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STRATEGIC DIRECTIONS FOR ENHANCING UKRAINE'S ICT SECTOR INTERNATIONAL COMPETITIVENESS
СТРАТЕГІЧНІ НАПРЯМИ ПІДВИЩЕННЯ МІЖНАРОДНОЇ КОНКУРЕНТОСПРОМОЖНОСТІ ІТ-СЕКТОРУ УКРАЇНИ

Summary. *Introduction. The relevance of this study lies in its practical value for policymakers, industry stakeholders, academic institutions, and international partners involved in shaping the future of Ukraine's digital economy. Research into the competitiveness of Ukraine's ICT sector is strategically important for determining the real state and development of Ukraine's economy. For the sustainable development of Ukraine's ICT sector, it is necessary to assess in detail the directions of development and define the goals and objectives necessary for its development. Furthermore, it is important to assess the need to increase the number of ICT specialists, increase the capital of ICT companies, develop information infrastructure, etc.*

Purpose. The purpose of our study is to develop and propose strategic recommendations for improving the international competitiveness of Ukraine's ICT sector, encompassing key domains of national economy's digital transformation.

Materials and methods. The analysis and synthesis of domestic and foreign literature on digitalisation and the ICT sectors development enabled the identification of priority areas for further advancement, in particular: ICT infrastructure, human capital, the business and regulatory environment for ICT, R&D and innovation, international trade and cooperation.

Results. Recommendations for the development and modernisation of Ukraine's ICT infrastructure focus on accelerating the deployment of modern communication networks (in particular 4G and 5G), expanding fixed broadband access, and reforming financing and regulatory models for key processes in Ukraine's ICT infrastructure. In terms of providing Ukraine's ICT sector with

qualified human capital, we identified three areas, namely: increasing and improving the talent pool, retaining and motivating qualified ICT specialists in Ukraine, and attracting foreign ICT professionals to Ukraine. In order to support the innovation-driven and knowledge-intensive development of Ukraine's economy, the proposed strategic goals focus on increasing investment in R&D, expanding the national research base, and stimulating patent activity. Furthermore, we outlined proposals to increase exports and diversify imports of ICT in Ukraine by improving institutional support and expanding global relations. Particular attention was paid to deepening cooperation with the EU, in particular through integration into the Digital Single Market and the development of joint initiatives in the field of innovation and cybersecurity.

Discussion. Ultimately, the proposed strategic directions and measures are designed not only to support economic recovery and modernisation, but also to facilitate Ukraine's integration into global value chains, ensuring long-term competitiveness and technological sovereignty. The recovery of Ukraine's ICT sector will help the country's economy grow, give a boost to the expansion and development of communications, infrastructure, 4G mobile networks and WiFi, as well as enable the development of certain areas of the IT industry. This study will answer questions about what needs to be done for the further development of Ukraine's ICT sector and how to increase the capacity of server equipment and the bandwidth of the Internet network as a whole.

Key words: *competitiveness, ICT sector, strategic goal, ICT infrastructure, human capital, ICT professionals, cybersecurity, global threats, ICT goods, digital fraud, cybercrime.*

Анотація. *Вступ. Актуальність цього дослідження полягає в його практичній цінності для політиків, зацікавлених сторін галузі, академічних установ та міжнародних партнерів, які беруть участь у*

формуванні майбутнього цифрової економіки України. Дослідження конкурентоспроможності IT-сектору України стратегічно важливе для визначення реального стану та розвитку економіки України. Для сталого розвитку IT-сектору України необхідно детально оцінити напрями розвитку, визначити цілі та задачі, що необхідно для його розвитку. Крім того, необхідно оцінити потребу у збільшенні ІКТ-фахівців, капіталу IT-підприємств, розвитку інформаційної інфраструктури тощо.

Мета. Метою нашого дослідження є розробка та пропозиція стратегічних рекомендацій із підвищення міжнародної конкурентоспроможності IT-сектору України, які охоплюють ключові сфери цифрової трансформації національної економіки.

Матеріали і методи. Аналіз та синтез вітчизняної та зарубіжної літератури з питань цифровізації та розвитку IT-секторів допомогли визначити пріоритетні напрями подальшого розвитку, зокрема: ІКТ-інфраструктура, людський капітал, ділове та регуляторне середовище з питань ІКТ, НДДКР та інноваційна діяльність, міжнародна торгівля та співробітництво.

Результати. Рекомендації з розвитку та модернізації ІКТ-інфраструктури України включають прискорення розгортання сучасних комунікаційних мереж (зокрема 4G та 5G), розширення фіксованого ШСД та модернізацію моделей фінансування та регулювання основних процесів в ІКТ-інфраструктурі України. В питанні забезпечення IT-сектору України кваліфікованих людським капіталом, ми виокремили три напрями, а саме: збільшення та вдосконалення кадрового резерву, утримання та мотивація кваліфікованих ІКТ-фахівців в Україні, а також залучення іноземних ІКТ-фахівців в Україну. З метою підтримки інноваційного та наукомісткого розвитку економіки України, запропоновані стратегічні цілі зосереджено на збільшенні інвестицій у НДДКР, розширенні національної дослідницької бази та стимулюванні патентної активності.

Крім того, ми навели пропозиції зі збільшення експорту та диверсифікації імпорту ІКТ України завдяки поліпшенню інституційної підтримки та розширення глобальних зв'язків. Особливу увагу приділено зміцненню співпраці з ЄС, зокрема шляхом інтеграції в єдиний цифровий ринок та розвитку спільних ініціатив у сфері інновацій та кібербезпеки.

Перспективи. У підсумку, запропоновані стратегічні напрямки та цілі не лише підтримають економічне відновлення та модернізацію, але й сприятимуть інтеграції України у глобальні ланцюги створення вартості, забезпечуючи довгострокову конкурентоспроможність та технологічний суверенітет. Відновлення IT-сектору України допоможе розвитку економіки України, зробить поштовх у збільшенні та розвитку комунікацій, інфраструктури, мобільного 4G, WiFi, дозволить розвинути деякі напрямки IT-індустрії. Дане дослідження дасть відповіді на питання, що треба зробити для подальшого розвитку IT-сектору України, як треба збільшити потужність серверного обладнання та пропускну здатність інтернет мережі в цілому.

Ключові слова: *конкурентоспроможність, IT-сектор, стратегічна ціль, ІКТ-інфраструктура, людський капітал, ІКТ-фахівці, кібербезпека, глобальні загрози, ІКТ-товари, цифрове шахрайство, кіберзлочин.*

The statement of the problem. In the context of accelerated digital transformation and growing global demand for ICT services, the information and communication technology (ICT) sector has become a key driver of economic growth, innovation and international trade. For Ukraine, the ICTs remains one of the most export-oriented sectors of the economy, demonstrating resilience even in conditions of macroeconomic and geopolitical instability. However, in order to maintain and strengthen its position in the global ICT market, Ukraine must adopt a clear, forward-looking strategy that will enhance the international competitiveness of its ICT sector.

Literature Review. The theoretical and methodological foundation of our study is based on an extensive analysis of scientific literature examining the determinants of growth and competitiveness of the ICT sector of the national economy. In particular, works [1-4] provide an important conceptual and empirical basis for understanding the key factors influencing ICT development at both national and international levels.

To capture the global context of digitalisation, we systematically reviewed international indices and reports on digital development [5-8], which served as primary analytical tools for examining trends in digitalisation, technological readiness and innovation capacity worldwide. In addition, these sources provided critical insights into how digital transformation is measured across countries, enabling us to assess Ukraine's positioning within the global digital landscape.

Concurrently, a specific group of studies [9-12] focused on Ukraine's performance in international digitalisation and innovation rankings, which allowed us to better understand Ukraine's comparative indicators, identify existing gaps and uncover trends affecting the trajectory of its digital development and competitiveness.

To formulate strategic directions and policy recommendations for enhancing the international competitiveness of Ukraine's ICT sector, we also conducted an in-depth analysis of the current state, strengths and weaknesses, as well as development constraints of the national ICT ecosystem. This was supported by a comprehensive review of empirical studies, analytical reports and industry studies addressing the impact of the Russian-Ukrainian war on the ICT sector [13-16], risk modelling and technological advancement [17-18], as well as strategic frameworks for ICT sector development [19-20]. Furthermore, policy-oriented assessments and international reports provided critical data on post-war recovery needs, infrastructure resilience, and investment prospects [21-24].

In addition, socio-economic analyses and labour market studies [25-28] contributed to understanding the dynamics of human capital, talent management and inclusiveness within Ukraine's ICT sector. Legal, intellectual property, and innovation governance aspects were examined through research on regulatory frameworks and opportunities at the level of ICT companies [29-32]. Finally, the export competitiveness of Ukraine's ICT services and their strategic potential in global markets were confirmed by studies on foreign trade, services exports, and international positioning [33-36].

This integrated and interdisciplinary approach to literature review enabled the substantiated formulation of strategic goals and development priorities tailored to the specific challenges and opportunities of Ukraine's ICT sector in the context of ongoing geopolitical instability and rapid global digital transformation.

The purpose of this study is to identify and substantiate key strategic directions for the development of Ukraine's ICT sector in order to enhance its international competitiveness. This involves formulating strategic goals based on empirical data, targeted at addressing structural weaknesses and leveraging the existing strengths of the ICT sector. Additionally, our study seeks to support the development of a coherent strategic framework that promotes sustainable development, innovation, human capital advancement and international integration of Ukraine's ICT sector, particularly in alignment with the standards and priorities of the European Union and other leading digital economies.

Methods and Materials. In our study, we employed a review and synthesis of existing publications with the aim of identifying strategic directions for enhancing the international competitiveness of Ukraine's ICT sector.

The preparative stage of our study involved a systematic analysis of a wide range of relevant sources, including peer reviewed scientific articles, analytical reports, industry studies, academic monographs, as well as policy reviews published by international organisations. This literature review helped us identify key trends and

strategical frameworks related to the development of Ukraine's ICT sector and its international competitiveness.

The recommendations and strategical directions proposed in our article are the result of a critical synthesis of the analysed sources. Particular attention was paid to identifying recurring thematic priorities, policy measures and success factors in different national and regional contexts. The results were then adapted to the specific institutional, economic and geopolitical conditions of Ukraine.

Results. During the war, Ukraine's ICT infrastructure faced a number of interrelated challenges and systemic risks that significantly affect its functionality and resilience [18; 20-24].

Firstly, the physical vulnerability of ICT infrastructure has become a critical concern [18; 24], as data centres, communication towers, cable lines and server facilities are highly exposed to direct military actions, including missile strikes, shelling and sabotage, leading to partial or complete service disruptions, increased downtime, as well as heightened financial and logistical burdens on ICT service providers.

Secondly, the deterioration of energy infrastructure has exacerbated instability in the ICT sector [21-24]. Extensive damage to power generation and transmission facilities, particularly due to targeted attacks on energy system, has led to prolonged power outages, which critically affect the operability of ICT networks and equipment, especially in regions near combat zones. Moreover, the deployment of alternative power supply solutions, such as mobile generators and backup power systems, remains limited and inconsistent.

Thirdly, the intensification of cyber threats creates an additional level of systemic risk [24]. Wartime has created new vulnerabilities that are actively exploited for cyber-attacks targeting government institutions, digital infrastructure and telecommunications providers. These attacks threaten data security, disrupt public administration and undermine trust in digital services.

In addition, population displacement, internal migration and the occupation of certain regions have further complicated the provision of stable ICT services [21-24]. The forced displacement of skilled ICT professionals and damage to educational and research institutions weaken the ICT sector's human capital, constraining its capacity for recovery and modernisation.

Most importantly, Ukraine's ICT sector development strategy must prioritise key areas that are critical to ensuring the resilience, security and continuity of the national ICT infrastructure [20]. Accordingly, our proposals for expanding and modernising the ICT infrastructure – aimed at strengthening the international competitiveness of Ukraine's ICT sector – are presented below in strategic goals 1-6.

Strategic Goal 1 (SG 1) – expand 4G coverage nationwide and establish the financial and regulatory framework for 5G development. To achieve this goal, it is necessary to: accelerate the deployment of 4G networks in rural areas and underserved areas through PPPs; implement spectrum reallocation policies (to optimise the use of frequency bands for mobile broadband); introduce regulatory incentives for mobile operators (to expand 4G coverage areas); develop a 5G rollout roadmap, including pilot projects in urban centres and industrial areas; promote infrastructure sharing among operators (to reduce deployment costs and maximise coverage); strengthen cooperation with international partners to attract investment in the development of 4G/5G infrastructure; create a competitive and transparent 5G spectrum auction process; establish PPP mechanisms (to finance large-scale 5G deployment projects).

Strategic Goal 2 (SG 2) – expand and modernise fixed broadband infrastructure, specifically through: developing nationwide fibre-optic backbone networks; encouraging investment (through subsidies, grants, tax incentives, etc.) in FTTH drop cable networks and FTTB-based optical Internet; obligating telecommunications operators to provide universal broadband

services in underserved areas; updating the regulatory framework to ensure fair competition and network neutrality; developing a national broadband coverage map to identify underserved areas and set expansion priorities; designing a national roadmap for short- and long-term investments in broadband; ensuring fibre-optic connectivity in new residential and commercial facilities.

Strategic Goal 3 (SG 3) – improve the legislative and regulatory framework to support ICT infrastructure development, via updating and implementing: telecommunications legislation (particularly to simplify licensing procedures, spectrum allocation and network deployment); a clear and transparent spectrum management policy for 4G and 5G; measures to promote fair competition and prevent monopolisation in the telecommunications market; alignment with EU digital policy and best ICT regulatory practices; simplified taxation for telecommunications and infrastructure equipment (necessary to reduce investment costs); standardised contracts and guidelines for network infrastructure sharing among operators; strengthened consumer rights legislation in broadband services (to ensure fair prices and quality standards).

Strategic Goal 4 (SG 4) – ensure sustainable financial and investment mechanisms for ICT infrastructure development. The key measures for achieving this goal include: establishing a national ICT infrastructure development fund; promoting FDI in telecommunications infrastructure; developing a PPP model for expanding broadband access; attracting international financial institutions to fund infrastructure projects; creating a national broadband development bank to provide low-interest loans for ICT infrastructure projects; designing co-financing models; issuing government bonds (to raise capital for large-scale investments in telecommunications infrastructure); setting up venture capital investment mechanisms for innovative broadband technologies; introducing an 'ICT infrastructure fund' financed through spectrum auctions (for reinvestment in connectivity projects);

supporting financial models that encourage infrastructure leasing (to reduce upfront capital requirements for smaller providers).

Strategic Goal 5 (SG 5) – strengthen and expand international communications via developing new cross-border fibre-optic channels with EU countries (to enhance international bandwidth capacity); concluding new agreements on submarine and terrestrial fibre-optic routes (to diversify international connectivity); promoting investment in data centres and cloud infrastructure (to reduce dependence on foreign providers); establishing and developing backup international communication channels; expanding regional Internet exchange points (to upgrade domestic traffic routing); integrate Ukraine's ICT infrastructure with the EU's Digital Single Market (to support cross-border services).

Strategic Goal 6 (SG 6) – modernise and secure critical ICT infrastructure. Within this goal, priority tasks include: implementing upgraded backup measures to ensure network continuity during crises; strengthening cybersecurity frameworks to protect ICT infrastructure; deploying energy-efficient and disaster-resilient network technologies; adopting EU and NATO standards for critical infrastructure protection (as well as enhancing cooperation with NATO and EU cybersecurity agencies to counter cyber threats); developing a national telecommunications emergency recovery plan; increasing investment in underground fibre-optic networks; reinforcing compliance requirements for cybersecurity legislation among providers; supporting the creation and operation of a national security monitoring centre to detect cyber and physical threats; implementing redundancy requirements for core telecommunications networks; introducing mandatory network encryption standards for the entire telecommunications traffic; requiring telecommunications providers to adopt AI-based threat detection systems; expanding cyber insurance markets.

The war in Ukraine has significantly affected the development of human capital in the ICT sector, triggering a range of structural and situational challenges that undermine both the short-term stability of the workforce and long-term competitiveness, particularly [11; 18; 25-31]:

- the war has reduced opportunities for building and enhancing digital competencies among the population, which are crucial for increasing innovation potential and improving Ukraine's position in international innovation and digital development indices;
- the ICT sector is experiencing a significant outflow of skilled personnel due to forced migration, internal displacement and mobilisation into the Armed Forces of Ukraine;
- the destruction of educational infrastructure and the reallocation of national resources to defence have limited access to ICT education and vocational training (which will further hamper the development of new talent and constrain reskilling and upskilling initiatives, thus further deepening the human capital deficit);
- the psychological consequences of the war, including trauma, uncertainty and prolonged stress, negatively affect the productivity, motivation and learning ability of ICT professionals and students (accordingly, the effectiveness of both formal and informal human capital development efforts is reduced);
- the war has exacerbated existing inequalities in access to educational and professional opportunities in the ICT sector (namely, women, internally displaced persons and other vulnerable groups face systemic barriers that limit their participation in education and employment, reinforcing gender and social disparities);
- the lack of a coordinated national strategy for ICT human capital development during wartime has led to fragmented efforts by various

institutions and stakeholders, thereby diminishing the impact of both governmental and non-governmental initiatives;

- the sustainability of human capital development programmes increasingly depends on external support from international partners and donor organisations (although this support is essential, excessive reliance on it raises concerns about the continuity of such programmes in the absence of long-term domestic planning and investment).

Given the negative consequences of the war, it is critical to revise Ukraine's approach to human capital development in the ICT sector with a focus on increasing its ability to adapt, retain and expand its pool of ICT professionals in alignment with national sustainable development and competitiveness goals (Table 1). Above all, the ICT sector's human capital development strategy must address three important aspects, namely building and expanding Ukraine's ICT talent pool, retaining and motivating experienced ICT professionals within Ukraine, and attracting foreign ICT talents to Ukraine [29]. Such a systemic approach to devising a national strategy for talent retention and development is important for maintaining ICT sector's status as one of the most stable and promising sectors of Ukraine's economy [29].

Table 1

Strategic directions for strengthening human capital in Ukraine's ICT sector

Strategic direction	Strategic goal	Aim	Expected outcome
Expansion and improvement of the talent pool	SG 7-9	improve the quality and quantity of skilled professionals in Ukraine's ICT sector through targeted educational programmes, partnerships with universities and vocational training initiatives	a significant increase in the number of graduates with relevant ICT skills, leading to the formation of a more competitive workforce capable of meeting industry needs and driving innovation in Ukraine
Retention and motivation of qualified ICT professionals in	SG 10-12	create an attractive working environment that promotes job satisfaction, professional growth and	reducing staff turnover among skilled ICT professionals, leading to increased productivity and

Ukraine		work-life balance for ICT professionals in Ukraine	workforce stability (which will further contribute to the formation of a positive corporate culture and long-term commitment to the ICT sector in Ukraine)
Attraction of foreign ICT professionals to Ukraine	SG 13-15	position Ukraine as a desirable country for foreign ICT talents	an inflow of foreign ICT professionals who will bring a variety of skills and perspectives, enrich the local talent pool, and promote knowledge transfer (i.e., strengthening cooperation within teams, stimulating innovation, and enhancing Ukraine's reputation as a global technology hub)

Source: expanded by the authors based on [18; 29]

Within the first strategic direction (Table 1), which aims to increase and enhance the talent pool in Ukraine's ICT sector, we propose to formulate strategic goals 7-9.

Strategic Goal 7 (SG 7) – improve ICT education at all levels including: modernisation of university curricula to align with global ICT trends; increased funding for R&D in ICT at HEIs; promotion of STEM education in secondary schools (to foster early interest in ICT careers); development of national ICT certification programmes for professionals; establishment of secondary schools with an ICT-focused curriculum; provision of financial aid, grants and scholarships to incentivise ICT education; support for student participation in international ICT Olympiads and hackathons.

Strategic Goal 8 (SG 8) – expand and improve professional and lifelong ICT education – it entails: designing reskilling and upskilling programmes for professionals from other industries; supporting coding bootcamps, online courses and professional certification programmes; establishing ICT training centres nationwide for practical training; continuing the development and delivery of free or subsidised ICT courses; developing programmes to train ICT professionals in business and entrepreneurship skills.

Strategic Goal 9 (SG 9) – facilitate cooperation between industry, academia and government (the 'triple helix'). It requires taking the following key measures: establishing PPPs to support ICT talent development and formulate a national ICT human capital strategy involving key stakeholders; creating and promoting platforms for knowledge exchange between HEIs and ICT companies; developing start-up incubators led by HEIs in collaboration with ICT companies; designing a dual education system where students spend part of their time working in ICT companies; introducing tax incentives for ICT companies that support ICT education programmes; launching an annual forum for policymakers, educators and ICT sector representatives to discuss ICT issues and solutions; creating an online platform that brings together ICT entrepreneurs with investors, mentors and resources; expanding partnerships between HEIs and ICT companies for practical training, internships and dual education programmes; providing government and industry incentives for continuous ICT workforce training; working out and promoting mentoring programmes.

Within the second strategic direction (Table 1), which aims to retain and motivate qualified ICT professionals in Ukraine, we propose to set strategic goals 10-12.

Strategic Goal 10 (SG 10) – improve working conditions and career prospects in the ICT sector, via: ensuring competitive salaries; developing and supporting start-up systems to create more employment opportunities in ICTs (in addition, providing financial support and incentives for ICT start-ups); establishing mechanisms for the reintegration of Ukrainian ICT professionals; improving legal protection for ICT freelancers; expanding the number of start-up incubators and accelerators in key cities in Ukraine; introducing national ICT awards to recognise the best professionals and companies; fostering ICT communities for collaboration, networking and professional growth.

Strategic Goal 11 (SG 11) – create a stable and favourable business environment for ICT companies – involves: maintaining a favourable tax regime for ICT companies; reducing bureaucratic barriers for ICT companies; developing updated legal protection for ICT professionals; strengthening IPR protection to stimulate innovation and entrepreneurship; formulating long-term national ICT sector strategies with clear policy commitments to ensure sectoral stability; introducing government-supported risk mitigation programmes for start-ups and SMEs; implementing and maintaining regulatory sandboxes for ICT companies to test innovative technologies without undue legal constraints; promoting the development of IT clusters through tax and infrastructure incentives; simplifying procedures for ICT companies to access public contracts and funding; facilitating cooperation between ICT companies and international organisations for knowledge exchange.

Strategic Goal 12 (SG 12) – strengthen the retention of ICT professionals in academic and research fields by: offering competitive salaries and grants for ICT research; providing public funding for ICT research projects; increasing investments in modern research infrastructure and laboratories; establishing joint doctoral and postdoctoral programmes between Ukrainian HEIs and international research institutions in ICT; introducing state scholarships for students engaged in ICT research; developing salary structures for ICT educators in HEIs that are comparable to average salaries in the private sector; supporting research commercialisation programmes; promoting dual careers, allowing ICT professionals to work part-time in both academic and business environments; establishing dedicated funding for ICT research projects with commercial potential; increasing funding for university technology incubators and innovation laboratories.

Within the third strategic direction (Table 1), which aims to attract foreign ICT professionals to Ukraine, we propose to set strategic goals 13-15.

Strategic Goal 13 (SG 13) – develop a national strategy for ICT talent branding, including the following measures: promoting Ukraine through targeted marketing campaigns as a leading ICT talent hub; highlighting the success stories of Ukrainian ICT professionals, start-ups and companies; creating a national ICT career portal that will showcase employment opportunities, career paths and educational programmes; building partnerships with international technology media to display Ukraine's ICT capabilities; increasing government and industry funding for PR campaigns for Ukraine's ICT sector; offering free or subsidised travel packages for foreign ICT professionals to visit and explore job opportunities in Ukraine; collaborating with international recruitment agencies to promote Ukraine as a destination for ICT careers.

Strategic Goal 14 (SG 14) – develop a favourable immigration policy for ICT professionals via: establishing a dedicated government agency or online platform for processing ICT work visas, work permits and residence applications; introducing a 'Technical Visa' programme with simplified requirements for senior foreign ICT professionals; providing a legal framework for self-employed foreign ICT professionals and freelancers; simplifying business registration procedures for foreign ICT entrepreneurs and start-up founders; strengthening cybersecurity measures to protect data and ensure safe remote work for foreign ICT professionals; enabling long-term residence with the possibility of obtaining citizenship for foreign ICT professionals who make a significant contribution to Ukraine's economy.

Strategic Goal 15 (SG 15) – improve quality of life and working environment for foreign ICT professionals through: developing immigrant-friendly areas in large cities with international services and cultural integration programmes; offering financial incentives for foreign ICT specialists to purchase or rent real estate; improving foreigners' access to international banking and financial services; creating a mobile app or digital hub for foreign

ICT professionals with legal, housing and networking resources; promoting international co-working spaces and innovation centres with facilities for foreign ICT professionals.

The reviewed studies [18; 31-32] highlight the following features and issues in the field of R&D and innovation capacity of the ICT sector in Ukraine, namely:

- structural weaknesses and limited priority given to science and technology by the state (reflected in underfunding of research and development and a reduction in the number of researchers);
- the deepening problem of brain drain due to the war (the main reasons for the relocation of Ukrainian scientists include power outages, poor Internet access, apathy and security issues);
- the volume of publications in key ICT fields such as artificial intelligence, communications and software fell sharply due to disruptions caused by the war, highlighting the vulnerability of research productivity to systemic shocks;
- patent activity declined sharply as a result of weak intellectual property protection and insufficient R&D funding, forcing companies to register patents abroad;
- a persistent gap between research institutions and the private sector, which hinders the scaling up of innovation;
- the lack of a clear national R&D strategy, outdated infrastructure and ineffective financing instruments limit Ukraine's innovation potential.

Our proposals for bolstering the innovative potential of Ukraine's ICT sector (as a component of its international competitiveness) are based on three strategic goals: increasing ICT R&D expenditures in private, public, and academic sectors (SG 16), thus increasing the number of researchers (SG 17) and boosting patent activity (SG 18).

Strategic Goal 16 (SG 16) – increase investment in ICT research and development. The action plan to achieve this goal must include the following steps: setting up and implementing tax incentives for businesses that invest in ICT R&D; initiating PPP programmes to co-finance R&D projects; increasing government grants and funding for ICT research; strengthening collaboration among HEIs, research institutions and the private sector; further developing the venture capital fund system and attracting FDI in R&D; supporting the establishment of corporate R&D centres (domestic and foreign), as well as technology parks; designing targeted funding programmes for emerging ICT areas and large-scale ICT research infrastructure projects; making a national ICT R&D roadmap with clearly defined investment priorities, along with mechanisms for measuring and evaluating ICT R&D effectiveness; promoting international research cooperation and joint ICT projects with global research institutions.

Strategic Goal 17 (SG 17) – increase the number of ICT researchers. The action plan to achieve this goal must include the following steps: developing scholarship and grant programmes for ICT students and researchers; improving salaries and working conditions for ICT researchers; enhancing access to modern research tools, databases and computing resources; supporting educational programmes in STEM and digital skills at all levels; launching repatriation programmes for Ukrainian ICT scientists; providing mentoring and career development programmes for young ICT researchers; supporting participation in international ICT research competitions and conferences.

Strategic Goal 18 (SG 18) – increase the number of ICT and AI patents. It requires providing financial support for patenting ICT and AI innovations (accordingly, it is necessary to create a national fund to cover patenting costs for start-ups and research institutions); offering legal assistance and training on IP rights; along with facilitating the commercialisation of research results through start-up incubators and technology transfer offices; simplifying the patent

registration process and reducing the associated costs; creating an online platform to support ICT researchers in preparing and filing patent applications.

Studies of Ukraine's ICT exports and imports [33-35] reveal a complex interplay of opportunities and vulnerabilities in the national ICT sector. On the one hand, the continuous expansion of ICT services, particularly IT outsourcing, positions Ukraine as a key player in the global ICT market. The high level of export specialisation, favourable trade conditions and a significant pool of skilled professionals underscore Ukraine's comparative advantage in this domain. However, this positive momentum is increasingly being challenged by geopolitical turmoil, macroeconomic instability and structural imbalances.

On the other hand, the consistently low performance in the ICT goods segment highlights Ukraine's limited ability to move beyond low-complexity manufacturing and integrate into high-value global equipment supply chains. Ukraine's ICT goods trade deficit [33], combined with its minimal share of the global market in key product groups and technological dependence on foreign suppliers, points to the inability to create a competitive domestic ICT manufacturing base. This structural asymmetry between goods and services in the ICT sector exposes Ukraine to strategic risks, including supply chain disruptions, limited innovation diffusion, and limited long-term value creation.

Heavy reliance on IT outsourcing, although economically beneficial in the short term, has inadvertently reduced the priority of developing domestic capabilities in hardware manufacturing, R&D, and proprietary product development. Moreover, the dominance of service exports in the form of outsourcing limits diversification and hinders Ukraine's potential to become a leader in advanced ICT domains (AI, cybersecurity, cloud computing, and ICT infrastructure).

From a geopolitical perspective, the Russian invasion has further exacerbated existing vulnerabilities, causing significant damage to infrastructure, a decline in FDIs, an outflow of skilled personnel, and

destabilisation of domestic ICT companies. Despite this, the ICT services sector has demonstrated remarkable resilience under wartime conditions. Nevertheless, the slowdown in export growth, shifting demand geography, and declining revenues from key partners such as the USA and Germany in 2023–2024 indicate that resilience alone is insufficient without strategic reorientation.

Accordingly, revising Ukraine's ICT sector foreign trade strategy in the context of national security should help to proactively respond to new threats, exploit economic opportunities and protect critical assets and interests in the digital domain [20; p. 284].

The national export strategy for Ukraine's ICT sector is a comprehensive plan or roadmap developed by the country's government to promote and facilitate the export of ICT goods and services [36; p. 25]. Accordingly, our proposals for increasing and diversifying exports in Ukraine's ICT sector are set out below in strategic goals 19-21.

Strategic Goal 19 (SG 19) is to strengthen institutional support for Ukraine's ICT sector exports promotion. Its implementation involves the following key actions: setting up a dedicated national agency or expanding the mandate of existing institutions to support ICT service exports; developing and implementing a national export strategy for the ICT sector, integrating it into Ukraine's broader economic strategy; streamlining coordination among government agencies, industry associations and ICT companies to support export-oriented policies; developing and implementing a national ICT export roadmap with clear KPIs for export growth and diversification; establishing specialised advisory services on IP protection and compliance with legislation in foreign markets; creating a centralised online platform with market-entry guidelines, legal resources and export assistance for Ukrainian ICT companies.

Strategic Goal 20 (SG 20) – expand Ukraine's presence in key foreign ICT markets. The necessary steps for its realisation include: development of market-specific ICT service offerings based on demand analysis in target

countries; negotiation and implementation of bilateral trade agreements focused on digital services with key ICT markets (in particular, the EU and the US); expansion of participation in public procurement and outsourcing opportunities in foreign markets; promotion of business consortia and clustering strategies to help Ukrainian ICT companies enter foreign markets together; support of nearshoring initiatives for EU markets to position Ukraine as a cost-effective but high-quality ICT supplier; facilitation of international partnerships and alliances between Ukrainian and foreign ICT companies.

Strategic Goal 21 (SG 21) – expand access to financial and investment support for ICT exporters. To ensure its execution the following steps must be taken: establishing an ICT export fund that will offer grants, loans and financial assistance to export-oriented start-ups; encouraging international ICT accelerators and incubators to open offices in Ukraine; developing state-supported venture capital initiatives to finance ICT companies with high export potential; promoting initiatives to attract international venture capital and FDI into Ukraine's ICT sector; guaranteeing access to export insurance and risk mitigation instruments.

Concurrently, the import strategy for Ukraine's ICT sector in the context of national security should help proactively respond to emerging threats, harness economic opportunities and protect its critical assets and interests in the digital economy [20, p. 284]. Accordingly, our recommendations for ***increasing and diversifying ICT-related imports (SG 22)*** include the following: prioritising the import of advanced ICT technologies (e.g., AI-based solutions, 5G equipment, IoT devices, blockchain applications, quantum computing equipment); conducting a comprehensive market study to identify alternative suppliers with competitive prices, reliable delivery networks and high-quality ICT goods; concluding bilateral and multilateral trade agreements with new ICT suppliers; developing a database of potential suppliers and manufacturers for domestic procurement; organising trade missions to key ICT-exporting

countries to assess their production capabilities; diversifying logistics routes and transportation methods to reduce dependence on specific transit hubs; create contingency plans for supply chain disruptions; establish partnerships with leading ICT manufacturers to serve as regional distributors of their products.

However, to further develop and strengthen the international competitiveness of Ukraine's ICT sector, it is essential to deepen cooperation with EU countries, gaining access to advanced technologies, investment opportunities and research collaboration. Stronger relations with the EU will facilitate integration into the European Digital Single Market, enabling Ukrainian ICT companies to expand exports and operate within a harmonised regulatory framework. Enhanced cooperation will also strengthen cybersecurity and digital resilience, which is crucial for Ukraine's national security. Accordingly, our recommendations for advancing cooperation between Ukraine's ICT sector and the EU are outlined in strategic goals 23-27.

Strategic Goal 23 (SG 23) – strengthen integration into the EU Digital Single Market. The goal achievement actions must be focused on: aligning Ukraine's ICT-related legal and regulatory frameworks with EU Digital Single Market policies and directives; implementing GDPR compliance standards within Ukraine; expanding cross-border digital trade between Ukraine and EU member states; enhancing legal cooperation to prevent digital fraud and cybercrime in cross-border transactions; facilitating integration of ICT infrastructure with the EU networks and increasing investments in the domestic ICT infrastructure; developing a national roadmap for digital convergence with the EU; ensuring compliance with EU competition policies by Ukrainian ICT companies.

Strategic Goal 24 (SG 24) – expand R&D and innovation collaboration through the development of joint EU-Ukraine ICT manufacturing research and innovation centres. Accordingly, this area of work will take into account: expanding the participation of Ukraine's ICT sector in the EU-funded R&D

programmes; establishing innovation centres and technology transfer partnerships with the EU institutions; creating consortia of domestic HEIs and research institutes with the EU counterparts; strengthening cooperation between Ukrainian ICT start-ups and the EU-based business incubators; promoting Ukraine as a test bed for new ICT manufacturing technologies; designing educational programmes to upgrade the skills of Ukrainian professionals in the next-generation ICT hardware production; supporting Ukrainian start-ups in ICT hardware innovations through the EU accelerator programmes; establishing technology incubators focused on ICT manufacturing.

Strategic Goal 25 (SG 25) – strengthen EU-Ukraine cooperation in cybersecurity via: aligning Ukraine's cybersecurity framework with the EU standards; creating joint cybersecurity educational programmes and knowledge-sharing platforms; developing bilateral agreements on cyber threats intelligence exchange; co-developing advanced cybersecurity solutions and cyber risk management tools; expanding Ukraine's participation in the EU cybersecurity initiatives; conducting regular cybersecurity drills and crisis simulations with the EU partners; establishing joint EU-Ukraine cybersecurity research centres; enhancing legal frameworks and rapid response capabilities for transboundary cyber risks.

Strategic Goal 26 (SG 26) – expand Ukraine's participation in EU public ICT procurement and digital government services by: ensuring Ukrainian ICT companies comply with the EU public procurement requirements; promoting Ukrainian ICT companies as reliable partners for the EU digital government services; enhancing Ukraine's participation in the EU GovTech initiatives, smart cities, open data, etc.; establishing mechanisms to facilitate Ukrainian ICT companies participation in the EU tenders; creating an advisory body to assist Ukrainian ICT companies in navigating the EU procurement system.

Strategic Goal 27 (SG 27) – position Ukraine as a key ICT manufacturing hub for the EU through: developing special economic zones for ICT manufacturing with tax incentives for the EU investors; harmonising Ukraine's industrial standards with the EU ICT production regulations and requirements; improving logistics and supply chain infrastructure to facilitate exports to the EU; promoting Ukraine as a cost-effective and highly skilled alternative to Asian ICT production centres; ensuring Ukraine's inclusion in the EU trade and technology agreements related to ICT manufacturing; streamlining vocational education programmes for ICT assembly and design; securing energy supply stability and infrastructure to support large-scale ICT component production; strengthening cybersecurity measures for ICT manufacturing facilities; attracting investment from the leading EU ICT hardware manufacturers into Ukraine; identifying key ICT components that Ukraine can produce for the EU supply chains; developing domestic production capacity for microchips, printed circuit boards and telecommunications equipment; scaling up domestic production of rare earth metals used in semiconductor manufacturing; strengthening Ukraine's participation in the EU programmes for semiconductors and microelectronics development; investing in automation and robotics to enhance efficiency in component manufacturing; simplifying import-export rules for ICT components between Ukraine and the EU.

Discussion. When making recommendations for the further development of Ukraine's ICT sector and strengthening its international competitiveness, we have emphasised the advisability of focusing strategic efforts on key areas related to ICT infrastructure, human capital, business and regulatory environment, R&D and innovation, as well as integration of Ukraine's ICT sector into global economic relations.

The further development of ICT infrastructure will depend on ensuring nationwide 4G coverage and creating conditions for the deployment of 5G

networks, expanding and modernising fixed broadband infrastructure, improving the legislative and regulatory framework for ICT infrastructure development, establishing sustainable financial and investment mechanisms for ICT infrastructure upgrading, strengthening international communications and ensuring the security of critical ICT infrastructure (SG 1-6).

To foster the sustainable development of human capital, we have proposed strategic goals aimed at expanding and improving the current talent pool in the ICT sector (SG 7-9), retaining qualified ICT professionals in Ukraine (SG 10-12) and attracting foreign ICT professionals to Ukraine (SG 13-15). The key priorities include upgrading ICT education, streamlining lifelong professional ICT education, strengthening cooperation between industry, HEIs and the government, optimising working conditions and career prospects in the ICT sector, creating a stable and favourable business environment for ICT companies, reinforcing retention of ICT professionals in academia and research, developing a national strategy for branding ICT talents, launching a supportive immigration policy for ICT professionals, and enhancing the quality of life and work environment for foreign ICT professionals. At the same time, our key proposals for reinforcing R&D activity and the innovative potential of Ukraine's ICT sector include increasing private, public and academic sector expenditures on ICT R&D (SG 16), scaling up the number of researchers (SG 17) and advancing patent activity (SG 18).

Ensuring the growth of ICT sector exports will require initiating efficient institutional support for promoting Ukraine's ICT sector exports, expanding Ukraine's presence in key foreign ICT markets, and broadening access to financial and investment support for ICT exporters (SG 19-21). The recommendations regarding imports focus on measures to increase and diversify Ukraine's ICT-related imports (SG 22).

We consider it expedient to develop further international cooperation of Ukraine's ICT sector with the EU countries, specifically in the context of

strategic goals 23-27, which provide for deepening Ukraine's ICT sector integration into the EU's Digital Single Market, boosting R&D and innovation partnerships, expanding export opportunities for Ukrainian ICT services and products to the EU, strengthening cooperation with the EU in cybersecurity, facilitating Ukraine's participation in ICT procurement and the EU digital public services, transforming Ukraine into a key ICT production centre for the EU, and enhancing Ukraine's role in the EU ICT components supply chain.

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