machinery, parallel driving, automation of weighing operations, electronic field maps and the use of drones. The adoption of digital twins and IoT technology is gaining popularity. Large agro-industrial holdings are currently trying to build machine learning (ML) models and implement AI to optimize decision-making systems, automate animal feeding and introduce robotic milking technologies.
- Post and communication: QazPochta has been introducing technologies since 2014. Since 2022, digital IDs have been used to process dispatching of parcels. In 2023, an innovative branch Qazpost Digital was established to improve IT infrastructure and launch new projects for mailing, cargo and logistics in general.
- Transport: Kazakhstan railways employ IT for passenger services and cargo management. The use of electronic tickets and cargo documents simplifies and speeds up business processes and facilitates interaction with foreign cargo companies. The dispatch system and online fare payment in Ust-Kamenogorsk is aimed at improving urban transportation management: buses, trams and minibuses operate according to a strict schedule and passengers can track their journeys real-time in special apps.

E-commerce

Significant growth has been noted in e-commerce, where Kazakhstan outperforms the global average. In 2022, the share of sales from marketplaces in Kazakhstan retail e-commerce reached 89%. In 2024, the e-commerce market in retail sales grew by 24.3%, the market size reached 2.44 billion tenge, which is about 2% of GDP. Sales volume doubled and the number of purchases increased by 126%. A distinguished example is e-commerce ecosystem ChocoFamily founded in 2011 to develop innovative software tools for restaurants helping them to manage orders and customer bases and optimize

service processes. Today the portfolio of ChocoFamily unites eight projects: Chocolife.me (discount coupons), Chocotravel/Aviata (sales of air and train tickets, metasearch of hotels), Chocofood (food delivery service), Rakhmet (mobile wallet, loyalty programme, POS solution), Ryadom (hyperlocal food delivery), Lensmark (contact lenses sales), iDoctor (medical services search engine) and ioka (payment processing service).

One of the emerging trends in e-commerce market is the rapid adoption of mobile and digital payment solutions. This trend is changing the approach to e-commerce in Kazakhstan: companies are optimizing their platforms for mobile users and offering payment methods that are convenient for them. The country's vast territory and diverse landscapes create logistical challenges, especially in remote areas. To address these challenges, businesses are adopting advanced technologies, including route optimisation, real-time shipment tracking and efficient warehousing systems. Teez marketplace was officially launched in September 2024. The service operates in 30 cities of Kazakhstan and offers free one-day shipping.

All achievements in the expansion of the use of ICT described above have implications for the labour market in terms of services, expertise and skills in demand and the skills needed by users and consumers of the new products and services.

Human Capital for Digital Economy: Knowledge, Skills and Employability

The success of a digital economy relies on balancing the supply and demand for ICT talent and fostering an ecosystem that drives technological innovation. Human capital is an aggregate of the knowledge, skills, talents and abilities of individuals. The value of human capital depends on how well it is developed and on the extent to which it is available and used for economic, social and personal benefit. The human capital development strand of the digitalisation strategy involves cultivating a new generation of ICT specialists. Through strategic investments in education, upskilling initiatives and lifelong learning programmes, Kazakhstan aims to bridge the gap between labour market demands and workforce capabilities, building a competitive and adaptable workforce ready to meet the challenges of a rapidly evolving global economy.

Labour market and demand for ICT talent

The labour market of Kazakhstan is shaped by a complex interplay of historical, geographical, demographic, institutional and technological factors. More specifically, the annual influx of young people, urbanization, migration trends and regional disparities in labour distribution, alongside rapid digital transformation, workplace automation and integration of artificial intelligence are catalysing major shifts in the employment landscape (Government of the Republic of Kazakhstan, 2023c).

According to the Bureau of National Statistics, approximately nine million people were employed across major economic sectors in 2023. Trade (17%), education (13%), mining and manufacturing (12%) and agriculture (12%) were the top four industries in terms of employment. The workforce was primarily concentrated in urban centres like Almaty (12%), Astana (7%) and Shymkent (5%), though rural employment remained significant, particularly in agriculture. The share of those with higher education totalled almost 4 million, including 47% males and 53% females. Up to 3.5 million of the total employed population were youth aged 15–34, of whom 1.8 million had a higher education degree.[16]

The labour market is exposed to external and internal competition, as well as regional disparities in labour force distribution. Migration impacts on labour market and economic activity of Kazakhstan. In 2023, the net external migration balance reached a positive value (9,300 people) for the first time since 2011, which is driven by both an increase in immigrant inflows and a decrease in emigrant outflows. Most immigrants came from the CIS countries (86.3%). The largest share of arrivals was from Russia (46.1%), Uzbekistan (25.7%), China (3.9%) and Mongolia (2.6%). Russia also remains the primary destination for most emigrants from Kazakhstan (72.9%), followed by Germany as the second most common destination (14.2%). The number of people relocating within the country increased by 27.5% compared to 2022. The positive net internal migration balance was recorded in three cities Astana (50,078 people), Almaty (38,113 people) and Shymkent (3,416 people) (Bureau of National Statistics, 2023).

[16] The abovementioned statistical data covers employees registered through formal labour contracts and may not fully reflect informal employment observed in the labour market.

The government commitment and efforts toward digital transformation and ICT human capital development are reshaping the labour market. In 2022, the President of Kazakhstan declared the development of talents for the IT industry to be a key national priority. The government announced plans to train at least 100,000 highly qualified IT specialists by opening 20 modern programming schools, allocating 20,000 educational grants to these schools and facilitating support from leading IT universities to regional universities across the country (Official Information Source of the Prime Minister of the Republic of Kazakhstan, 2022).

In 2023, the information and communication sector represented about 2% of the total workforce, employing around 187,000 people, of whom 58% were men and 42% were women. ICT specialists were concentrated in two major cities — Almaty (26%) and Astana (22%).[17] Over 90,000 young people were employed in the ICT sector, of them 30% were in Almaty and 21% were in Astana (2023).[18]

The rise of AI and technology is disrupting job markets around the world, including the labour market in Kazakhstan. The companies that are most in need of IT specialists belong to the following sectors: information technology, system integration, internet (35%), financial sector (13%), retail (9%), business services (8%), media, marketing, advertising, BTL, PR, design, production (7%), telecommunications, communications (6%), construction, real estate, operation, design (5%), education (5%) (Profit, 2023). Today, the most in-demand IT specialists are programmers/developers, designers, analysts, system administrators, technical support specialists, information security specialists, system engineers, QA/QC engineers, network engineers and game designers.

The Atlas of New Professions and Competencies ensures navigation for new and emerging professions that will inevitably emerge within the next 15 years as a result of accelerating progress in R&D. The Atlas covers nine priority sectors of the economy. For IT sector, it identifies 40 new, six transforming and nine disappearing professions. While some jobs are being automated, new jobs are being created that require the following skill sets: processing and analysis of big data, design programming and maintenance of robots, cybersecurity, programming in multiple languages, creation, customization and interaction with AI. The key technologies will be AI, quantum computing and quantum cryptography, IoT and edge computing, blockchain and distributed ledger, VR, AR and MR, brain-computer interfaces and exocortex. The Atlas forecasts that the following professions will emerge and become widely spread in Kazakhstan by 2040: quantum computing designer/operator/technologist, developer of aggregated digital twins or digital avatars, distributed register designer, blockchain developer/engineer of intelligent cyber-physical infrastructures, AI ethics consultant, universal AI developer, designer of artificial neural networks, developer of neurocomputer interfaces for human AI interaction, ICT talent manager and digital skills constructor, etc. (Ministry of Labour and Social Protection of Population of the Republic of Kazakhstan, 2020).

Kazakhstan is modernizing its employment and education systems through digital transformation and a unified qualifications framework. The National Portfolio of TVET Programmes, integrated into the National Qualifications System, ensures educational continuity, recognition of prior learning and alignment of workforce training with

[17] Bureau of National Statistics. 2023. Information and Communication Technologies and Communications: Dynamic Tables. https://stat.gov.kz/ru/industries/business-statistics/stat-it/dynamic-tables/

[18] Bureau of National Statistics. 2023. Key Labor Market Indicators by Region of the Republic of Kazakhstan. Youth in the Labour Market. https://stat.gov.kz/api/iblock/element/50986/file/en/

economic needs. The Electronic Labour Exchange, established under the Social Code (April 20, 2023), is a digital platform connecting job seekers with employers and offering proactive employment services. It is part of a broader digital employment ecosystem enbek.kz and related platforms skills.enbek.kz, business.enbek.kz, hr.enbek.kz, career.enbek.kz, migration.enbek.kz guiding citizens from career selection to employment. The Career Enbek platform consolidates national and sectoral qualification frameworks, occupation classifications, professional standards, registries of professions and educational programmes, qualification recognition centers and databases of recognized qualifications and documents. These efforts create a seamless, digitally driven system enhancing education quality, improving workforce readiness and supporting lifelong learning and economic growth.

In line with global trends, Kazakhstan is experiencing a shift from traditional employment towards the gig economy. Freelance and platform-based employment have gained prominence, providing flexibility, diverse opportunities and the ability to tailor work to individual lifestyles. In 2023, self-employed individuals and independent entrepreneurs numbered approximately 17,000 people, of whom 66.5% were men and 33.5% were women.[19] Additionally, around 12.7% of the total working population was engaged in informal employment.[20]

Table 6. Key labour market data

Indicator	Total	Men	Women
Employed population	**9,081,920**	**4,711,744**	**4,370,176**
• with higher education	3,982,708	1,872,875	2,109,833
• in ICT sector	187,833	109,277	78,556
• youth aged 15–34	3,555,791	1,929,168	1,626,623
Self-employed population	2,188,491	1,212,282	976,209
Informally employed population	1,155,694	614,193	541,501
• with higher education	256,342	119,932	136,410
• in ICT sector	8,696	5,155	3,541

Source: Bureau of National Statistics, 2023b

A rising proportion of the population is engaged in platform employment, which includes both the remote delivery of services through freelance marketplaces and the physical delivery of services facilitated by digital platforms that connect customers with service providers. According to expert estimates, platform employment in Kazakhstan reached one million people (Government of the Republic of Kazakhstan, 2023c). According to the Online Labour Observatory, software development and technology are the most frequent occupations among online freelancers in Kazakhstan. While the sector remains underdeveloped and data varies significantly, estimates suggest that 16.6% of the

[19] Bureau of National Statistics. 2023. Key Labor Market Indicators by Region of the Republic of Kazakhstan. Self-employed Population: According to International Labour Organization Standards. https://stat.gov.kz/api/iblock/element/50978/file/en/

[20] Bureau of National Statistics. 2024a. The number of informally employed population in Kazakhstan. 17'th Serie Labor and Employment Statistics. https://stat.gov.kz/api/iblock/element/166912/file/en/

population was engaged in freelance work in 2021, earning their living and benefiting from the gig economy (WDC, 2022). This number is expected to increase further, particularly in the ICT sector, driven by the rapid expansion of digital platforms and services.

The growing adoption of IT outsourcing and IT outstaffing has become a popular business model in the labour market of Kazakhstan. IT outsourcing involves partnering with an agency that assembles and manages remote teams, while IT outstaffing entails delegating specific tasks or projects to an external team that operates independently. These practices provide local IT professionals with opportunities to work on international projects, develop their skills and gain exposure to global standards.

GitHub commits, which reflect developer activity and contributions to open-source projects, serve as a key indicator of technological engagement and professional skill levels within a country. The number of GitHub users from Kazakhstan grows gradually reflecting increased interest in programming and technological development among local professionals. Most of these users are based in cities such as Aktobe, Almaty, Astana, Karagandy, Kostanay, Pavlodar, Oskemen, Semey, Shymkent and Taraz.[21] Both students and IT specialists leverage GitHub as a platform to showcase their skills, collaborate on projects and engage with the global developer community.

Overall, Kazakhstan demonstrates dynamic growth of well-educated workforce. According to the 2021 population census, every fourth resident of the country (3.6 million people) held a higher education degree (Bureau of National Statistics, 2023d). However, employer surveys in the region show that skill mismatches are widespread (OECD, 2018). Based on a survey from the World Economic Forum, Kazakhstan ranks at the bottom in terms of the ease of finding skilled employees (World Economic Forum, 2019).[22] The relevance of graduates' skills is also a concern, with almost half of the companies in the region facing difficulties in recruiting qualified employees (UNESCO, 2021a).[23]

While the government remains committed to cultivating and retaining qualified professionals, the demand for skilled talent in the ICT industry presents a challenge to further growth and development. In 2023, the shortage of ICT specialists was estimated approximately at 30,000 people of them 31% developers, 21% specialists in IT infrastructure and 19% technical support staff (IDC, 2023). In addition to talent shortage, there is an issue of limited access to professional development and upskilling opportunities, particularly through lifelong learning initiatives (Government of the Republic of Kazakhstan, 2023c).

The Concept for the Development of the Labour Market of the Republic of Kazakhstan for 2024–2029 outlines the following major obstacles in the labour market: low labour productivity and limited economic diversification due to reliance on natural resource extraction and exports, persistent mismatch between skills and labour market demands, high share of informal employment, disparities in job access and income among various social groups, etc. (Government of the Republic Kazakhstan, 2023c).

[21] GitHub. 2025. Top GitHub Users by Public Contributions in Kazakhstan. 31 January 2025. https://github.com/gayanvoice/top-github-users/blob/main/markdown/public_contributions/kazakhstan.md

[22] Ease of finding skilled employees. The following question from the questionnaire was used: "In your country, to what extent can companies find people with the skills required to fill their vacancies?" [1 = not at all; 7 = to a great extent] | 2018– 2019 weighted average or most recent period available.

[23] Skillset score. The average score of the two Executive Opinion Survey questions: "In your country, to what extent do graduating students from secondary education possess the skills needed by businesses?" and "In your country, to what extent do graduating students from university possess the skills needed by businesses?" ranges from 1 (not at all) to 7 (to a great extent) / 2018–2019 weighted average or most recent period available.

Digital infrastructure and ICT solutions in higher education

In March 2020, the Minister of Education and Science of the Republic of Kazakhstan approved the use of digital portfolios in education by the Order No. 79, which defined the minimum requirements for the software and hardware complex and application software used in educational organizations, in particular for computer and peripheral equipment, data transmission networks, access control and management systems, information systems and software.

Article 61 of the Model Rules Governing the Activities of Higher and Postgraduate Education Organizations approved by the Order of the Minister of Education and Science of the Republic of Kazakhstan No. 595 of October 30, 2018 (with the latest amendments dated August 2, 2023), mandates that the Organizations for Higher and Postgraduate Education (OVPO) ensure the operation of an educational management information system—a high-technology information and learning environment comprising a website, an information and educational portal, an automated system supporting credit-based learning and a suite of information and educational resources—as well as a distributed computer network with broadband, high-speed internet access.

According to the Bureau of National Statistics, the country's higher education institutions saw an overall enhancement of their infrastructure between the beginning of the 2023–2024 and 2024–2025 academic years. Between the end of 2023 and 2024, the number of computers utilized in the educational process rose from 82,931 to 91,583 units. The number of internet-connected computers increased from 78,710 to 86,188 units during the specified timeframe. Interactive equipment in higher education institutions also maintained an upward trajectory, increasing from 6,975 to 7,639 sets over the reporting period. These figures correlate with the increase in student admissions over the specified period. The total number of enrolments increased from 171,699 in 2023 to 183,630 in 2024. Of these, 37,018 students were enrolled in ICT-related degree programmes in 2023, rising to 43,946 in 2024 (Bureau of National Statistics, 2024b).

The recent insights from Kazakhstani researchers, referring to the digital technologies used in enabling the educational process in HEIs, specify online communication solutions, digital learning platforms and social media tools (Nurtayeva et al., 2024). Digital platforms deliver both effective and flexible instructional modalities within contemporary higher education. By facilitating the creation of virtual courses and learning environments, they enable remote access to instruction. The interactive and adaptive functionalities of these systems empower institutions to personalize the educational experience. Universities employ digital platforms to record student attendance, thereby facilitating the monitoring of engagement and the assessment of academic performance. All HEIs in Kazakhstan possess the requisite digital infrastructure, though the effectiveness of its application varies by university. At present, 100% of the institutions have access to learning management systems (LMS): HEIs employ a variety of domestic online systems and platforms, including Platonus (44% of HEIs), HeRo Study Space, Univer (10%) and Wsp.kz, and prominent international LMS providers (Nurtayeva et al., 2024; Medetbayeva et al., 2024).

To enhance visibility and promote academic offerings, universities actively cultivate digital communities around their institutional brands and leverage social media platforms, which facilitate knowledge exchange and forge robust connections among students, faculty

and alumni. These channels serve multiple functions: disseminating information on educational achievements; organizing recruitment events and promotional campaigns; and providing up-to-date schedules, academic activity announcements, research opportunities and other aspects of campus life. Additionally, universities use social media to share scholarly outputs, attract collaborators for joint research projects and participate in broader academic debates (Nurtayeva et al., 2024).

Higher education and professional training in ICT

The Government of Kazakhstan acknowledges the pivotal role of education for national development and allocates substantial budgets for all educational levels and sectors. Government expenditures on education increased from 3.15% of GDP in 2018 to 4.87% of GDP in 2023, reflecting the transformations in the demands of economy and labour market under the influence of new challenges, including digitalisation.[24]

Higher education and TVET play a significant role in human capital development and economic growth. Kazakhstan has a centralized model of higher education governance where the Ministry of Science and Higher Education plays a key role in setting quality standards, defining investment priorities, appointing university leadership and allocating resources across the higher education sector. As a member of the Bologna Process, the country has adopted a three-cycle higher education system (bachelor's, master's and doctoral studies) alongside internal and external quality assurance mechanisms and a credit-modular framework. The national higher education system comprises both public and private institutions. Public HEIs operate under a dual-track funding system, some students pay full tuition fees while the others receive nearly full financial support from the government budget.

Digital skills are a central focus of implemented strategies, e.g. Digital Kazakhstan, which aims to enhance digital literacy, build a digital ecosystem and promote technology adoption for productivity growth. These efforts are further supported by the Concept for the Development of Higher Education and Science in the Republic of Kazakhstan for 2023–2029. The document puts forward such priorities as improving quality and access, developing science and research capacity, enhancing infrastructure and digital architecture, and strengthening internationalization. While reinforcing quality assurance in higher education, Kazakhstan seeks to align graduate skills with labour market demands by incorporating outcome-oriented key indicators, such as digital literacy and graduate employment rates. Significant attention is paid to developing a lifelong learning system that enables individuals to add new professional competencies to existing ones, recognize the outcomes of non-formal and informal education and use diverse learning formats, including Massive Open Online Courses (MOOCs) offered by leading international providers.

Furthermore, MDDIAI intends to develop infrastructure and human capital and eliminate outdated or low-demand scientific and educational disciplines by means of strengthening relevant and emerging fields and fostering collaboration between scientific organizations and companies to drive the development of innovative products. These areas were defined as key strategic priorities for 2023–2027 to further advance the IT sector and enhance innovation, scientific and technical potential (MDDIAI RK, 2023).

[24] UIS. 2023. Government expenditure on education as a percentage of GDP (%). https://databrowser.uis.unesco.org/

According to the Bureau of National Statistics, digital literacy among the population between 6 and 74 years of age reached 90.2% in 2023 (Bureau of National Statistics, 2023c).[25] The Global Knowledge Index 2024 ranks Kazakhstan 48th (out of 141 countries) in the share of individuals with standard ICT skills and 94th in share of tertiary graduates from ICT programmes (UNDP & MBRF, 2024).

In 2023, 112 HEIs and 711 technical, vocational and post-secondary education organizations were accredited in Kazakhstan. The number of HE students totalled 592,694 (314,694 or 53% females) and the number of TVET students totalled 547,994 (263,556 or 48% females) (Bureau of National Statistics, 2023e).[26] In the 2023/2024 academic year, 157,106 students graduated from HEIs and 141,013 completed TVET programmes (Bureau of National Statistics, 2024). The share of women in tertiary education surpasses that of men, which ranks Kazakhstan ahead of other countries in the region.[27]

In 2025, 21 HEIs were included in the QS World University Rankings,[28] three of them entered top 500: Al-Farabi Kazakh National University (Almaty) was ranked 163d, L.N. Gumilyov Eurasian National University (Astana) — 321st and Satbayev University (Almaty) — 405th. These universities are also the leaders among Kazakhstan's HEIs in the QS World University Rankings by subject "Engineering & Technology" and by region "Central Asia". According to the Times Higher Education World University Rankings,[29] Nazarbayev University (Astana) was included in the 501-600th category.

The universities offering opportunities for education and research in computer science are located in Almaty (International University of Information Technologies, Kazakh-British Technical University, Al-Farabi Kazakh National University, Satbayev University, SDU University, Almaty Technological University), Astana (Astana IT University, Nazarbayev University, L.N. Gumilyov Eurasian National University, Kazakh University of Technology and Business), Karaganda (Karaganda State Technical University) and Ust-Kamenogorsk (East Kazakhstan Technical University named after D. Serikbayev). HEIs play a pivotal role in ICT talent development by supporting enabling ecosystems, developing ICT infrastructure, driving innovation, enhancing advanced ICT expertise and strengthening research.

Astana IT University (AITU) applies modern technologies and provides students with access to specialised laboratories, including Smart City, Industry 4.0, Big Data and Blockchain Technologies, AgroTech research and innovation centres, FabLab and the Embedded Systems and IoT Laboratory. Collaboration with leading companies enhances practical learning through internationally certified training centres. AITU's digital infrastructure integrates smart services (Unified Online Service Centre), a virtual learning environment (Moodle, Digital Continuous Education Institute), cloud platforms, library resources, IoT solutions, including smart classrooms and labs. Additionally, the university connects

[25] Digital literacy implies the share of users equipped with the skills to operate personal computers, smartphones, tablets and laptops, as well as to use standard software programmes and access online services. Bureau of National Statistics. 2023. Information and Communication Technologies and Communications: Dynamic Tables. Digital Literacy of the Population. https://stat.gov.kz/api/iblock/element/162400/file/en/

[26] According to UIS data for 2024, 733,181 people were enrolled in tertiary education.

[27] World Bank Open Data. 2023. School enrolment, tertiary (% gross). https://genderdata.worldbank.org/en/indicator/se-ter-enrr

[28] QS Top Universities. 2025. QS World University Rankings 2025: Top global universities. https://www.topuniversities.com/world-university-rankings

[29] Times Higher Education. 2025. World University Rankings 2025. https://www.timeshighereducation.com/

with external systems such as the Electronic Document Management System, National Educational Database and Unified Higher Education Management System, fostering a dynamic ecosystem for innovation and education.

To cultivate ICT talents, Kazakh-British Technical University (KBTU) integrates advanced digital infrastructure, establishes specialised laboratories and fosters industry collaboration. KBTU School of Information Technology and Engineering facilities support ICT education and research. The Cloud Technologies and Big Data Laboratory, established in partnership with Halyk Bank, offers facilities for training in programming, web technologies and e-commerce. The Cybersecurity Laboratory is specialised in ethical hacking, digital forensics and cryptography. The Electronics Laboratory supports hands-on learning in analog circuits, mechatronics, power electronics and digital communications. The Robotics and Mechatronics Laboratory is equipped for training and research in automation, intelligent control, industrial robotics and augmented reality applications. KBTU also hosts industry-supported labs. R&D initiatives include GameLab KBTU for video game development and specialised laboratories for AI and for Intelligent Robotics and Mechatronics.

The International University of Information Technologies (IITU), with the support of the Ministry of Education and Science of the Republic of Kazakhstan, established the Mixed Reality Laboratory to advance virtual, augmented and mixed reality technologies in education and research. Additionally, IITU collaborates with leading companies to enhance practical learning through specialised laboratories. IITU R&D projects are focused on the elaboration of a digital transformation platform for the national economy, the development of methodology, as well as architectural and software solutions for cloud-based automation of business workflows and machine learning methods, the enhancement of tools for qualitative and quantitative analysis of unstructured data, the establishment of virtual electronic laboratories incorporating augmented and virtual reality technologies and the design of a software-hardware complex for the monitoring and analysis of climate and environmental data, etc.

L.N. Gumilyov Eurasian National University accommodates an AI research laboratory and a range of specialised educational laboratories in cybersecurity, multiservice networks, digital circuitry and microelectronics, computing and microprocessor technology, electronic device design and information encoding, robotics and mechatronics systems, smart city technologies, IT-Alem network simulator, analogue and digital electronics, etc. to support advanced research and hands-on learning in cutting-edge technological fields. The labs and computer classrooms are equipped with advanced devices for 3D modelling and printing, VR technologies and multimedia applications. A range of software supports diverse educational and research needs.

Satbayev University offers facilities to advance ICT education and research. It hosts a FabLab, part of the global network established by the Massachusetts Institute of Technology, which provides access to advanced technologies and opportunities for international collaboration. The lab is equipped with 3D printers, laser cutters, CNC machines and devices for electronic prototyping. Information and telecommunications systems are one of the main research areas at the university. Projects are focused on computer vision, machine learning and deep neural networks to monitor agricultural land. Through the application of unmanned aerial systems, researchers classify plants, detect stress and map fields to reduce herbicide use, enhance crop vitality and improve farming efficiency. The university also hosts the Institute of Digital Engineering and Technology, a leading

developer in automation, big data and AI, which specializes in industrial automation, digital twins and intelligent systems for major enterprises. The institute accommodates an experimental design bureau and a supercomputer modelling laboratory for processing large datasets. It offers services in software design, production management and digital solutions like smart city and corporate cloud systems.

The four departments of the Faculty of Information Technology (Department of Information Systems, Department of Cybersecurity and Cryptology, Department of Computer Science and Department of Artificial Intelligence and Big Data) at Al-Farabi Kazakh National University focus on information and communication technologies as a priority of educational and research activities. The projects cover a wide range of fields, including digital infrastructure and automation (e.g., enterprise information systems, Wi-Fi-based multimedia delivery), AI-driven analytics and decision-making (e.g., smart health assessment, AI-powered content analysis), cybersecurity and data protection (e.g., data encryption, cyber-forensics tools), machine learning and computer vision (e.g., real-time facial recognition, vehicle classification), natural language processing and machine translation (e.g., Kazakh-English neural translation, multilingual Turkic language processing), education and virtual learning technologies (e.g., AI-driven virtual learning, national video conferencing system), healthcare and public safety technologies (e.g., COVID-19 self-diagnosis app) and supercomputing and scientific computing (e.g., parallel computing for geophysics).

Nazarbayev University (NU) fosters ICT talent development based on the use of advanced infrastructure and specialised laboratories in robotics, telecommunications, computer science and electronics. The labs are equipped with cutting-edge tools such as 3D printers, universal testing machines and soldering stations. Computer classrooms provide access to industry-standard software. NU's facilities create a practical, safe and goal-oriented environment empowering students and researchers to build ICT expertise and drive technological innovation. NU builds a robust digital ecosystem for effective and innovative education through the LMS, the Registrar's Office platform for course coordination and registration, the NU Library and the student portal.

Kazakh University of Technology and Business integrates a robust digital infrastructure into its educational process. The university hosts specialised laboratories for robotics and automation, supporting high-quality training sessions, scientific research and student-led projects. Computer classrooms are equipped to enable the study of network technologies, programming languages and mastering development of application, databases and information systems. Classrooms for IT and systems engineering, digital education, applied AI, robotics, digital models and control systems, AI tools, mathematical modelling and intelligent control, data analytics, etc. expand the university's capacity for advanced digital education and research.

An inter-university AI standard has been adopted in Kazakhstan: 17 universities developed 21 educational programmes on Applied AI, AI Engineering and Blockchain, Cybernetics and AI, AI in Medicine, AI and Data Analysis, Smart Technologies and AI in Transport Engineering, Computer Science and AI, etc. Learners will be equipped with skills, such as Python programming, data analysis and visualization (Pandas, NumPy, Matplotlib, Seaborn), natural language processing (NLP), working with libraries and frameworks (TensorFlow, Keras, PyTorch), managing big data and databases (SQL, NoSQL), integrating AI solutions into business processes, developing and implementing neural networks,

automating processes using AI, etc. (Official Information Source of the Prime Minister of the Republic of Kazakhstan, 2024c).

Public and private educational institutions are adopting innovative learning formats, including online education, through partnerships with international platforms. HEIs are integrating Coursera courses into their curricula and developing their own online courses. As of 2024, 93 universities offered courses on in-demand skills, with 152 courses translated into Kazakh and Russian. Universities and technical colleges provide specialised courses and programmes tailored to high-demand sectors such as fintech, medical informatics and energy, equipping students and professionals with the advanced competencies for technology-driven industries. Since 2023, Kazakhstan has been piloting the digital university model at two leading institutions: Kazakh National Research Technical University and East Kazakhstan Technical University (Official Information Source of the Prime Minister of the Republic of Kazakhstan, 2024c).

While Kazakhstan performs well globally in the share of STEM graduates, accounting for 24%, it still lags the levels achieved by developed countries. Similarly, the percentage of graduates in ICT programmes remains relatively modest accounting for 3.4% of all university graduates. The share of female STEM graduates remains lower than that of males, 14% and 36% respectively. Likewise, the share of female graduates in ICT programmes is 2.3%, while male graduates made up 4.7%.[30]

To strengthen ICT education nationwide, various initiatives are implemented to enhance ICT skills and broaden access to digital education, fostering a highly skilled workforce for the evolving digital economy:

- The Bolashak International Scholarship Programme, established by the President of the Republic of Kazakhstan, provides citizens with an opportunity for training abroad in leading HEIs or undertaking an internship in international organizations (Government of the Republic of Kazakhstan, 2007). While the programme covers a wide range of disciplines, it significantly contributes to expertise development in ICT, particularly in advanced fields such as AI, cloud computing and cybersecurity.
- Astana Hub is actively involved in developing ICT human capital development and enhancing the employability of ICT professionals. It serves as a platform for a wide range of educational programmes and courses in IT and technological entrepreneurship, including Tech Orda programmes, Tomorrow School, Freelance School, etc. Since 2019, over 18,000 people have completed IT education programmes through Astana Hub.
  - The government-supported Tech Orda programme addresses labour market needs and aims to train 20,000 IT specialists across the whole country by the end of 2025, offering grants for student training and upskilling school teachers and university instructors. Accredited IT schools and companies provide courses in web development, 3D design, AR/VR applications, operating systems, mobile app development, cybersecurity, IoT, AI, Big Data and GameDev (Official Information Source of the Prime Minister of the Republic of Kazakhstan, 2024d).
  - Freelance School is designed to equip freelancers with essential knowledge of digital technologies and social skills empowering them to succeed on digital labour platforms.

[30] UIS. 2023. UIS Data Browser. https://databrowser.uis.unesco.org

  - Tomorrow School is a unique AI school in Kazakhstan which utilizes the innovative peer-to-peer learning system to foster cutting-edge skills in AI.
  - IT-Aiel Programme, implemented under the President of the Republic of Kazakhstan in collaboration with the National Commission on Women's and Family Demographic Policy, offers training to women interested in pursuing careers in the IT field.

- The ITeachMe programme promotes digital inclusion by empowering persons with disabilities and socially vulnerable groups through digital skills training and employment opportunities. Using gamification and large-scale events, it equips participants with in-demand competencies in such fields as AI, No Code development, UX/UI design and web design. Since 2019, ITeachMe has partnered with over 100 enterprises, more than 90% of graduates successfully joined the workforce.
- AI-Sana educational programme is designed to develop AI competencies among students, support DeepTech startups and promote technological entrepreneurship. The programme aims to train approximately 100,000 participants.

Initiatives and programmes aimed at ICT skills development

To further align learning outcomes with labour market needs and enhance employability in the ICT industry, the Ministry of Science and Higher Education promotes collaboration between academia and the private sector. Public-private partnerships are fostered with major tech companies.

These partnerships enable access to innovative learning technologies and facilitate enhancement of advanced digital skills and better integration of practical experience into academic training.

Kazakhstan's HEIs also benefit from international collaboration with different organizations and universities worldwide. As of 2024, HEIs implement about 245 joint educational and double-degree programmes. Funds are annually allocated to engage 200 foreign scientists for teaching (Official Information Source of the Prime Minister of the Republic of Kazakhstan, 2024c).

The partnerships aimed at faculty and student exchange programmes bring cutting-edge practices into academic programmes and contribute to the global recognition of Kazakhstan's education system. In collaboration with Seoul Technical University, the Higher School of Artificial Intelligence and Informatics has been established at Korkyt Ata Kyzylorda University. A branch of the City University of Hong Kong was opened at Satbayev University (offering dual-degree programmes in AI), and an Artificial Intelligence Centre was established at D. Serikbayev East Kazakhstan Technical University in partnership with the Lu Ban Workshop (Official Information Source of the Prime Minister of the Republic of Kazakhstan, 2024c).

To enhance employee development and equip young professionals with the skills needed for high-demand jobs in emerging fields, various training courses in programming, data analytics and AI were introduced as part of specialised youth-centred programmes. These include UNDP Accelerator Lab, hackathons SKILLS UP, ICESCO youth training programme in the field of technology and innovation, etc.

To foster professional development of women in STEM, the Women in Tech initiative was launched in Kazakhstan in 2024 as part of a global movement. The initiative offers training programmes and facilitates experience-sharing with accomplished experts in engineering and technology. The long-term objective of such initiatives is to increase the representation of women in technical fields, strengthen their roles in the ICT sector and achieve gender balance. These advancements promote equality and foster the creation of an innovative and inclusive society.

Research and innovation

Kazakhstan is actively advancing research and development initiatives across the country. R&D efforts are mainly driven by the National Academy of Sciences, universities, innovative companies and start-ups. According to the Bureau of National Statistics, in 2023 R&D expenditure amounted to 172,585.9 million tenge, accounting for 0.14% of Kazakhstan GDP, an increase of 0.02% from 2022. This funding is mainly aimed at supporting fundamental and applied research as well as R&D in fields such as natural sciences, engineering and technology, medical sciences, agricultural sciences, social sciences and humanities. In 2023, the share of the expenditure on R&D in engineering and technology was 3.4% of the total expenditure on R&D. Priority technological areas include MedTech, AgriTech and GreenTech, AI, industry 4.0, GovTech and metallurgy. In total, 425 organizations employing 25,473 people were engaged in R&D activities.[31]

In 2024, the Law On Science and Technology Policy was enacted in Kazakhstan to foster the advancement of science and the implementation of technology policy, facilitate the application of scientific achievements and enhance the country's competitiveness.

Various initiatives have been launched to strengthen ICT and AI development, including the adoption of new legislative acts, increased funding and the creation of research centres and technoparks. For example, the National Centre for Artificial Intelligence, planned to be opened in Astana in 2025, will promote collaboration among companies and start-ups on IT and AI projects, driving further innovation and growth across these fields.

In addition to academic training opportunities, the Bolashak International Scholarship Programme provides opportunities for scientific internships in various fields, including ICT, engineering and natural sciences at leading HEIs, research centres and other organizations worldwide. Through the PhD Research and Training Grant Programme, the Government offers financial support to researchers, research engineers, constructors and designers from industrial enterprises to conduct studies in priority areas aligned with scientific and technological development. These areas include digital services, 3D printing, automation, robotics, AI, nanotechnology and big data. Leading national HEIs and universities also play a pivotal role in advancing R&D in ICT and AI. A notable example is the Institute of Smart Systems and Artificial Intelligence (ISSAI) established at Nazarbayev University in 2019. ISSAI serves as a hub for research and innovation, focusing on AI research and interdisciplinary studies in machine intelligence to address real-world challenges faced by industries and society.

[31] Bureau of National Statistics. 2023. Statistics of education, science and innovation. https://stat.gov.kz/ru/industries/social-statistics/stat-edu-science-inno/dynamic-tables/

Conclusions and Recommendations

The effectiveness of Kazakhstan's reforms and notable progress in advancing digital skills development is evidenced by its positions in global indices and rankings. In 2024, the UN E-Government Survey ranked Kazakhstan first among Central Asia countries and 24th globally, which indicates that the country is improving its e-government services. It took 10th position (out of 193) in the Online Service Index. According to the United Nations E-Participation Index, Kazakhstan ranked 27th (out of 193) in 2024. According to the Government AI Readiness Index 2024, Kazakhstan ranks 76th (out of 188), which is higher than the regional average for South and Central Asia.

Kazakhstan's performance in the ICT Development Index and the Network Readiness Index is also notable. According to recent data, Kazakhstan ranks 34th (out of 169) in the ICT Development Index. The Network Readiness Index ranks Kazakhstan 61st (out of 133), the second place in the CIS region after the Russian Federation. Overall, Kazakhstan's performance suggests the potential for growth based on the progress in e-commerce legislation (1st), government online services (8th), socioeconomic gaps in use of digital payments (9th), e-participation (15th), affordability of mobile tariffs (17th), international internet bandwidth (30th) and digital inclusion (39th).

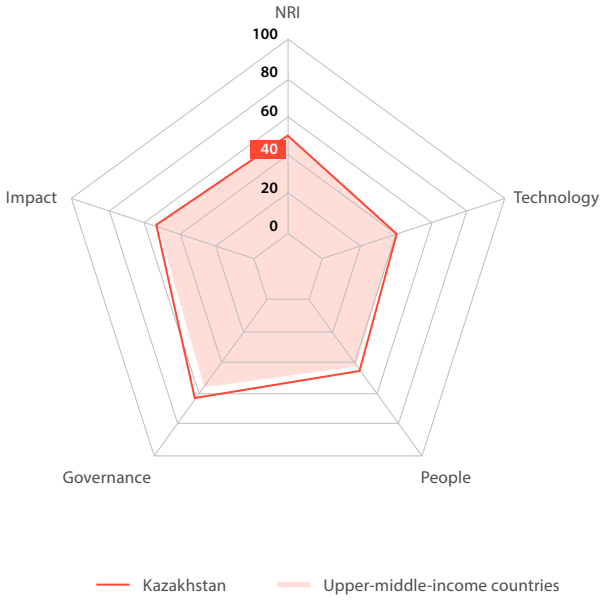
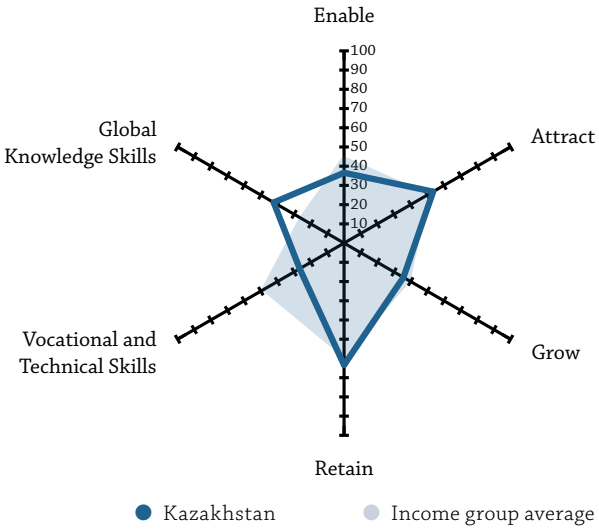


Figure 1. Comparison of Kazakhstan with upper-middle income countries in the Network Readiness Index 2024 Source: Portulans Institute, 2024, p. 144.

In the Global Knowledge Index 2024, Kazakhstan occupies 72nd position among 141 countries and has the highest rankings in the following pillars: pre-university education (42nd), economy (60th), ICT (62nd), enabling environment (62nd), which shows high potential for further development. The Index specifies government online services among the areas of strength and government expenditure on vocational education, investment in telecommunication services, educational attainment rate (master's or equivalent) as areas of improvement.

Figure 2. Comparison of Kazakhstan with world average score and average score of countries with very high human development in Global Knowledge Index. Source: UNDP & MBRF, 2024, Global Knowledge Index 2024, p. 237.



Kazakhstan ranks 67th in the Global Talent Competitiveness Index with a score of 43.01, which is slightly below the upper-middle income group average score. Kazakhstan is one of the top three performers in Central and Southern Asia, ranked the second and is in the top quartile in the Global Knowledge Skills (30th) and High-Level Skills (14th), which indicates high numbers of tertiary-educated professionals. However, the country is not fulfilling the potential of its domestic talent, which is reflected in skills gaps that lead to poor Employability (132nd) and low Vocational and Technical Skills (122nd).

Figure 3. Comparison of Kazakhstan with upper-middle income countries average score in the Global Talent Competitiveness Index 2023. Source: INSEAD, 2023, p. 131.

In the IMD World Digital Competitiveness Index 2024, Kazakhstan ranked 34th (out of 67), which shows progress in implementing and using digital technologies as a key factor in economic transformation. Kazakhstan ranks 35th (out of 146) in the Global Attractiveness Index 2024, which assesses the attractiveness and competitive sustainability of countries, since 2023 it improved its rank by 11 positions. In the Digital Intelligence Index, Kazakhstan is ranked 55th in digital evolution and 20th in digital momentum scores (out of 90) (Fletcher, n.d.). In Huawei Global Digitalization Index 2024, which measures digital maturity of countries based on the assessment of ubiquitous connectivity, digital foundation, green energy, policy and ecosystem, Kazakhstan is ranked 58th out of 77 countries.

Table 7: Kazakhstan ranking in international indices

Index	2018	2019	2020	2021	2022	2023	2024
Government AI Readiness Index	n/a	65 (194)	64 (172)	66 (160)	72 (181)	72 (193)	76 (188)
Network Readiness Index	n/a	60 (121)	56 (134)	61 (130)	58 (131)	58 (134)	61 (133)
Global Innovation Index	74 (126)	79 (129)	77 (131)	79 (132)	83 (132)	81 (132)	78 (133)
Global Talent Competitiveness Index	51 (119)	56 (125)	54 (132)	60 (134)	62 (133)	67 (134)	n/a
Global Knowledge Index	n/a	n/a	62 (138)	78 (154)	78 (132)	74 (133)	72 (141)
ICT Development Index	n/a	n/a	n/a	n/a	n/a	32 (168)	34 (169)
Global Attractiveness Index	65 (144)	52 (144)	51 (144)	56 (148)	50 (148)	46 (146)	35 (146)
Global Sustainable Competitiveness Index	59 (180)	72 (180)	72 (180)	80 (180)	73 (180)	66 (180)	69 (191)

Index	2018	2019	2020	2021	2022	2023	2024
IMD World Digital Competitiveness Index	38 (63)	35 (63)	36 (63)	32 (64)	36 (63)	34 (64)	34 (67)
E-Government Development Index	39 (193)	n/a	29 (193)	n/a	28 (193)	n/a	24 (193)
E-Participation Index	42 (193)	n/a	26 (193)	n/a	15 (193)	n/a	27 (193)

Sources: Oxford Insights; Portulans Institute; WIPO; INSEAD; UNDP & MBRF; ITU; The European House — Ambrosetti Group; SolAbility Sustainable Intelligence; IMD: International Institute for Management Development; UN E-Government Knowledgebase.

Despite the achieved progress, there are still some challenges related to digital skills development in Kazakhstan. At the regulatory level, a specific policy on ICT skills and competencies as applied to career development is lacking. A shortage of skilled ICT talent at the national labour market is observed and noted by national authorities. Higher education and TVET face challenges in addressing the mismatch between learning outcomes and industry demands, as well as overcoming gender imbalances in ICT and STEM fields. Reskilling and upskilling adults remain an issue in bridging the gaps in a rapidly evolving labour market that requires a tech-savvy workforce. Connections between educational institutions and companies are not maintained in a regular and consistent manner, limiting opportunities for mutually beneficial partnerships. Insufficient investments in R&D limit the growth of national innovation potential, enabling the widespread adoption of digital technologies across all economic sectors and strengthening Kazakhstan's position in regional and global ICT markets. Access to standardized statistical data—disaggregated by gender, age, skill level, geographic location, socioeconomic status, access to technology and other factors—is restricted, hindering evidence-based decision-making and the advancement of ICT and digital technologies across all economic sectors.

The following recommendations are proposed to address the challenges revealed in the field of digital skills development in Kazakhstan:

Recommendation 1: Embrace long-term investment in education and digital learning infrastructure to ensure equitable access to quality education and training programmes nationwide. Sustainable financing mechanisms are essential to build up a robust and inclusive digital ecosystem, including education and R&D. Tax incentives can further encourage ICT companies to actively contribute to training and professional development of the workforce.

Recommendation 2: Elaborate a comprehensive strategy for ICT skills and talent development to ensure satisfaction of labour market demands of digital economy. It is advisable to draw a strategy upon existing national strategic and legislative documents regulating digital transformation processes, equipping it with operational, monitoring, assessment and adjustment mechanisms to ensure effective implementation.

Recommendation 3: Adopt a cross-ministerial coordination mechanism to ensure cohesive and aligned implementation of the strategy for ICT skills and talent development. A dedicated team of representatives of all stakeholders should be built to provide organizational and technical leadership, coordinate the efforts and establish strong links between digital transformation initiatives and education policies.

Recommendation 4. Foster a favourable learning environment to support ICT skills and talent development. An enabling learning environment is essential for ensuring interactive personalized adaptive practice education and allows to improve learning outcomes. Creation of smart learning environment requires institutional policies, thoughtful planning and implementation, involvement of professional educators and employment of digital technologies and tools to design learning activities and content.

Recommendation 5: Strengthen pre-service and in-service training for educators to ensure the effective delivery of ICT development programmes. Equipping educators with digital and pedagogical competencies suggests nurturing creativity and problem-solving skills to integrate new technologies into teaching. Online training and cloud-based platforms can expand learning opportunities for educators. Professional networking can foster peer-to-peer mentorship and offer ongoing support and knowledge sharing.

Recommendation 6: Ensure the high quality of ICT programmes by aligning them with international standards and national professional qualifications. To reflect emerging trends in digital technologies and AI and further enhance the quality of ICT training in HE and TVET institutions, ICT curricula and teaching methods should be regularly updated, assessment and quality assurance procedures should be strengthened.

Recommendation 7: Integrate cybersecurity education into curricula to equip individuals with essential digital skills and encourage specialised training in cyber threat detection and data protection. Cybersecurity has become one of the major skills related to the use of ICT. In addition to the existing frameworks and ongoing initiatives, digital safety and risk management skills should be properly integrated into curricula in accordance with the level of education to equip individuals with competencies needed to identify, prevent and respond to evolving cyber threats effectively.

Recommendation 8: Ensure inclusive ICT education and digital skills development to all disadvantaged groups of population regardless of gender, age, ethnic origin, health conditions, geographic location, etc. Efforts to bridge digital gaps may include ensuring access to internet, tailoring educational programmes to the needs of diverse learners, deploying trained tutors and developing digital content in national and ethnic languages. Promoting gender parity in ICT and STEM education can help enhance career opportunities for women in the digital sector.

Recommendation 9: Foster a strong culture of lifelong learning by expanding opportunities for reskilling and upskilling amid rapid digital transformation. Developing flexible training programmes in ICT and ensuring recognition of prior learning outcomes would enhance continuous professional development along personalized learning pathways. Expanding access to modular courses within on-the-job training should be supported by adjustable credit transfer and accumulation system recognized by employers.

Recommendation 10: Strengthen public-private partnerships to overcome talent shortages and bridge the gaps between digital skills and industry needs. Collaboration between HEIs, TVET organizations, private enterprises and industry associations should focus on joint development of industry-aligned curriculum and industry-led ICT skills assessment and certification, as well as work-based learning, including digital apprenticeships, that offer skill mastery, practical experience, industry connections and tailored learning.

Recommendation 11: **Encourage motivation of the youth and people of all ages to acquire and refine basic and advanced digital skills.** Organization of ICT and robotics competitions and hackathons, summer bootcamps and coding schools in partnership with leading Kazakhstani and international IT companies should help to shape national ICT talent ecosystem. Implementation of digital literacy initiatives would help adult learners bridge the second digital divide and develop effective ICT skills.

Recommendation 12: Promote a culture of innovation and enhance research and development to advance information and communication technologies. Fostering a startup-friendly environment and encouraging R&D in such fields as AI, big data, blockchain and IoT through the establishment of innovation hubs and incentives for collaboration between academia and industry will stimulate the creation of cutting-edge ICT solutions and bridge the gap between research and practical application.

Recommendation 13: Strengthen the system for collecting, analysing and disseminating data on digital skills to support evidence-based decision-making. An AI-based national-scale database of digital skills would provide insights into skills demand/supply dynamics and employment trends, enhance forecasting of future skills needs and enable data-driven decision making on digital skills development and workforce planning.

Recommendation 14: Strengthen the role of TVET institutions in cultivating a new generation of ICT professionals. To address the growing demand for skilled ICT professionals and nourish ICT expertise in such areas as information systems design, information security, database management, software development, etc., TVET institutions should modernize curricula, integrate hands-on training and foster partnerships with the private sector, incorporating lifelong learning elements.

Recommendation 15: Strengthen international collaboration to boost human capital and drive digital skills development. Exploration and adoption of international experience and collaboration with foreign HEIs and international organizations in human development in the areas of smart technologies, AI, robotics, cyber-physical systems, future energy, design and engineering, etc., sharing of resources, expertise and best practices will support the national efforts in ICT skills advancement.

Annex. ICT Talent Cultivation Paving the Way to All Intelligence[32]

Huawei has been dedicated to working with partners across the Middle East and Central Asia to deliver greater value to individuals, organizations and entire nations. Over the years, Huawei has played an active role in shaping national digital transformation strategies, both globally and regionally. A key factor in every successful transformation has been the cultivation of digital talent, which is essential for a national progress.

By the end of 2024, Huawei had established over 260 ICT Academies in partnership with leading universities across 19 countries in the region: more than 300,000 students and 2,000 teachers have been trained in advanced ICT skills and over 35,000 individuals have earned technical and project management certifications. At the ICT Academies, students gain access to the latest technologies, develop essential ICT skills and obtain internationally recognized professional certifications. Students are also encouraged to participate in the annual ICT Competition, which allows them to compete, collaborate and connect with peers from across the globe, gaining exposure to leading innovations and new perspectives. Top-performing students often secure jobs and internships at Huawei or its partner organizations. Huawei has built a comprehensive programme to support participants throughout their development and help to bridge the gap between education and employment. The rapid growth and effectiveness of the ICT Academy and ICT Competition are due to strong support from national governments and talent initiatives, partner organizations and, as importantly, Huawei's ongoing investment in empowering ICT talent for an intelligent future.

Huawei's guiding principle "Digital Talent Cultivation Paves the Way to All Intelligence" consists of four subprinciples:

1. Developing an environment that nurtures digital talent.
2. Providing advanced digital skills needed for industry transformation.
3. Unlocking potential and creating opportunities through job fairs and internships.
4. Leading the digital transformation of higher education with innovative platforms throughout the learning process.

In alignment with the Education 2030 Agenda and SDG 4, UNESCO IITE promotes the innovative use of ICT, empowers teachers and facilitates knowledge sharing to transform education worldwide. The collaboration between UNESCO IITE and Huawei on ICT talent cultivation by leveraging technology, educational innovation and global best practices is aimed to equip students and professionals in the Middle East and Central Asia with the digital skills and competencies necessary for sustainable development and inclusive digital transformation. In the framework of this partnership, Huawei activities are focused on empowering local communities with digital skills, promoting knowledge exchange and sustainable technology adoption.

[32] The Annex is the courtesy of Huawei.

Nurturing ICT talent is a long-term commitment, much like planting trees for future generations. As the old proverb says: "The best time to plant a tree was 20 years ago, the second-best time is now". While the world undergoes rapid transformation driven by intelligent technologies, ICT talent remains at the core, enabling innovation across all sectors. Huawei's comprehensive and strategic approach to nourishing ICT talent in any one country is inspired by the national vision and global best practices. It is embodied in tangible on-the-ground initiatives outlined in a clear roadmap for the translation of high-level goals into actionable programmes. The entire framework is guided by the national vision/strategy. A three-pronged approach is focused on digital transformation, ICT leadership and economic prosperity. ICT talent is at the heart of this approach, pumping intelligence to every sphere of life and every industry. The phrase "Talent for Intelligence" can be read reversely as "Intelligence for Talent", which reflects the need for advanced technology innovations throughout the full life cycle of the cultivation and development of ICT talent at the level of students, teachers, campus, contents and administration. Figure 1 details four key pillars, acting as a distinct, yet interconnected, initiative.

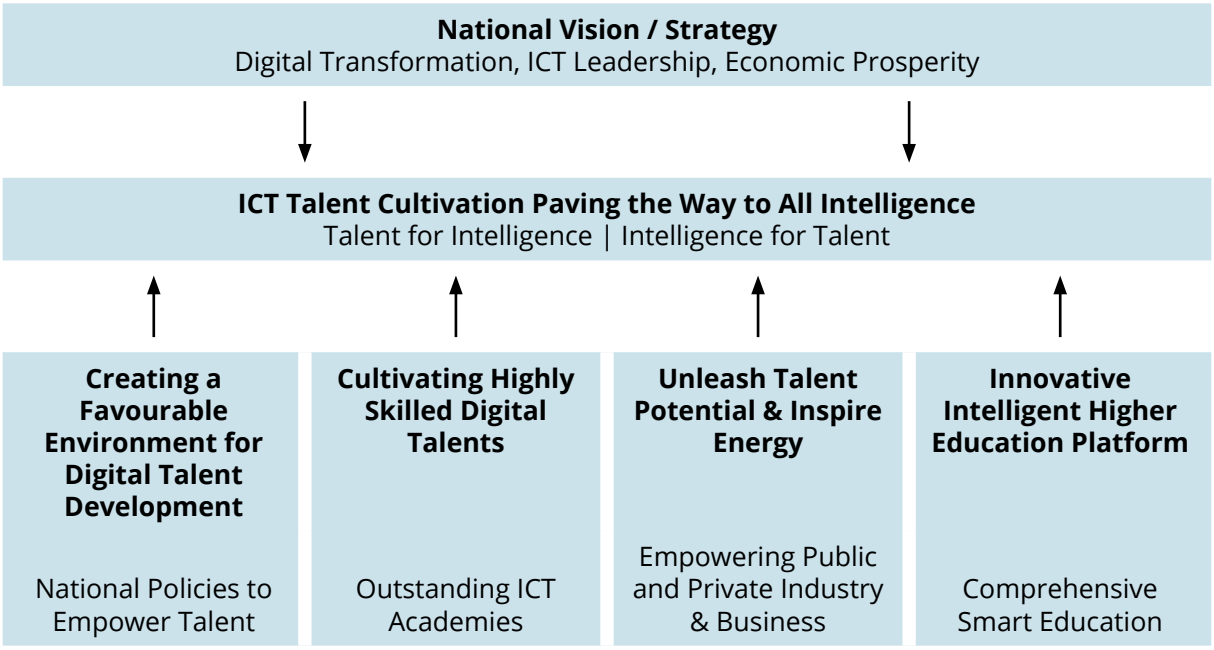


Figure 1. ICT Talent Ecosystem Framework

Pillar 1: Creating a Favourable Environment for Digital Talent Development

The first pillar is about establishing the right conditions for growth through national policies, talent development programmes, skills certification and competitions to improve hands on practice and foster innovation in ICT. Industry best practices for ICT talent development emphasize the importance of building a talent ecosystem grounded in partnerships. Governments seeking to enhance ICT talents and skills among citizens can use ICT Academies to deliver educational content based on digital platforms, while maintaining close collaboration with universities and colleges, upholding the following key essentials.

- **Integration with higher education:** By embedding ICT training into university and college programmes, students from diverse backgrounds gain access to world-class tech education, levelling the playing field and creating pathways to economic advancement. As of September 2025, the number of Huawei ICT Academies reached 48, across 19 cities in Kazakhstan, covering all regions of the country and including 27 anchor universities.

In 2024, over 3,500 students from 40 ICT Academies in 19 cities across Kazakhstan registered for the Huawei ICT Competition 2024–2025, which evidenced the growing interest to the contest. After national finals, 12 students from KBTU, AUPET, AITU, AIU, Al-Farabi and Yessenov Universities represented Kazakhstan at the regional finals in Riyadh, Saudi Arabia, in December 2024 and at the global finals in Shenzhen, China, in May 2025.

The following standout institutions are participants of the programme:

- Al-Farabi Kazakh National University (Almaty), one of the most active ICT Academies, which annually produces winners in Huawei ICT Competitions, many of whom are employed by leading technology companies.
- Kazakh-British Technical University (Almaty), a prominent academy whose students consistently perform at top levels in ICT contests and are recruited into industry roles.
- Almaty University of Power Engineering and Telecommunications, a vigorous ICT Academy where competition winners frequently emerge and later secure employment with companies or through partner networks.
- Satbayev University (Almaty), known for strong training in networking and computing technologies.
- L.N. Gumilyov Eurasian National University (Astana), a leader in digital education and regional ICT talent development.
- Astana IT University, a growing hub for AI and cloud learning in Central Kazakhstan.
- Yessenov University (Aktau), representing the western region and promoting ICT competencies among young specialists.

Together, these academies not only help develop local ICT talent but also serve as pipelines for competition winners and industry-ready graduates, connecting academia with employment opportunities and contributing to a sustainable digital ecosystem in Kazakhstan. The programmes provide internationally recognized certification in advanced fields such as AI, digital technologies, 5G, big data and cloud computing.

- **Government involvement:** Policy support and funding from government agencies are crucial for scaling ICT talent initiatives and ensuring alignment with national digital strategies.
- **Digital training platforms:** Centralized platforms enable the delivery of educational content, facilitate assessment and support remote and blended learning models, ensuring continuity and flexibility in talent development.
- **ICT Competition:** The ICT Competition, celebrating the 10th anniversary in 2025, has grown into a widely recognized international platform for ICT talent contest, industry-academia collaboration and international cooperation. The competition now spans over 100 countries in several regions, engaging more than 2,000 universities and

over 960,000 students and teachers. It fosters cross-regional cooperation and talent exchange among higher education institutions worldwide. It promotes the integration of theory and practice in higher education through the "competition-driven learning and teaching" model. Over the eight years, the regional edition for the Middle East and Central Asia has attracted over 160,000 participants. Since 2024, UNESCO IITE has been the co-organizer of the event. In Oman, Saudi Arabia and Bahrain, the competition has received endorsement from ministries of education and support from local enterprises and telecom operators, ensuring multi-stakeholder participation in talent development. The competition supports regional digital transformation and alignment of talent development with global standards. Kazakhstan students have been actively participating in the Huawei ICT Competition since 2018, demonstrating strong technical knowledge, creativity and professionalism and achieving prize-winning results each year.

Several success case stories of how Huawei ICT Completion, the International Collegiate Programming Contest co-sponsored by Huawei and Seeds for the Future programmes have helped Kazakhstani students secure their dream jobs, were run by local media in Kazakhstan: ER10 Media and Manshuq.

Initiatives such as Women in Tech, Green Development and Digital Inclusion awards foster diversity and sustainability, reinforcing broader social impact.

- In early 2025, Huawei has elevated its collaborative programme in the Middle East and Central Asia to the next level by championing a comprehensive AI talent cultivation programme **T.H.E. GOLD Talent** (**T**housands miles exploration, **H**undreds universities collaboration, **E**mpowering intelligent future. Together, we will **G**ear it up for you to **O**wn your future by our **L**eading platform for intelligent **D**evelopment of intelligent talent). The programme marked the second decade of Huawei's commitment to ICT talent development and opened a transformative decade inspired by new leading-edge technologies. The programme focuses on:
  - Cultivating AI-based well-rounded talent with industrial problem solving ability.
  - Transforming higher education by using AI-based innovations throughout the lifecycle of ICT talent cultivation targeting students, teachers, campus, contents and administration.
  - Closing the loop of ICT talent cultivation process through job-fairs and internships with engagement of all industrial stakeholders.
  - Providing incentives for active universities: certification vouchers, trainings and workshops for students, instructors and administrators.

During the first five years, the programme intends to train and develop One Million AI Talents in the region. As of August 2025, in collaboration with over 100 universities, 220,000 individuals were equipped with the AI skill sets essential for advancing digital transformation.

- **Seeds for the Future** programme is the global corporate social responsibility initiative launched in 2008 to develop skilled ICT talent and foster cross-cultural communication. The programme brings together top students from around the world aiming to bridge the divide between academic learning and real-world industry needs,

As part of the Seeds for the Future 2024 in Middle East and Central Asia, Kazakhstan was represented by 15 students from seven universities: Astana IT University, Nazarbayev University, KBTU, AUPET, SDU, Al-Farabi Kazakh National University and De Montfort University.

offering hands-on experience in technologies, guided by top experts. Supported by local ministries, regulatory authorities and educational institutions, the programme advances and promotes four key pillars: innovation, digitalization, sustainability and entrepreneurship, ensuring that young talents are well equipped to address global challenges and able to drive local industry transformation. Through Tech4Good, students are challenged to solve real-world social problems by leveraging cutting edge digital technologies, nourishing the next generation of socially conscious tech entrepreneurs. This continued investment is vital for the cultivation of young ICT leaders who contribute meaningfully to the growth of local and global digital economies.

Pillar 2: Cultivating Highly Skilled Digital Talents

The second pillar is about building strong partnerships between universities and enterprises and providing incentives for training the next generation of qualified instructors to meet the demand for talented professionals, who will drive scientific and technological progress and preserve cultural heritage. Universities, using a strong foundation in theoretical knowledge and abundant teaching resources, cultivate talents and contribute significantly to the development and prosperity of the nation, while enterprises have successful practical experience and diverse application scenarios. Therefore, their collaboration is crucial for establishing a high-quality talent cultivation system.

Huawei works with government agencies and educational organizations for ICT talent development. In the era of AI technology, Huawei ICT Academies are intended to address the growing need for ICT talent development by creating localized learning materials, offering learning platforms and collaborating with governments to train skilled ICT professionals. The ICT Academy is a collaborative programme that aims to provide universities with the latest ICT and knowledge. The ICT Academy Support Centre (IASC) is certified and authorized to provide local support for the operation of ICT Academies: (1) assisting in expanding the ICT Academy network; (2) providing teacher training services for supported ICT Academies; (3) assisting supported ICT Academies with course offerings and addressing issues related to curriculum, lab environments, teaching platforms and exam applications; (4) assisting in organizing teaching seminars, ICT Academy conferences and talent recruitment events. Huawei has established 38 IASC across the globe operating in 24 countries to support over 500 ICT Academies providing training to 300,000 students annually. Five Centres operate in four countries across the Middle East and Central Asia, providing support to more than 120 ICT Academies that train over 100,000 students annually.

In August 2025, the Huawei Instructor Summit organized in partnership with UNESCO IITE brought together over 70 representatives from university leadership and instructors of 48 Huawei ICT Academies in Kazakhstan to discuss the development of ICT education, new models of university-industry collaboration, the AI-SANA project and the Smart Campus initiative jointly supported by the Ministry of Science and Higher Education of the Republic of Kazakhstan. The highlight of the event was the official launch of the 10th Huawei ICT Competition 2025–2026. A large-scale Roadshow kicked off in September 2025 covering 48 universities across the country.

Huawei's ICT courses mainly include general courses, professional and certification courses that are closely related to the industry needs and are required for cultivating industry-oriented talent in the future. From the technical perspective, the courses can also be divided into three categories: cloud and computing, connectivity and application development. The courses designed for colleges and universities follow students' improvement path of ICT theories, hands-on practice and application innovation. Modular courses are offered based on the credit-based teaching model of colleges and universities. Each course provides rich learning and teaching resources, including syllabus, MOOC, slides, electronic teaching materials and lab guide (for students), as well as lab guide (for instructors), lab setup guide and mid-term/end-of-term test questions. The ICT Academy has released a total of 134 courses in languages other than Chinese, including 51 in English and 83 in other languages: French (13), Arabic (14), Portuguese (15), Spanish (18), German (8), Russian (4), Indonesian (5), Japanese (2), Turkish (1) and Kazakh (3).

In 2025, an ICT Academy Support Centre was established in Kazakhstan to ensure the development and operations of 48 ICT Academies, delivering certified training in 5G, AI, Cloud Services, Cybersecurity and Networking. Every university has the potential to train up to 100 students annually, with certification vouchers (HCIA-level) as part of the programme.

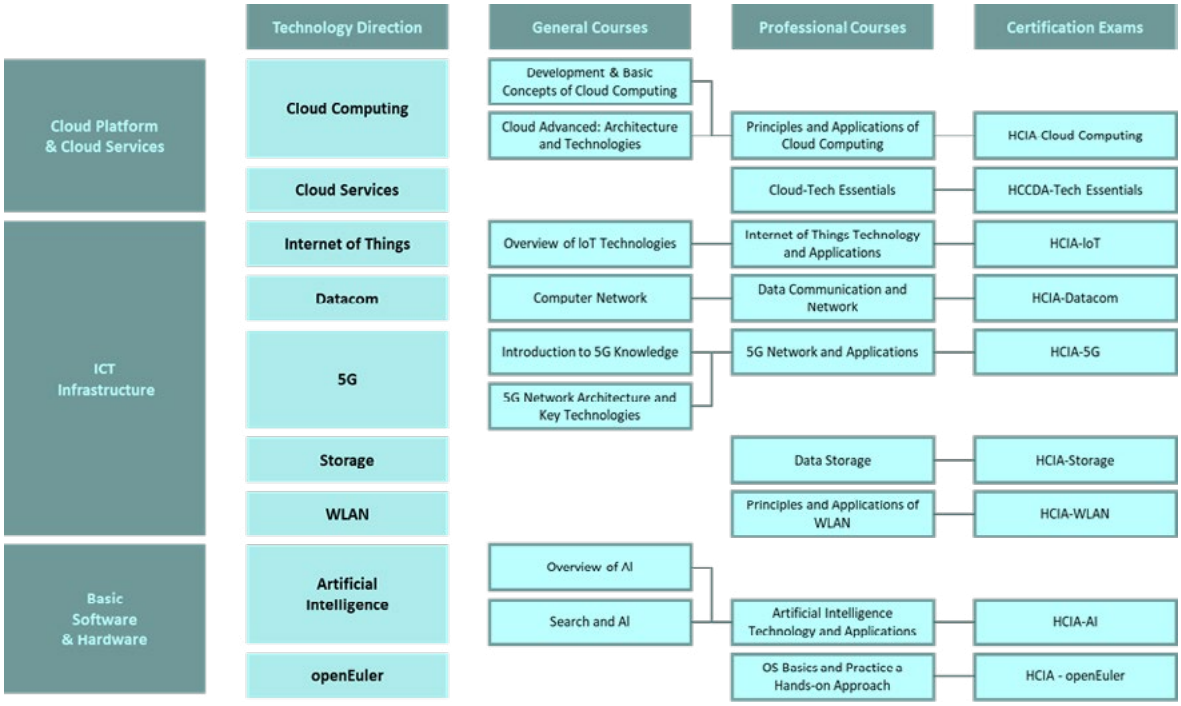


Figure 2: Huawei ICT Academy Course and Certification

Pillar 3: Unleash Talent Potential & Inspire Energy

The third pillar is a bridge to the professional world, offering access to job opportunities for students through internships and campus job fairs and creates a pool of certified talents for potential employers. All faculty enablement and innovative training programmes are aimed to enhance the ICT skills of both teachers and students and lead to decent careers. Through university-enterprise collaboration projects, Huawei helps teachers to combine theory and practice in the field of ICT, building on an online talent platform with comprehensive functions to facilitate learning and communication.

Pillar 4: Innovative Intelligent Higher Education Platform

The fourth pillar is about modernizing the educational experience itself, which includes developing smart classrooms, smart campuses and a nationwide research and education network. This provides the cutting-edge tools and environment needed to train the next generation of digital leaders.

Higher education ICT infrastructure and enablers

The education sector stands at the forefront of profound change, propelled by technological advancement and the urgent need to address challenges such as inequality, accessibility and opportunity gaps. Digital transformation in education is not simply about introducing new technologies; it is about reimagining how learning is delivered, managed and experienced. From classrooms equipped with intelligent technology and AI to cloud-based systems that foster seamless learning experiences, innovative digital solutions are helping make education more equitable, high-quality and accessible to all. In today's fast changing world, everyone needs access to quality education to close economic and social gaps and to prepare future leaders and innovators. Digital technology is driving major changes in education, creating new ways to make learning fair, accessible and effective for all. Smart classrooms, AI tools and cloud systems transform teaching and learning. Huawei is working with the industry stakeholders to lead this transformation through its Digital Education blueprint "1+3" approach which includes ICT Talent Development, Smart Classrooms, Smart Campuses and Scientific Research.

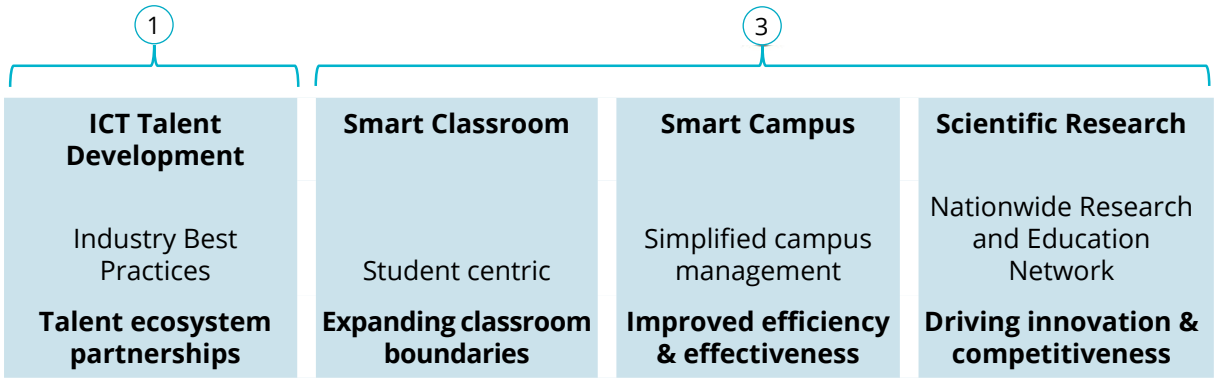


Figure 3. Digital Education blueprint

ICT talent development (digital training)

As digital transformation of various industries enters the next stage, there is a shortage of interdisciplinary talent with both ICT skills and industry knowledge. To address this issue, Huawei launched the Digital Training Solution to help universities and vocational colleges cultivate applied ICT talent. The solution provides comprehensive services ranging from industry case studies, teaching plan, curriculum, practice, teacher training, certificate and employment guidance, based on close collaboration with partners in the industry talent demand chain to promote ICT talent development and supply. Huawei Digital Training Solution combines the one-stop talent training platform, Digital Training Practice Lab, rich teaching resources and hands-on training tools to provide multiple ICT courses for universities and vocational colleges, to cultivate ICT talent with theoretical knowledge and

applied skills and to help schools build a cross-domain, cross-disciplinary and cross-region training base featuring industry-academia collaboration.

Smart Classroom: expanding the boundaries of learning

The Smart Classroom represents the first and most fundamental layer of ICT talent and skills development. It is inherently student-centric, designed to expand classroom boundaries before, during and after class. The Smart Classroom leverages advanced ICT infrastructure to create interactive, personalized and engaging learning environments.

ICT infrastructure requirements for Smart Classroom:

- High-speed connectivity: reliable wired and wireless networks are essential to support real-time collaboration, access to digital resources and seamless integration of devices.
- Interactive display technologies: large-format interactive panels, projectors or digital whiteboards enable dynamic presentations, collaborative problem-solving and multimedia content delivery.
- Student and teacher devices: laptops, tablets and other devices facilitate both in-person and remote participation, ensuring all students can engage with digital content.
- Learning Management Systems: centralized platforms for distributing assignments, tracking progress and facilitating communication between students and instructors.
- AI-powered analytics: tools that analyse student engagement and performance data, providing actionable insights for personalized instruction and timely interventions.
- Classroom collaboration tools: software for live polling, group projects and digital board activities, supporting active learning and critical thinking.
- Content creation and sharing platforms: systems that allow educators to develop, curate and share digital learning materials tailored to diverse learning styles.

Before Class: Teachers use digital tools to prepare lessons tailored to each student's needs, leveraging analytics to identify knowledge gaps and recommend resources. This proactive approach ensures students are better prepared and more engaged from the outset.

During Class: Interactive technologies facilitate real-time collaboration, enabling students to participate in group projects, live discussions and digital activities whether in person or remotely. AI-driven feedback helps teachers adapt their methods to maximize participation and understanding.

After Class: Analytics platforms offer insights into student performance and engagement, helping educators identify those who may need additional support or enrichment. Students receive personalized feedback and recommended resources, fostering continuous learning and improvement.

By integrating these components, the Smart Classroom creates a comprehensive learning experience that supports students and teachers before, during and after class, making education more inclusive, engaging and effective.

Success Story — Innovating Education Models with 300 Futuristic Classrooms

Ningxia University has contributed to the redefinition of higher education through a strategic digital transformation. In response to the evolving demands of today's economy and society, the university is establishing itself as a regional innovation hub for talent and technology in western China. Central to this forward-thinking initiative is the development of 300 state-of-the-art smart classrooms that seamlessly integrate digital, interactive and intelligent teaching methods to create a cohesive learning ecosystem.

This transformation is especially attuned to the needs of Gen Z learners-students who have grown up with instant connectivity, mobile devices and digital media. The School of Life Sciences uses a social media like environment of real-time resource sharing and interactive dialogue, turning traditional lectures into dynamic, two-way exchanges. In a similar spirit, the School of Ethnology enriches history lessons by incorporating digital media such as videos, images and virtual archives, inviting students to engage in immersive debates and reflective discussions, while the School of Agriculture adopts a cloud-based learning platform that supports pre-class preparation, in-class interaction through a smart system and post-class consolidation, all enhanced by AI and big data analytics to pinpoint essential learning elements.

By merging physical and virtual spaces, Ningxia University is pioneering innovative teaching models that include flipped classrooms (a teaching approach where students engage with instructional content like videos or readings outside of class, then use class time for interactive activities, discussions and apply what they have learned), hybrid learning and project-based approaches. Advanced technologies like the smart blackboard, integrated with an Education Cloud ecosystem, facilitate efficient content sharing, collaborative group work and instant, data-driven instructional feedback. This comprehensive system enables educators to continuously evaluate and refine their teaching strategies while ensuring that students receive personalized and engaging learning experiences.

Embracing AI, IoT and cloud computing, Ningxia University not only enhances teaching quality and efficiency but also sets a benchmark for modern educational reform. Through its commitment to smart education, the institution equips both faculty and students with the tools and insights needed to thrive in a digitally driven world, paving the way for a transformative future in higher education.

Smart Campus: simplified campus management for enhanced efficiency

Building on the foundation of the Smart Classroom, the Smart Campus encompasses the broader educational environment, focusing on the theme of simplified campus management to improve efficiency and effectiveness. The Smart Campus leverages advanced ICT infrastructure to connect people, devices and systems across the institution.

Key ICT infrastructure components for Smart Campus:

- Cloud data centres: centralized computing resources that support data storage, processing and application hosting for campus-wide services.

- Fiber and wireless networks: high-speed backbone networks and pervasive wireless coverage ensure connectivity across all campus facilities, enabling seamless access to digital resources.
- Edge and IoT devices: sensors, cameras and smart devices collect real-time data on campus operations, security and resource usage.
- Digital enablement platforms: platforms that integrate big data analytics, unified communications and IoT management, providing a foundation for intelligent campus services.
- Integrated communications: unified communication systems facilitate collaboration among students, faculty and staff, supporting voice, video and messaging.
- Intelligent operations centre: a centralized hub for monitoring and managing campus operations, security and emergency response.
- Smart education platforms: systems that manage academic records, scheduling, facilities and student services, streamlining administrative processes.
- Campus security: IoT sensors and AI-driven analytics enhance safety through real-time monitoring, automated alerts and incident response.
- Energy management: smart meters and automation systems optimize energy usage, reducing costs and environmental impact.
- Facility management: digital platforms track maintenance needs, occupancy and resource allocation, improving operational efficiency.
- Student services: mobile apps and self-service kiosks provide students with real-time information on schedules, transportation and campus events.

By integrating these technologies, the Smart Campus transforms campus life, creating a connected, sustainable and safe environment that supports both academic and administrative excellence.

Success Story — Pioneering Digital Transformation in Higher Education

Dongguan University of Technology, the first general undergraduate institution in Dongguan, Guangdong Province, completed the redesign of operations by embracing a forward-thinking digital transformation that spans Songshan Lake and Guancheng campuses. The institution redefined the learning environment through the seamless integration of state-of-the-art teaching tools and remote technologies that foster an atmosphere where teaching and learning extend beyond traditional boundaries.

The university launched an innovative initiative that enriches the classroom experience by incorporating advanced whiteboards, projectors and remote teaching systems. This digital framework not only elevates teaching efficiency but also ensures that students can access interactive and engaging content at any time. By adopting a modern Teaching Cloud platform, the institution is able to facilitate hybrid teaching models that bring learning to life, making every class a dynamic encounter rather than a static lecture.

At the core of this transformation is an interconnected digital ecosystem built on cutting-edge display and interaction devices, comprehensive recording and live streaming systems and reliable IoT management units. These technologies work harmoniously over a high-speed campus network to support dual-screen teaching, multi-terminal interactions and group collaborations. This integration creates a fluid and cohesive teaching environment where both instructors and students can benefit from an engaging online and offline hybrid approach.

Real-time interaction and data-driven feedback lie at the heart of this initiative. Comprehensive data recordings throughout classes allow for precise evaluation of student performance, while the introduction of innovative learning methods-such as group-based learning and remote synchronous classrooms-has led to a 62% increase in student interaction rates. With a 95% boost in network speeds, access to extensive digital resources is both swift and seamless, and a 60% surge in the use of online on-demand courses reflects how deeply integrated and accessible these learning materials have become. The enhanced digital infrastructure also facilitates real-time online supervision, reducing administrative workloads dramatically.

Scientific Research: enabling nationwide research and education networks

The third layer of the "1 plus 3" framework focuses on Scientific Research, which is vital for driving innovation and maintaining global competitiveness. This layer requires a robust, scalable and secure ICT infrastructure that connects students, educators and research resources across institutions and borders.

Core ICT infrastructure for Scientific Research:

- Nationwide Research and Education Network (NREN): high-speed, secure and scalable networks that interconnect universities, research institutions and laboratories, enabling collaboration and resource sharing.
- Education cloud: centralized platforms that manage large-scale data, facilitate access to national and global content and support advanced research applications.
- Trust and identity management: systems that ensure secure access to research resources, protecting sensitive data and intellectual property.
- Advanced security solutions: comprehensive cybersecurity measures to safeguard research data and maintain the integrity of collaborative networks.
- Shared access to research infrastructure: platforms that allow institutions to share high-performance computing, storage and specialized research tools, optimizing resource utilization and fostering innovation.

Benefits of Scientific Research infrastructure**:**

- Collaboration: researchers can collaborate in real time, share data and findings and access global expertise, accelerating the pace of discovery.

- Resource optimization: centralized management of computing and storage resources enables institutions to support large-scale, data-intensive research projects without duplicating investments.
- Uninterrupted access: education cloud platforms ensure that researchers and students have continuous access to critical resources, regardless of location or time.
- Security and compliance: robust identity management and security protocols protect sensitive research data and ensure compliance with regulatory requirements.

By investing in these advanced ICT infrastructures, higher education institutions can support cutting-edge research, foster innovation and contribute to national and global knowledge economies.

Success Story — The Best Education Cloud in the UAE and Middle East

In today's increasingly digital landscape, the education sector must evolve to meet the always-on demands of both students and educators. Ankabut, the Advanced National Research and Education Network of the United Arab Emirates, embodies this transformation with a clear vision. As the country's largest ICT service provider in education, Ankabut delivers a wide range of services, from cloud solutions and network connectivity to comprehensive IT infrastructure, and managed services, to over 35 educational institutions and 80 campuses, including the UAE Ministry of Education and Khalifa University.

Recognizing the central role of cloud technology in fostering collaboration in today's interconnected world, Ankabut strategically established a premier education cloud that serves universities and research institutes throughout the UAE and the broader Middle East, through the rapid deployment of a complete cloud stack that includes a robust cloud platform, cutting-edge software-defined networking, high-speed data centre networks and high-performance all-flash storage.

The design of the cloud stack has allowed for the creation of high-performance resource pools that outperform traditional hardware systems, supported by seamless, ultra-broadband connectivity across multiple data centres, ensuring that a diverse range of workloads-whether physical, virtual or container-based-can operate efficiently. The utilized all flash storage, powered by proprietary AI chips and innovative algorithms, set a new industry benchmark by offering remarkable throughput and minimal latency.

The results of this transformative project are evident. By transitioning from traditional data centres to an integrated cloud environment, Ankabut has reduced costs and complexity while providing a unified infrastructure that supports a variety of critical applications, from domain services to intelligent campus management and interactive e-learning platforms. As Fahem Al Nuaimi, CEO of Ankabut, noted, this significant investment not only streamlines academic processes and reduces expenses but also bolsters collaborative efforts, firmly establishing the UAE as a regional leader in education, research and technology innovation.

The Impact of the ICT Talent Development Digital Framework on Education Equity and Quality

The framework for ICT talent development and infrastructure is designed to transform higher education. By prioritizing talent ecosystem partnerships and investing in Smart Classroom, Smart Campus and Scientific Research infrastructures, educational institutions can:

- Bridge the gender and digital divide: ensuring that all students, regardless of background or location, have access to high-quality digital learning resources and opportunities.
- Enhance teaching and learning to bridge the skills gap: empowering educators with tools and data to personalize instruction, engage students and drive better learning outcomes.
- Streamline campus operations: improving efficiency, safety and sustainability through intelligent management of campus resources and services.
- Accelerate collaboration between academia and industry to enhance research and innovation: providing researchers with the connectivity, computing power and collaborative platforms needed to tackle complex challenges and drive scientific progress.
- Foster lifelong learning, upskilling, reskilling and certification: creating flexible, accessible pathways for continuous skills development, supporting workforce readiness and economic growth.

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