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Entrepreneurial university: Exploring its essence, phases of development, and operating mechanism during wartime in Ukraine

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ABSTRACT

This study investigates the essence and characteristics of entrepreneurial universities during wartime in Ukraine by applying theoretical abstraction and expert survey methods. A statistical analysis of hypotheses reveals a positive impact of the entrepreneurial model on university innovativeness. The research highlights a notable deficiency in understanding the forms and methods of business-academia collaboration, constituting a significant hindrance. Factor analysis discloses three operating mechanisms for entrepreneurial universities based on internal, external, or combined resource orientation. A cluster of Ukrainian HEIs closely aligned with the entrepreneurial model is discerned, encompassing KNU Shevchenko, Kyiv and Lviv Polytechnic, Sumy National, and Ukrainian Catholic Universities. The study determines the most auspicious avenues of cooperation between businesses and HEIs. Hypothesis testing with regards to critical university activities during wartime underscores the importance of retaining students, professors, and other higher education staff and financial support for their activities. Financing HEIs during wartime involves state support, revenues from educational services, and grants. The study findings can assist university management in selecting appropriate methods for implementing an entrepreneurial model during and after wartime. Public educational authorities could effectively deploy the proposed methodologies to scrutinize the efficacy of entrepreneurial models introduced by Ukrainian HEIs.

1. Introduction

In the 21st century, divergent forces have markedly impacted the landscape of university education and scientific pursuits. On the one hand, the global economy is being shaped by the swift assimilation of the fourth industrial revolution, novel paradigms for economic development, the proliferation of knowledge-driven economies, and the rapid evolution of entrepreneurial dynamics within society. When situated within a historical backdrop, it becomes evident that solely those economic sectors and facets of public life capable of forging efficient frameworks for innovation development and implementation will be equipped to sustain their competitive advantage.

Conversely, global civilizational changes are unfolding against diverse destructive processes, encompassing the worldwide economic crisis, political and social tumult, environmental degradation, disintegration, pandemics, and armed conflicts. These adverse trends have impacted both highly developed countries and exacerbated the conditions within developing economies. The response of governments to the Covid-19 pandemic has brought a new perspective to the role of entrepreneurial universities (EnUs). Notably, the higher education institutions (HEIs) that have already embraced an entrepreneurial model demonstrated business-oriented approaches in both education and scientific spheres throughout the pandemic. These positive and negative factors have underscored the pivotal role of EnUs in addressing the socioeconomic challenges nations face.

Within the contemporary landscape, the role of knowledge in fostering socioeconomic development, ensuring employment stability, and cultivating business competitiveness within a globalized economy is transforming (Audretsch, 2014). HEIs are assuming an increasingly significant role within their respective nations innovation systems,

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evolving to serve as primary hubs for creating and disseminating knowledge (European University Association, 2010; Kirby, 2002, 2006; Kirby et al., 2011). Beyond their traditional education and research functions, HEIs proactively align with economy of society and societal aspirations. Entrepreneurial functions have emerged as integral facets of the innovative economic development paradigm, culminating in formulating and gradually adopting the EnU concept within the academic realm (Etzkowitz, 1983).

In a highly competitive business environment, producing new knowledge, training highly qualified professionals, and generating high-quality research outcomes become crucial resources (De Silva, 2016; McClure, 2016; Uslu et al., 2019). Consequently, HEIs are evolving from solely centers of education and research to business-oriented universities that actively foster academic entrepreneurship (Guerrero et al., 2014; Miller et al., 2018; Schmitz et al., 2017). These institutions, often referred to as "Third Mission" universities, are transcending their conventional roles and are recognized now as the driving forces of the knowledge-based economy (Vorley and Nelles, 2008, 2009; Sánchez-Barrioluengo and Benneworth, 2019).

Scholars have observed a significant augmentation in the role and functions of EnUs within the socioeconomic advancement of nations. This expansion has resulted in new relationships between HEIs, governmental bodies, businesses, and civil sector entities, crucial for fostering innovation within the knowledge-driven economy (Etzkowitz, 2003a). It represents a "second revolution" in HEIs' mission, integrating economic development as an additional facet alongside the academic and research functions introduced during the first academic revolution (Etzkowitz, 1998, 2003b; Peris-Ortiz et al., 2018).

There is a growing interest in understanding the essence, content, and operating peculiarities of EnUs. The Web of Science database contains 459 English-language publications from 1983 to 2018. From 2009–2014, approximately 15 articles were disseminated annually. This number increased to 82 in 2016, and it continues to grow (Cerver Romero et al., 2021). Arroyabe et al. (2022) comprehensively analyzed 1110 papers dedicated to EnUs from 1983 to 2020.

The growing number of publications and scholarly investigations in the EnU field underscores its significance. The transformation of the global business landscape, characterized by increasing variability and unpredictability, and the integration of post-communist countries into the global economy has imparted noteworthy ramifications on the academic domain. Certain countries are presently traversing economic transitions, entailing distinct higher education, scientific, technological, and innovative pursuits, together with establishing connections with external stakeholders. Concurrently, their active involvement in the globalization process requires effective coordination of relationships with international collaborators.

During the Soviet era, the EnU concept remained absent from scholarly discourse due to historical and political reasons. However, a system of scientific and industrial associations took root, establishing partnerships between state universities and enterprises. The Decree of the USSR Council of Ministers (1975) aimed to strengthen the connections between academia and industry, enhance R&D efficiency, and encourage practical implementation. As a result, 158 scientific and industrial associations had been established by 1980, facilitating cooperative ventures between HEIs and enterprises through direct contractual arrangements. The USSR budget (1981) allocated 5 billion rubles for scientific expenditures, while direct contracts brought in 10.4 billion rubles, fostering a culture of research and entrepreneurial spirit among university personnel. Ukrainian HEIs had to demonstrate agility in securing direct contracts with enterprises, and the competencies honed during this period proved invaluable in the subsequent era marked by heightened dynamism and the struggle for survival (Strikha, 2017). The program of the USSR Communist Party (1986) underscored the importance of integrating science and manufacturing for economic growth, accentuating the indispensable interplay between the state, academia, and the economy within Soviet state policy. This policy contributed to introducing the entrepreneurial model to contemporary Ukrainian HEIs.

Since gaining independence in 1991, Ukraine has faced numerous systemic crises spanning the socioeconomic and political domains. On the one hand, the nation has struggled with imperfect or inadequate legislative frameworks hindering the effective advancement of innovations. It has disintegrated the governmental system regulating and financing fundamental and applied scientific research. On the other hand, Ukrainian outdated physical infrastructure has undermined its competitiveness in strategic economic sectors. Additionally, the country has witnessed a decline in its scientific and technical human capital, attributed to continuous reductions in education and science budgets, the erosion of the HE system capacity for innovation, and a lack of a shared vision for revitalizing the scientific and technical landscape. In recent times, situation in Ukraine has been further complicated by Russian annexation of Crimea and the military conflict in the eastern region, which escalated into a full-scale Russian invasion in 2022.

The interplay between HEIs and society during war has garnered scholarly attention. Studies by Docherty (2015), Taylor (2018), Bound and Turner (2002), Weldemichel et al. (2022), Bohannon (2012), and AlMunifi and Aleryani (2021) have delved into this subject within the context of world wars and regional military conflicts across diverse nations, including Ethiopia, Afghanistan, and Yemen. However, these inquiries predominantly centered on transformations in university life amid conventional wars, where male students and faculty are often departed from classrooms to be engaged in military service. In such instances, universities frequently scaled back their curricula or entirely suspended their activities (Usher, 2020). Some researchers have also examined the activities of Ukrainian HEIs that relocated from occupied territories between 2014 and 2021 (Shevchenko, 2019; Malyarenko, 2015).

The Ukrainian situation differs from the previously cited conflicts in several key aspects. Firstly, unlike those instances, students and professors are not subject to conscription into the military. Secondly, HEIs have not suspended their activities but have instead embraced distance learning for most educational programs, leveraging the competencies gained during the Covid-19 pandemic. In this context, EnUs' introduction presents a promising approach for addressing both wartime and post-war reconstruction in Ukraine. EnUs hold the potential to emerge as centers for fundamental and applied R&D, to catalyze innovative clusters, and to play a pivotal role in fostering and funding technology transfer, a critical component for the country recovery once victory is achieved.

This article seeks to provide a comprehensive understanding of EnU's essence and operating attributes during times of war. It aims to introduce a new definition of EnUs, constructed through a discerning assessment of prevailing perspectives that seek to encapsulate their nature. The forthcoming methodology section outlines the expert survey among the faculty, researchers, and management of Ukrainian HEIs. The survey encompasses a statistical analysis of hypotheses related to HEIs' innovative potential and the barriers they face in their development. Additionally, the survey examines HEIs' components, features, operating mechanisms, challenges, prospects, and the most critical activities during wartime.

2. EnU's essence

Since 1983 the concept of entrepreneurial universities has garnered substantial research attention, prompting scholars from the United States, Great Britain, Italy, Spain, Germany, and other various European nations to contribute to the discourse by publishing numerous papers on the subject (Arroyabe et al., 2022; Forliano et al., 2021; Bronstein and Reihlen, 2014). Following independence in 1991, Ukrainian scholars actively participated in this ongoing discourse, forging collaborations with international researchers to delve into distinct aspects of HEIs. For instance, the works of Morris and Polese (2016), Denisova-Schmidt et al. (2019), and Osipian (2009, 2017) examined informal relations and

corruption within HEIs. Akbash et al. (2021) adopted scientometric indicators to assess the research output of Ukrainian HEIs. Romanovskyi et al. (2021) explored how academic capitalism has influenced transformative changes in higher education. Osipian (2022), Shevchenko (2019), Sych (2022), and Malyarenko (2015) have investigated the impact of war on HE reforms in Ukraine. In a broader context, Hernández-Torrano et al. (2021) analyzed 6754 publications on educational research in postSoviet countries indexed in the Web of Science Core Collection database from 1992 to 2020.

Despite extensive discussions, attaining a comprehensive grasp of EnUs' essence, model, and operating mechanism remains challenging, mainly due to their interdisciplinary nature. This phenomenon significantly affects the economy, society, environment, and civilization. The business environment and the socioeconomic internationalization of each respective country significantly influence the functionality of EnUs. Scholars widely advocate for the expansion of EnUs' economic and business functions through diverse mechanisms (Etzkowitz, 1983; Konstantynov and Fylonovych, 2007; Romanovskyi, 2011, 2021; Kalenyuk and Dyachenko, 2016; Chang et al., 2009; Chankseliani, 2022).

EnUs aim to establish new business ventures led by university professors, technicians, or students (Chrisman et al., 1995; Dill, 1995; Clark, 1998), characterized by closer partnerships between HEIs and businesses (Subotzky, 1999). These entities strive to maximize their potential for commercializing knowledge (Jacob et al., 2003; Gibb and Hannon, 2006; Gibb, 2012). This particular function of higher education is commonly referred to as the "third mission," representing the second academic revolution and highlighting the university's contribution to regional and economic development (Etzkowitz, 1983, 1998; Clarysse et al., 2005; Philpott et al., 2011; Guerrero et al., 2011; Kirby, 2006). The third mission of EnUs primarily revolves around "economic interactions based on knowledge transfer" (Vorley and Nelles, 2008).

Various criteria are employed to determine EnUs' nature. These criteria encompass the functions performed (functional approach), the organizational structure type (institutional approach), the objectives, outcomes, and attributes (outcome approach), as well as the relations between partners (subjective approach). Among these approaches, the functional one is the most prevalent, which involves listing the functions and activity areas performed by HEIs. In this light, EnUs produce and disseminate knowledge (Kirby, 2006), facilitate knowledge commercialization (Gibb and Hannon, 2006), establish HE spin-offs (Duberley et al., 2007), transfer technology to industry, and provide students with business competencies (Fetters et al., 2010; Philpott et al., 2011). An EnU is delineated as an HEI that cultivates highly proficient graduates with an entrepreneurial mindset, generates practical knowledge for commercial utility, facilitates the transfer of innovative technologies to industry, and contributes to societal advancement within the community through its services (Uslu et al., 2018).

The institutional approach presents a variation of the previous functional concept, defining EnUs as HEIs, natural incubators, or organizations with a delineation of constituent elements (Clark, 1998; Röpke, 1998; Jacob et al., 2003; Williams, 2003; Etzkowitz, 2003a; Kalenyuk and Dyachenko, 2016; Bizri et al., 2019; Konstantynov and Fylonovych, 2007; Romanovskyi, 2011). However, this interpretation of EnU's nature risks lapsing into a tautology as it essentially defines a university as a university.

Guerrero-Cano et al. (2006) adopted an outcome approach to defining EnUs as HEIs that exhibit the ability to independently innovate, identify and generate opportunities, work collaboratively, embrace risks, and adeptly address challenges. Gibb and Hannon (2006) highlighted that EnUs strive to optimize the potential for knowledge commercialization. Guerrero et al. (2015) also asserted that EnUs catalyze regional economic and social development. However, we argue that these approaches might obscure a comprehensive understanding of EnUs' fundamental nature and operating mechanism.

Etzkowitz (1998) introduced a subjective perspective through his triple helix model. It integrates the university, industry, and government helices into a relational system based on their roles in advancing innovation and its transfer (Etzkowitz, 1983, 2003a, 2003b; Etzkowitz and Leydesdorff, 1997; Cooke, 2005; Motohashi, 2005; Meyer, 2006a, 2006b; Etzkowitz and Klofsten, 2005). This model also advocates for a closer partnership between HEIs and businesses (Subotzky, 1999), encapsulating the economic nature of the EnU phenomenon rather than solely its external form.

In our perspective, an academically comprehensive definition should encompass essence, content, and outcomes as three foundational components that highlight the most significant facet of the phenomenon, elucidate its manifestation in a specific context, and specify the consequences of its implementation (Starostina and Kravchenko, 2013). Therefore, we propose the following definition for the EnU concept:

EnU denotes socioeconomic relationships between a university, the state, businesses, and other domestic and international stakeholders geared towards executing educational, research, and entrepreneurial endeavors grounded in specific principles contingent upon requisite and adequate circumstances (both external and internal) to harmonize and ensure the interests of all stakeholders at a particular development juncture within the innovative economic framework.

This definition underscores EnU's essence as a novel system of relationships with external stakeholders, which requires cultivating partnerships to address each stakeholder's interest. The concept encompasses educational, research, and entrepreneurial mechanisms of HEIs, including principles, forms, and instruments that align with the partnership strategy and factors influencing HEIs' activities within a specific business environment. The third component of the definition accentuates EnU's outcomes, underscoring their role in fostering the advancement of innovative economic framework.

3. EnU's development phases and operating mechanism

The literature encompasses several approaches to elucidating EnUs' operating mechanisms. Burton et al. (2001) identify five main components: a strengthened steering core, an enhanced development periphery, a discretionary funding base, a stimulated academic heartland, and entrepreneurial belief. Etzkowitz (2013) suggests that EnUs operate autonomously while maintaining close interactions with the state and business. They adopt a hybrid management structure that dynamically adapts to fluctuations in the business and government landscape. The OECD's Guiding Framework for Entrepreneurial Universities (2012)) introduces seven domains for evaluating EnUs' operating mechanism: leadership and governance, organizational capacity, people and incentives, entrepreneurship development in teaching and learning, pathways for entrepreneurs, university-business relationships for knowledge exchange, internationalization, and measuring EnUs impact. Guerrero and Urbano (2010) developed a conceptual model grounded in seven existing EnU paradigms. This model incorporates internal factors (resources and opportunities) as well as external factors such as formal aspects (organizational structure and support programs) and informal aspects (entrepreneurial culture and methods of teaching entrepreneurship). Combining these factors culminates in the desired learning, research, and entrepreneurship outcomes.

We propose defining the operating mechanism of EnUs as a set of interconnected institutional components aimed at harmonizing the interests of HEI's owners and stakeholders (Fig. 1). These institutional components encompass the legal framework, principles and forms of interaction, instruments, and governing bodies within HEIs. The proposed model provides a basis for testing hypotheses through an expert survey.

Etzkowitz (2013) outlines three stages of EnU development that differ in terms of the university management role, funding sources, ability to commercialize R&D and promote regional development. Wissema (2009) proposes utilizing the "Triple Six Model" to evaluate an HEI's advancement toward becoming a third-generation university, equivalent to an EnU. The model evaluates intrinsic quality factors like

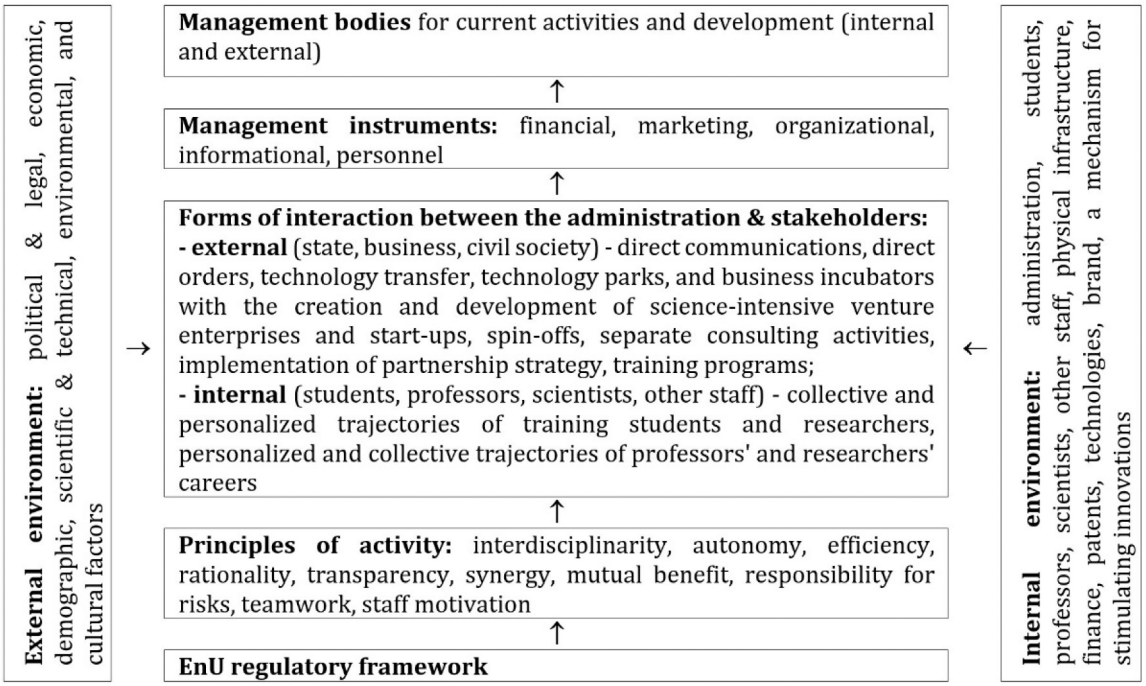

Fig. 1. EnUs' operating mechanism.
Source: research findings.

values, attitudes, and assets, specific instruments for know-how commercialization and techno-startups, and networks encompassing the quality of internal communication and external contacts. Zaslavska et al. (2020) suggest measuring success along this trajectory by assessing how an HEI safeguards the four fundamental freedoms outlined in the Lisbon Declaration: academic, organizational, financial, and personnel.

Other research has delved into the development of EnUs through empirical methodologies. Investigations in developed countries include studies by Sam and van der Sijde (2014), Jacob et al. (2003), Lazzeretti and Tavoletti (2005), Yokoyama (2006), O'Shea et al. (2007), Feola et al. (2020), Bezanilla et al. (2020), Klofsten and Jones-Evans (2000), Guerrero and Urbano (2010, 2012), Guerrero et al. (2011), Fernandez-Nogueira et al. (2018), and Wong et al. (2007). Experiences of transitional and underdeveloped economies have been analyzed by scholars from Kazakhstan (Stepanytskaia, 2000; Jonbekova et al., 2020; Omarova, 2019), Russia (Volkodavova et al., 2019; Ovsyannikova, 2005; Andryushkevich and Denisova, 2014), Iran (Salamzadeh et al., 2011), Vietnam (Dinh, 2020), and Bangladesh (Shil et al., 2020).

The specific nature of post-communist countries, including Ukraine, poses challenges in directly transferring mechanisms for EnU activities. In the former USSR, secondary and higher education were entirely funded by the state, resulting in inventions and innovations being considered state property without the need for commercialization. Economic contracts between state-owned enterprises and state HEIs did not involve market relations or competitive pricing. Following the transition to a market economy, Ukraine witnessed the emergence of alternative ownership structures, including private ownership within the HE sector (Rumyantseva and Logvynenko, 2018). Private or non-state universities started offering educational services for tuition fees. However, these HEIs often confront research and innovation development limitations due to financial, material, and human resource constraints.

In contrast to the United States and Europe, tuition fees in the private sector are lower than those ones in state HEIs, primarily covering basic expenses such as salaries and utilities. This situation hampers the ability of private universities to fully embrace the entrepreneurial mission and function as hubs of innovation and business development. Consequently, the top-ranking HEIs in Ukraine are predominantly state universities, as reported by Euroosvita (2022, 2023). This pattern highlights that state universities possess more resources and capacities to fulfill the entrepreneurial mission than private institutions.

Dual education in Germany is another noteworthy example of EnU mechanisms, whose direct implementation in Ukraine may face challenges. This model entails enduring partnerships among the state, businesses, and HEIs, aligning their interests. The state addresses youth employment concerns, businesses acquire skilled employees for innovative endeavors, and HEIs benefit from funding, internships, and knowledge exchange. The effectiveness of this approach relies on comprehensive legal regulation and a continuous improvement framework, with these responsibilities primarily resting with the government. The Vocational Training Act, established in 1969, mandates companies to provide training for eligible students. Standardized certificates ensure uniform knowledge levels across regions, fostering accountability among government entities, employers, HEIs, and labor unions (Gessler et al., 2018; Haasler, 2020).

The former Soviet Union implemented a vocational education system focused on training workers and professionals. Vocational schools were typically located at large enterprises, offering specialized training in specific fields. Each student was assigned a master who supervised the practical aspects of his or her education. Upon completion of their studies, students were assured of employment opportunities. The system was monitored by trade unions and funded through the state budget. Some aspects of dual education were integrated at the HE level, involving enterprises sending their workers to HEIs for specialized training, with expenses covered by the state. Additionally, students were granted monthly leaves three times yearly to pursue higher education while retaining their wages. However, following the collapse of the Soviet Union, this system underwent a gradual phase-out process over time.

Directly transferring experiences from Germany or other countries to Ukraine faces several challenges. Firstly, a lack of necessary legal framework exists, although some trial projects are currently being tested. Secondly, the industrial leaders of the Soviet era were privatized and transferred to private ownership, with new proprietors reluctant to

shoulder expenses for employee training. Thirdly, state funding for these programs has been discontinued, and businesses lack the financial resources, motivation, and personnel to implement such training. They can easily find qualified employees in the labor market without investing in their prior education. The ongoing war crisis further exacerbates these challenges.

To address these issues, the establishment of EnUs and their gradual transformation into hubs of innovation clusters could be a potential solution. Aligned with this notion, we propose a sequence of seven phases for EnU development (Fig. 2), which could serve as a roadmap for EnUs in Ukraine. These phases also provide a valuable avenue for further research in this field by Ukrainian scholars.

4. Method

In 2019–2020 and 2022, which followed the Russian full-scale invasion of Ukraine, we conducted surveys during academic council meetings, scientific conferences, and roundtable discussions at various academic events (refer to Table 1). We tested hypotheses on specific components of EnU's developmental phases and their interconnectedness by applying statistical analysis to the primary data. To ensure variance equality across the samples (homogeneity of variances), we applied the nonparametric Levene's test, enabling combining all the samples into one (Nordstokke and Zumbo, 2010; Nordstokke et al., 2011).

The initial dataset was obtained through self-administered questionnaires (see the appendix) completed by 121 respondents, including scientists, professors, and university management representing 39 Ukrainian HEIs, two higher education authorities, and four non-governmental organizations. All participants held doctoral degrees (specifically, a Candidate of Science degree equivalent to a Ph.D. and a Doctor of Science degree), with 95% of them also possessing a habilitation degree.

The survey was conducted in Ukrainian, the official language of education in the country, understood by all university staff and state officials, irrespective of their native language. Respondents had the option to choose whether to disclose their personal information. Trust and transparency were not problematic during the interviews, as the researchers' contact details were provided in all questionnaires. Moreover, respondents for surveys C1-C5 were either personally acquainted with the researchers or were familiar with the reputation of the conducting HEI, Taras Shevchenko National University of Kyiv (KNU Shevchenko).

Table 1
Expert survey.

ID	Survey place / time / mode	Experts' status / number / representing universities
C1	Taras Shevchenko National University of Kyiv / May 2019 / face-to-face	Participants of the international conference / 15 / 7
C2	Taras Shevchenko National University of Kyiv / September 2019 / face-to-face	Participants of the Academic Council meeting / 12 / 6
C3	Illya Mechnikov National University of Odessa / May 2019 /face-to-face	Participants of the international conference / 20 / 8
C4	Ukrainian State University of Chemical Technology (Dnipro) / November 2020 / online	Participants of the international conference / 26 / 15
C5	Ukrainian Institute for International Politics (Kyiv) / December 2020 / online	Participants of the international Web-seminar /15 / 15
C6	Ukrainian Union of Marketing experts (Kyiv) / April – May 2022 / online	Members of the Union, academic staff / 33 / 20

Source: research findings

Drawing from our observations of participants' behavior during the analyzed events, we classified them into two categories: "conventional" university staff and "active" professors and administrators. The former category included respondents from classical conferences (C1, C3, C4) and the Academic Council meeting (C2), who demonstrated relatively passive engagement during the events. In contrast, the latter category comprised participants in a seminar on contemporary university development practices (C5), which fostered active discussions (Ukrainian Institute for International Politics, 2020). To reach out to potential interviewees, we utilized a chat function during a Facebook streaming event, specifically at the timestamp 1:12:19. This allowed us to send interview invitations to individuals actively engaged in the event and expressing their views. This categorization relates to the social activism of higher education staff in terms of their involvement and advocacy for reforms in the field of university management.

We tested a total of eleven hypotheses, categorized into four groups.

1. The first category focused on the innovative potential of HEIs and the obstacles they face. In this category, we tested two hypotheses:

H1: The EnU model positively impacts the R&D innovativeness of

Fig. 2. EnU phases of development.
Source: research findings.

HEIs.

H2: A significant obstacle involves a lack of awareness regarding potential formats and methods of collaboration between businesses and academia.

2. The second category examined the features and operating mechanisms of EnUs. We tested four hypotheses in this category:

H3: Commercializing R&D results and effective mechanisms to encourage HEI staff are essential features of EnUs.

H4: Distinctions might arise in evaluating EnU attributes between "conventional" university staff and "active" professors and administrators.

H5: Variations in the prevalence of specific attributes could exist among different EnU models.

H6: Some Ukrainian HEIs can be considered close to implementing the EnU model.

3. The third category focused on the development phases of EnUs. We tested three hypotheses in this category:

H7: Purchasing and selling innovations and launching start-ups represent effective collaboration avenues for leveraging the innovative capacity of HEIs.

H8: The adept management of innovations and human resources is crucial for the entrepreneurial university model.

H9: The optimal income distribution for stimulating research activity is when the intellectual property owner receives most of the income generated by its application.

4. The fourth and final category examined the activities of HEIs during wartime. We tested two hypotheses in this category:

H10: The preservation of personnel, student retention, and financial assistance are critical areas of HEIs' activity during wartime.

H11: State support, revenue generated from business contracts, and income from educational services are vital funding sources for HEIs during periods of conflict.

To ascertain the questionnaire reliability, we applied Cronbach's alpha, an indicator of internal consistency. We used diverse types of scales to measure the variables parameters. The preliminary questionnaire evaluation was conducted at the Faculty of Economics at KNU Shevchenko University. We employed the SPSS 15 software for data analysis, which enabled us to test hypotheses, construct variation series, compare means and medians, perform cross-tabulation, conduct factor analysis, and carry out nonparametric testing of variables.

5. Results

5.1. HEI's innovative potential and obstacles to its development

Regarding the innovative potential of EnUs and the obstacles they face, we tested hypotheses H1 and H2. The findings strongly supported H1, with 92.2% of respondents (surveys C1, C2, C4, and C5) recognizing the importance of EnU's innovative potential. In particular, respondents believed that embracing market economy principles, particularly regarding wage structures and levels, would be advantageous. They also expressed that transitioning to the EnU model would improve financial flow transparency.

Concerning the challenges encountered by HEIs in their interactions with businesses (hypothesis 2), our study revealed several key obstacles. These included a perceived absence of cooperation necessity, an ineffective mechanism for financial incentives, and a lack of familiarity with various forms and methods of cooperation (Table 2). These findings align with the outcomes of a survey on innovation activity within Ukrainian enterprises conducted by the Ministry of Education and Science of Ukraine (2020). The survey found that 44.0% of respondents allocate less than 5.0% of their income to internal and external research. Notably, many business representatives cited a lack of information (40.0% of respondents) and a limited understanding of communication channels related to R&D in their relevant domains of interest (31.0%).

Ukraine finds itself trapped in a detrimental cycle where businesses lack of resources for R&D contributes to a limited interest in innovation. It, in turn, results in poor communication between businesses and academia, leading to a dearth of potentially valuable scientific advancements. It is, therefore, not surprising that Ukrainian enterprises exhibit low levels of innovation activity. From 2010–2019, Ukraine's average percentage of innovation-active enterprises stood at 16.5%, with R&D expenditures accounting for 14.0% of total innovation outflows and external R&D expenditures representing a mere 3.0% of overall outflows. In terms of concrete monetary value, these expenditures ranged from UAH 180 million in 2010 to UAH 533 million in 2014 (State Statistics Service of Ukraine, 2020).

5.2. EnU features and operating mechanism

To understand the EnUs operating mechanism, we considered the importance of its key attributes (hypothesis 3). Our assessment of these attributes was grounded in our comprehensive apprehension of EnUs' underlying essence, content, and outcomes presented earlier. The findings revealed that all the characteristics received a rating of 4 or higher, highlighting their importance according to the survey respondents (Table 3).

The study revealed that the top-ranked EnU characteristic was an efficient mechanism for personnel stimulation. This feature aligns with an entrepreneurial approach to HEI management, focusing on fostering creative initiatives, individual efficiency, and the ability to take and manage risks. The high ranking of this feature reflects the desire to address the disparity between relatively modest salaries for professors and researchers (constituting 90% of university staff) and substantial wages for top management, who might benefit from divesting institutional assets. Faculty members argue that their highly creative activities warrant higher salaries, considering the voluntary work they contribute.

The commercialization of R&D results was ranked second, highlighting its potential to harness HEIs' innovative potential. Partnerships with stakeholders and diverse funding options shared the third and fourth positions, underscoring their role as mechanisms for driving innovationi and transitioning to multi-source funding for HEI activities.

Hypothesis 4. examined differences in the assessment of EnU attributes between "conventional" HEI staff and "active" professors and administrators. The study found a statistically significant difference, with a p-value of 0.05, exclusively for EnU's leadership style. This observation indicates the presence of personnel within EnUs who are personally invested in their development and highly appreciate the leadership style in university management (Table 4).

Table 2
Barriers to collaboration between businesses and academia, grouped median.

Absence of perceived necessity for cooperation from businesses	Lack of a centralized university body to coordinate cooperation efforts	Ignorance of various forms and methods of cooperation	Low level of trust in potential partners	Lack of experience in collaboration between businesses and academia	Insufficient number of innovative R&D activities	Ineffective mechanism for financial incentives
8,77	5,79	7,04	6,56	6,80	6,76	7,56

Notes: considered surveys C3, C4, C5
Source: research findings

Table 3
Ranking of EnU key features, grouped median.

Leadership style of management	Effective mechanism to stimulate HEI staff	Entrepreneurial organizational culture	Partnerships with stakeholders	Wide range of funding	Commercialization of scientific research	Entrepreneurial courses for students
4,06	4,59	4,21	4,38	4,35	4,48	4,31

Notes: considered surveys C1, C2, C4, C5
Source: research findings

Table 4
Evaluation of EnU features among "conventional" and "active" university staff.

Leadership style of management	Effective mechanism to stimulate HEI staff	Entrepreneurial organizational culture	Partnerships with stakeholders	Wide range of funding	Commercialization of scientific research	Entrepreneurial courses for students
Grouped median: conventional / active						
3,91 / 4,50	4,55 / 4,71	4,14 / 4,46	4,28 / 4,64	4,29 / 4,50	4,46 / 4,57	4,30 / 4,33
Mann-Whitney test: Asymp. Sig. (2-tailed)						
0,048	0,347	0,148	0,121	0,375	0,574	1,000

Notes: considered surveys C1, C2, C4, C5 (53 "conventional" and 15 "active" HE staff)
Source: research findings

The study aimed to explore different variations of the EnU model that vary in the prevalence of specific characteristics (hypothesis 5). To test this hypothesis, the investigators engaged in a factor analysis of seven EnU features to identify strongly correlated variables and determine the latent factors enveloping them (Table 5). The results of the factor analysis revealed three distinct factors. According to experts, factor 1 comprises HEIs with an effective mechanism for stimulating staff, fostering partnerships with stakeholders, encompassing a broad spectrum of funding sources, and prioritizing R&D commercialization. HEIs associated with factor 2 exhibit an entrepreneurial organizational culture, provide entrepreneurship education to students, and prioritize the commercialization of R&D results. Lastly, factor 3 is characterized by the leadership style alone, indicating that HEIs with this factor prioritize leadership practices within their EnU implementation.

Based on the factor analysis results, the study identified three distinctive typologies of operating mechanisms for HEIs, determined by a fusion of external environmental opportunities and internal strengths (Fig. 3). The first group of HEIs belongs to an externally oriented category. These institutions utilize an efficacious personnel motivation system to harness external development opportunities. These HEIs rely heavily on external factors for their success and are highly responsive to changes in the external environment.

Conversely, the second group of HEIs can be classified as intra-oriented, focusing primarily on their internal strengths to propel their evolution. These HEIs leverage their internal resources, capacities, and expertise to foster innovation and entrepreneurial initiatives. The third cluster of HEIs is leadership-oriented and attributes its success to strong leadership entrenched within the institution. These HEIs balance internal and external factors in shaping their business model. They effectively capitalize on the influential leadership position of their upper management to propel entrepreneurial strategies.

Table 5
Rotated component matrix of EnU features.

EnU features	Factors		
	1	2	3
1. Leadership style of management	0,233	0,200	**0,944**
2. Effective mechanism to stimulate HEI staff	**0,738**	0,363	0,327
3. Entrepreneurial organizational culture	0,293	**0,821**	0,238
4. Partnerships with stakeholders		0,262	0,168
5. Wide range of funding	**0,862**	0,284	0,164
6. Commercialization of scientific research	**0,632**	**0,494**	0,113
7. Entrepreneurial courses for students	0,347	**0,829**	0,118
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0,898		
Sig.	0,000		
Total Variance Explained (Rotation Sums of Squared Loadings)	**% of Variance**		**Cumulative %**
Factor 1	38,427		38,427
Factor 2	27,532		65,959
Factor 3	16,230		82,190

Notes: considered surveys C1, C2, C4, C5
Source: research findings

While each group incorporates EnU components to differing extents, what distinguishes them is a central unit or trigger within the model that empowers the university to adopt entrepreneurial approaches. This central unit acts as a catalyst for the self-replicating cycle of the EnU operating mechanism. It is present across all three groups, initiating and sustaining the cycle of entrepreneurial activities within the HEI.

In Fig. 3, the EnU groups are differentiated by the triggers that initiate the EnU operating mechanism. For externally oriented EnUs, the trigger is an effective mechanism to motivate university staff. This group relies on the proactive engagement of professors and researchers as the core human resources. Through a system of financial incentives, these individuals foster partnerships with businesses and other relevant stakeholders, thereby facilitating R&D commercialization and diversification of funding channels. Subsequently, this increased financial flow can be allocated towards enhancing staff incentives.

In contrast, the central element of the operating mechanism for intra-oriented EnUs is an entrepreneurial organizational culture. The core human resources in this group are a combination of staff and students. The cultivation of an entrepreneurial spirit is facilitated by a strong entrepreneurial culture within the HEI and the development of business-oriented competencies among students. This is achieved by integrating entrepreneurship education and successfully implementing commercial innovations during students' studies and after graduation.

The leadership-oriented EnUs, represented in the third group, feature a distinct trigger in the form of a strong leadership management style. This leadership style plays a significant role in initiating and driving the EnU operating mechanism. The success of these EnUs is attributed to the leadership ability to balance both internal and external factors, thereby creating an environment that nurtures entrepreneurship and innovation. Overall, the different triggers and core human resources within each EnU group highlight the diverse strategies HEIs adopted in implementing the entrepreneurship philosophy and establishing the EnU model.

The study also aimed to identify Ukrainian HEIs that exhibit characteristics aligned with the EnU model, as hypothesized in hypothesis 6. The respondents were asked to nominate HEIs they believed embodied EnU characteristics. Analysis of the survey responses revealed five HEIs that stood out as top contenders, collectively accounting for 66% of the total responses (as illustrated in Fig. 4).

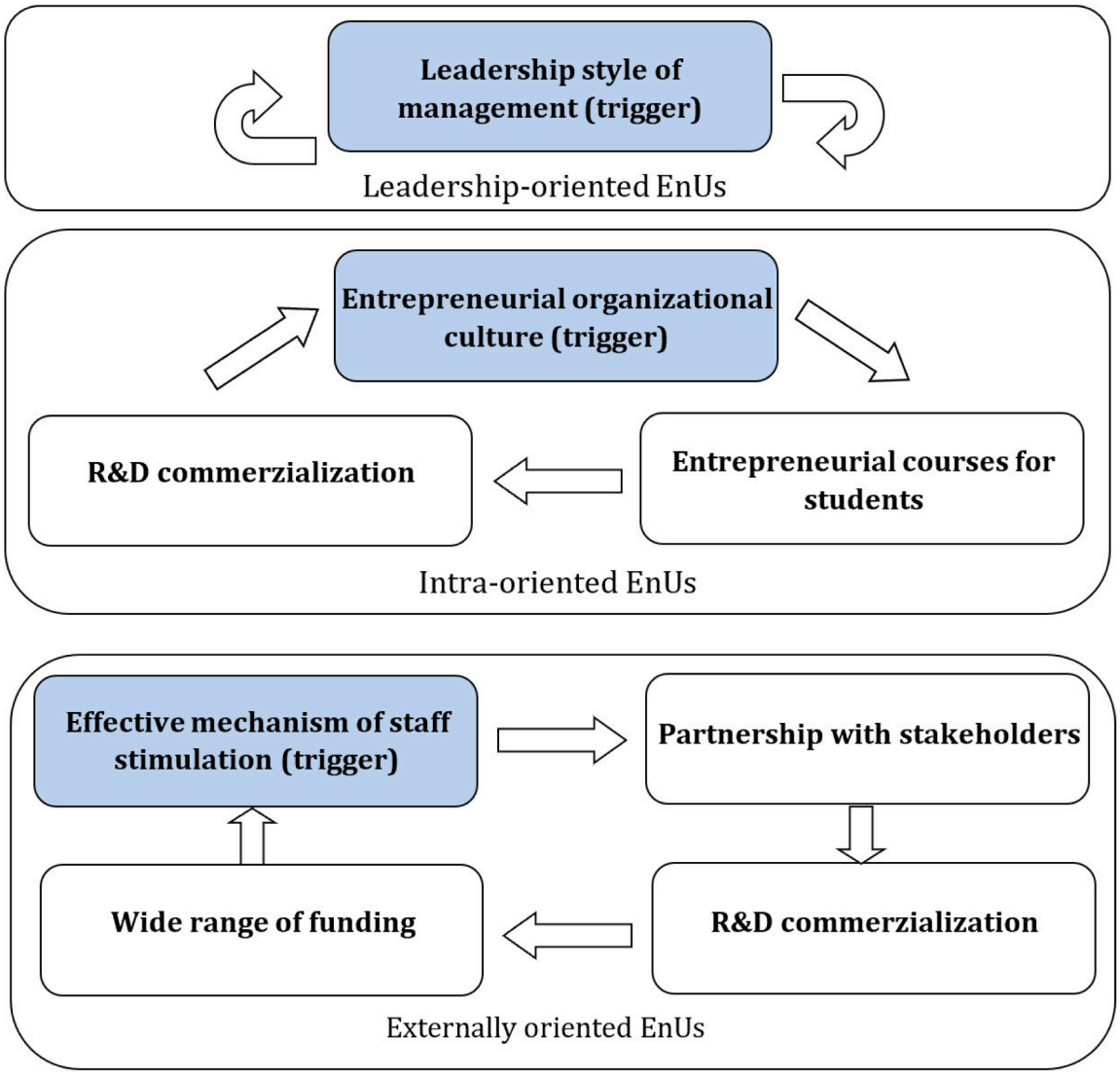

Fig. 3. EnU's operating mechanism: a categorization of three types.
Source: research findings.

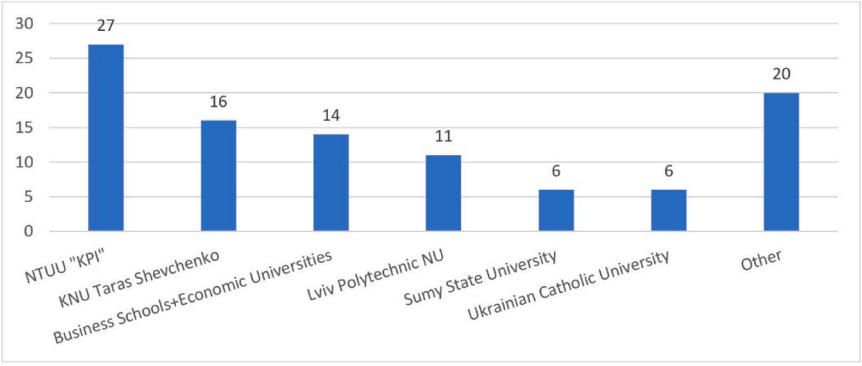

Fig. 4. EnU-enabled HEIs in Ukraine, % of responses.
Source: research findings.

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" emerged as the frontrunner, receiving 27.0% of the responses. Taras Shevchenko National University of Kyiv closely followed with 16.0% of the responses. Lviv Polytechnic National University, Sumy State University, and Ukrainian Catholic University also garnered recognition, receiving 11.0%, 6.0%, and 6.0% of the responses, respectively. Notably, economic HEIs and business schools received an acknowledgment, accounting for 14.0% of the responses.

This indicates that these institutions are also recognized for their potential to adopt EnU characteristics.

As evident from Table 6, the first four HEIs in the Euroosvita (2022, 2023) National Rating also appear in The World University Ranking (2022, 2023), albeit in relatively lower positions. These four HEIs are among the five HEIs that experts identified as closely aligned with an entrepreneurial model in the previous analysis. This observation suggests the possibility of a correlation between an HEI's entrepreneurial orientation and its position in national and international rankings.

The primary reason for the lower rankings of Ukrainian HEIs in global ratings is the specific evaluation criteria, which significantly emphasize scientific research. This research-oriented component constitutes over 60% of the evaluation criteria, comprising factors such as citations (30%), research volume, income, and reputation (30%). Ukrainian HEIs have faced notable disadvantages in this area since the Soviet era, mainly because of the historical institutional separation of these universities from the Academy of Sciences, which served as Ukraine's primary producer of scientific output. Only recently, HE authorities started actively encouraging university lecturers to publish their research in peer-reviewed international scientific journals to improve the global rankings of HEIs. This shift reflects a concerted effort to improve the research profile of Ukrainian HEIs and align them more closely with global academic standards and expectations.

Another contributing factor to the suboptimal placement of Ukrainian HEIs in global rankings is the insufficient material and technical resources available to these institutions. This limitation severely hampers their capacity to conduct research at a level of excellence desired for higher rankings. This issue was highlighted in a survey conducted by the Ilko Kucheriv Democratic Initiatives Foundation (2015), where nearly 80% of university rectors identified the weak material and technical infrastructure as the primary obstacle to enhancing higher education. Unfortunately, the situation has not improved and may have even worsened due to various crises that have affected the country, including economic downturns in 2014–15 resulting from a hybrid war with Russia, the Covid-19 pandemic, and the full-scale Russian invasion in 2022. These events have further hindered the development and modernization of material and technical resources within Ukrainian HEIs, negatively impacting research output and international rankings.

5.3. EnU phases of development

The practical implementation of the EnU model is a critical aspect, as depicted in Fig. 2. An expert survey was conducted to explore the fourth and fifth phases (H7-H9), and the results partially confirmed hypothesis 7, as shown in Table 7. Forms of university-business cooperation that harness a HEI's innovative potential with minimal associated risks were rated as the highest priority. University staff emphasized the importance of collaborating with businesses to develop commercially viable innovative products, establish connections within the dual education and innovation clusters framework, and receive support from their HEIs. However, establishing start-ups and business incubators were considered less attractive forms of cooperation, possibly due to the perceived higher levels of risk associated with these endeavors.

Table 6
Ranking of Top-5 Ukrainian HEIs with EnU features.

No	University	The Times Higher Education World University Rankings 2023	TOP-200 Ukraine 2023 University Rating
1	National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"	1201–1500	1
2	Taras Shevchenko National University of Kyiv	1201–1500	2
3	Lviv Polytechnic National University	601–800	6
4	Sumy State University	401–500	7
5	Ukrainian Catholic University	-	11

Source: Euroosvita (2023); The World University Rankings (2023)

Table 7
The most appealing forms of collaboration between business and academia, grouped median.

Innovative cluster*	Sales of innovations*	Start-ups*	Business incubators**	Dual education***
7,63	7,65	7,41	6,67	7,64

Notes: Source: research findings
* considered surveys C3, C4, C5
* * considered survey C3
* ** considered surveys C4, C5

As introduced by Chesbrough (2006), the open innovation model offers a promising approach to fostering collaboration between EnUs and businesses. This model emphasizes the targeted exchange of knowledge to enhance internal innovation efforts and create opportunities for implementing innovations in the external environment. Given the rapid pace of technological advancement, large companies often struggle to respond quickly to innovative shifts in manufacturing, labor practices, and management, potentially lagging behind international competitors. Consequently, it becomes imperative for these companies to engage in creative collaborations with HEIs in R&D to maintain their competitive edge.

While testing hypothesis 8, it was discovered that innovation and intellectual property management were the most effective managerial tools for developing the HEI entrepreneurial model, as shown in Table 8. All the proposed managerial instruments in the questionnaire received high rankings from the experts, surpassing a score of 4. However, the lower rankings for risk and didactics management suggest that the respondents may underestimate these aspects, which could potentially hinder the development of EnUs.

The survey results confirmed hypothesis 9, which suggests that the intellectual property owner or author should receive a significant portion of the income generated from its application in order to incentivize further research activity (see Fig. 5). This finding aligns with a similar proportion reported in a 2011 survey conducted among scientists and professors at KNU Shevchenko (Starostina et al., 2013). However, implementing such an approach presents challenges within the current Ukrainian clan-oligarchic economic model (Soskin, 2014; Balabushko et al., 2018). In the transitional Ukrainian society, trade unions may not adequately represent the interests of HE staff in negotiating favorable conditions. According to a 2019 expert survey (Kravchenko, 2019), 75% of the respondents agreed that HE trade unions tended to align with the administration regarding salaries, while only 2% believed that trade unions effectively defended the interests of the faculty. Consequently, it becomes crucial to actively encourage scientists to create and commercialize intellectual property for the success of HEIs' entrepreneurial activities, as stated in hypothesis 9.

5.4. HEIs' activities during wartime

The outbreak of the Russia-Ukraine war on February 24, 2022, resulted in the declaration of martial law and presented complex challenges for Ukrainian HEIs, affecting their administrations, professors, and students. As of July 4, 2023, Ministry of Education and Science of Ukraine, (n.d.) reported that 3119 institutions had been damaged, with 331 of them completely destroyed. These circumstances have profoundly influenced the functioning of HEIs. This impact was examined through an expert survey conducted in 2022 among professors and administrators from 20 Ukrainian HEIs, specifically investigating Hypotheses 10 and 11.

Table 8
The most effective managerial tools for EnUs, grouped median.

Innovation management*	Risk management*	Intellectual property management*	HR management*	Finance management*	Marketing management*	Education management**
4,49	4,29	4,44	4,38	4,42	4,41	4,13

Notes: Source: research findings
* considered surveys C1, C2, C4, C5
* * considered surveys C4, C5

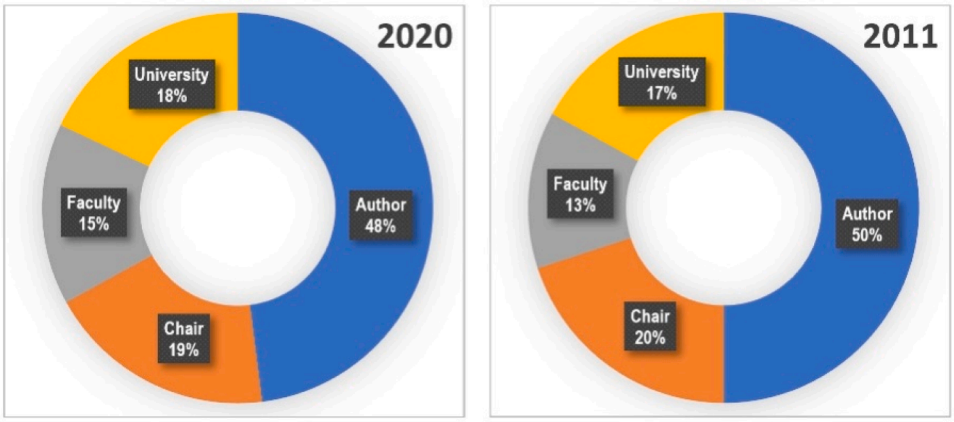

Fig. 5. Desired allocation of earnings from intellectual property implementation, average %.
Source: research findings.

The survey results indicated that during wartime, the most critical university activities focused on preserving staff and students and providing financial support for their activities, thereby confirming hypothesis 10 (Table 9). These findings are consistent with the narratives shared in the special issue of Problems and Perspectives in Management (2023) titled "Academic Management in War," which features accounts from 18 Ukrainian universities. For instance, KNU Shevchenko, mentioned by respondents as closely associated with the EnU model, has identified preserving its personnel potential as a strategic priority task (Bugrov et al., 2023). This underscores the importance placed on safeguarding the university's human resources and ensuring their continued contribution to its mission and goals amidst the challenging times of war.

Hypothesis 11. as revealed in the study, indicated that state support, educational services, and grants were considered the most important funding sources for Ukrainian HEIs during the conflict, according to the experts surveyed (Table 10). This finding aligns with the efforts and priorities outlined by the National Council for the Recovery of Ukraine from the Consequences of the War (2022) and the Ministry of Education and Science of Ukraine (2022). In response to the challenges confronted by Ukrainian HEIs in the aftermath of the Russian invasion, these authorities have jointly summarized the difficulties and proposed strategies to address them. The proposed plan emphasizes the importance of developing grant proposals for foreign partners, indicating the state's commitment to supporting HEIs during recovery. It recognizes the need to address the severe decline in student enrollment and the destruction of infrastructure, including higher education facilities. The results of the expert survey conducted in the study align with the perspective of state authorities, highlighting the significance of state support, educational services, and grants as crucial funding sources for HEIs in times of conflict. This underscores the recognition of the importance of these resources in revitalizing and rebuilding the HE sector in Ukraine.

Table 10
The crucial sources of funding for HEIs during times of war, grouped median.

Educational services	R&D	University owner	International organizations	Grants	State support
6,14	5,38	5,25	5,60	5,83	6,38

Notes: considered survey C6
Source: research findings

The full-scale Russian invasion of Ukraine has introduced a complex and contradictory impact on the operational capabilities of Ukrainian HEIs. While the war has posed significant challenges to teaching, scientific research, and entrepreneurial activities, it is worth acknowledging that no HEI has entirely halted its operations. This resilience and entrepreneurial spirit can be attributed to the determination and adaptability of HEIs' management and staff in overcoming strategic and tactical obstacles.

Despite the ongoing threat of aggressive missile attacks and the disruption of everyday activities, Ukrainian HEIs have demonstrated their unwavering commitment to education reform and innovation. They have explored alternative funding avenues, including foreign grants and business partnerships with operating companies, to ensure

Table 9
The most crucial activities of HEIs during times of war, grouped median.

Staff preservation	Financial support	Restoration of physical infrastructure	Expansion of cooperation with foreign partners	Close cooperation with the state and business	Intensification of scientific and innovative activities	Students' preservation
6,66	6,50	6,10	5,91	6,42	6,14	6,56

Notes: considered survey C6
Source: research findings

the continuation of their operations during the conflict. HEIs have implemented new teaching methodologies to adapt to continuous blackouts and air attacks, ensuring that education continues despite challenging circumstances. Additionally, they have continued their research efforts by publishing scholarly articles, participating in conferences, and leveraging professional organizations to provide support for destroyed or relocated institutions.

One remarkable aspect of the response to the conflict has been the significant increase in volunteerism and the strengthening of moral incentives for teaching, research, and entrepreneurship. The academic community and HEIs' management have come together to support one another and contribute to the reconstruction efforts. This highlights the growing importance of EnUs in rebuilding post-war Ukraine. Despite the numerous challenges imposed by the war, Ukrainian HEIs have demonstrated remarkable resilience, innovation, and an unwavering commitment to education and research. The role of EnUs in this context becomes even more vital as they contribute to the reconstruction and revitalization of higher education in Ukraine, fostering entrepreneurship and driving positive change in the post-war era.

6. Conclusion

The concept of an Entrepreneurial University within the context of wartime Ukraine encompasses a comprehensive framework that includes its essential nature, substantive components, and eventual outcomes. This innovative paradigm requires establishing strategic partnerships to effectively address the diverse interests of key stakeholders, including academia, the state, businesses, and domestic and international actors. The EnU model underscores the three interconnected domains of education, research, and entrepreneurship within an innovative economic system, aiming to harmonize and ensure the interests of all parties involved. Transitioning from a state-supported education system to a market-oriented economy necessitates adapting and transforming operating mechanisms underlying EnU activities. Constrained by financial limitations, private universities struggle to fully embrace their entrepreneurial mission and serve as innovation and commercial advancement centers. Consequently, state universities in Ukraine, with greater resources and capacities, predominantly serve as conduits for advancing the entrepreneurial mission.

The experiences of countries like Germany, with its dual education paradigm, offer invaluable insights into EnUs' operating mechanisms. However, directly applying these experiences to the Ukrainian context encounters significant challenges, such as lacking the necessary legal framework, privatization of key industrial players, and discontinuing state funding for educational training initiatives. The ongoing war crisis further exacerbates these challenges. To address these issues, the establishment of EnUs and their gradual transformation into innovation-driven clusters emerges as a potential solution. In this context, delineating seven developmental phases for EnUs in Ukraine provides a roadmap, guiding progress and offering promising avenues for subsequent scholarly exploration. By leveraging the potential of the EnU model, HEIs could serve as pivotal agents, fostering innovation, facilitating the dissemination of knowledge, and nurturing human resource development, even in times of war.

Through the analysis of survey data and empirical investigations, this study has unveiled that EnUs can enhance the innovative capacity of HEIs. However, this potential encounters impediments, such as a lack of understanding regarding business-academia cooperation and ineffective financial incentive mechanisms. These obstacles hinder the collaborative synergy that EnUs aim to foster. Ukrainian enterprises exhibit low levels of innovation activity due to limited resources and communication gaps between businesses and academia. Several critical aspects were identified regarding EnU features and operating mechanisms, including compelling personnel motivation, R&D commercialization, partnerships, and diverse funding sources. Notably, differences in the assessment of EnU features were observed between different groups of university staff, professors, and administrators, highlighting the presence of staff members personally invested in EnU's development. Factor analysis revealed three distinct types of operating mechanisms, influenced by external opportunities, internal strengths, and leadership styles.

In the context of war, HEIs face significant challenges in areas such as personnel retention, financial assistance, and state support. The successful implementation of EnU could contribute to addressing these challenges and ensure the uninterrupted continuation of educational and research endeavors, even in the face of adversity. HEIs could enhance their resilience by nurturing innovation, fostering entrepreneurial culture, and promoting collaboration with businesses. This, in turn, enables them to contribute to economic growth and effectively address the ever-evolving societal needs, even amidst the challenges posed by wartime circumstances.

The study limitations encompass the limited sample size and scope of the investigation. The data were collected from a cohort of 39 Ukrainian HEIs, two HE authorities, and four non-governmental organizations. While the study acknowledged the sample size, it may not fully represent all Ukrainian universities' diverse perspectives and experiences. Furthermore, the ongoing war introduces a dynamic factor that necessitates potential adjustments to the EnU model to address the changing circumstances. Another limitation is associated with a limited representation of business perspectives, as the study primarily focused on the viewpoints of HEI staff, including scientists, professors, and university management. The views and experiences of external stakeholders, particularly businesses, were not extensively explored. This limitation could potentially impact the comprehensiveness of the findings, given that EnUs' success depends on effective partnerships with businesses.

In conclusion, the EnU concept in wartime Ukraine holds great potential to drive innovation, foster partnerships, and address challenges HEIs face. Despite the unique obstacles posed by war, EnUs have the potential to serve as catalysts for progress, enabling universities to adapt, thrive, and contribute to developing an innovative economic system even amidst ongoing conflict. Future research should explore the evolving functions of EnUs in post-war reconstruction and their contributions to the socioeconomic development of Ukraine.

CRediT authorship contribution statement

Conception and design of study: **A.Starostina, V.Bugrov, V.Kravchenko, N.Kochkina, G.Gatto.** Acquisition of data: **A.Starostina, V. Bugrov, V.Kravchenko.** Analysis and/or interpretation of data: **A. Starostina, V.Kravchenko, N.Kochkina, G.Gatto**. Drafting the manuscript: **A.Starostina, V.Kravchenko, N.Kochkina.** Revising the manuscript critically for important intellectual content: **V.Bugrov, N. Kochkina, G.Gatto**. Approval of the version of the manuscript to be published (the names of all authors must be listed): **A.Starostina, V. Bugrov, V.Kravchenko, N.Kochkina, G.Gatto**.

Conflicts of interest statement

None.

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Appendix

C1, C3 questionnaire (May 2019).

1. Do you agree or disagree with the following statement: Using an entrepreneurial model by HEIs will contribute to university science innovativeness:

1. Agree
2. Absence of perceived necessity for cooperation from businesses
3. Lack of a centralized university body to coordinate cooperation efforts
4. Ignorance of various forms and methods of cooperation
5. Low level of trust in potential partners
6. Lack of experience in collaboration between businesses and academia
7. Insufficient number of innovative R&D activities
8. Ineffective mechanism for financial incentives
9. Other (please indicate)

Disagree.

2. Please mark the importance of the following features for entrepreneurial universities in Ukraine (where 1 is the least important, and 5 is the most important):

Importance	1	2	3	4	5	Hard to answer
Leadership style of management						
Effective mechanism to stimulate HEI staff						
Entrepreneurial organizational culture						
Partnerships with stakeholders						
Wide range of funding						
Commercialization of scientific research						
Entrepreneurial courses for students						
Other features (please, indicate)						

3. Please indicate what Ukrainian HEIs are close to implementing the entrepreneurial university model.
4. Please mark the importance of using the following managerial instruments for entrepreneurial universities in Ukraine (where 1 is the least important, and 5 is the most important):

Importance	1	2	3	4	5	Hard to answer
Innovation management						
Risk management						
Intellectual property management						
HR management						
Finance management						
Marketing management						
Education management						

C2 questionnaire (September 2019).

1. Do you agree or disagree with the following statement: In the current world, HEIs not only provide educational services but actively cooperate with businesses becoming entrepreneurial universities:

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

2. Could effective business cooperation with entrepreneurial universities become a company's innovation source?

1. Yes
2. No

3. If so, which forms of cooperation are the most favorable (where 1 is the least favorable, and 10 is the most favorable)?

1. Innovative cluster
2. Sales of innovations
3. Start-ups

4. Business incubators
5. Other (please indicate)

4. Do you consider an entrepreneurial model a strategy for developing a HEI?

1. Yes
2. No

5. What cooperation with enterprises do you consider a part of the educational process?

1. Master's thesis on business topics
2. Experts' participation in thesis presentations
3. Internship
4. Visiting lecturers
5. Graduates' employment
6. Dual education
7. Other (please indicate)

6. What is an entrepreneurial university?
7. What are the main features of entrepreneurial universities?
8. What are the main obstacles in the interaction between business and science (where 1 is the least important, and 10 is the most important):

1. Absence of perceived necessity for cooperation from businesses
2. Lack of a centralized university body to coordinate cooperation efforts
3. Ignorance of various forms and methods of cooperation
4. Low level of trust in potential partners
5. Lack of experience in collaboration between businesses and academia
6. Insufficient number of innovative R&D activities
7. Ineffective mechanism for financial incentives
8. Other (please indicate)

C4-C5 questionnaire (November-December 2020).

1. Do you agree or disagree with the following statement: Using entrepreneurial principles by HEIs will contribute to the growth of university science innovativeness:

1. Agree
2. Disagree
3. Hard to answer

2. Please mark the importance of the following features for entrepreneurial universities in Ukraine (where 1 - the least important, 2 – not important, 3 – neutral, 4 – important, 5 - the most important):

Importance	1	2	3	4	5	Hard to answer
Leadership style of management						
Effective mechanism to stimulate HEI staff						
Entrepreneurial organizational culture						
Partnerships with stakeholders						
Wide range of funding						
Commercialization of scientific research						
Entrepreneurial courses for students						

3. Please mark the importance of using the following managerial instruments for entrepreneurial universities in Ukraine (where 1 - the least important, 2 – not important, 3 – neutral, 4 – important, 5 - the most important):

Importance	1	2	3	4	5	Hard to answer
Innovation management						
Risk management						
Intellectual property management						
HR management						
Finance management						
Marketing management						
Education management						

4. Please indicate what Ukrainian HEIs are close to implementing the entrepreneurial university model.
5. Which forms of cooperation between business and HEIs are most favorable for universities' innovative potential (where 1 is the least favorable, and 10 is the most favorable)?

1. Innovative cluster
2. Sales of innovations
3. Start-ups
4. Dual education

6. What are the main obstacles in the interaction between business and science (where 1 is the least important, and 10 is the most important):

1. Absence of perceived necessity for cooperation from businesses
2. Lack of a centralized university body to coordinate cooperation efforts
3. Ignorance of various forms and methods of cooperation
4. Low level of trust in potential partners
5. Lack of experience in collaboration between businesses and academia
6. Insufficient number of innovative R&D activities
7. Ineffective mechanism for financial incentives
8. Other (please indicate)

7. What distribution of revenues from intellectual property rights (patents, copyright etc.) do you consider the most effective for stimulating research:

Author (HEI employee)	Department/lab where the author works	Faculty	University	Total
___%	___%	___%	___%	100%

C6 questionnaire (April-May 2022).

1. Please indicate the importance of the following HEIs' activity in 2022 (where 1 is the least important, and 7 is the most important):

Importance	1	2	3	4	5	6	7
Staff preservation							
Financial support							
Restoration of physical infrastructure							
Expansion of cooperation with foreign partners							
Close cooperation with the state and business							
Intensification of scientific and innovative activities							
Other (please, indicate)							

2. What are the vital funding sources for HEIs in 2022 (where 1 is the least important, and 7 is the most important):

Importance	1	2	3	4	5	6	7
Educational services							
R&D							
University owner							
International organizations							
Grants							
State support							
Other (please, indicate)							

3. What are the main areas of activity for the Ukrainian Union of Marketing Experts in 2022 (where 1 is the least important, and 7 is the most important):

Importance	1	2	3	4	5	6	7
Scientific research aimed to restore Ukraine's economic potential							
Conferences, round tables, articles							
Partnership with business							
Partnership with state authorities							
Partnership with foreign professional marketing organizations							
Professional support for members of the Ukrainian Union of Marketing Experts							
Other (please, indicate)							

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