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Strategic academic leadership and high-tech economic growth

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Considering the context of the Fourth Industrial Revolution, higher education must play a significant role in the social-investment model of economic growth. To what extent higher education supports strategic academic leadership and high-tech economic development is still being determined. The article proposes direct actions for improving university management through higher educational and technological functions. We establish the specific directions for university management in neo-industrialization 4.0 to ensure extensive accessibility of higher education and enhance university management efficiency.

KEYWORDS

higher education, strategic academic leadership, high-tech economic growth, neoindustrialization 4.0, socio-investment model of economic growth, universities, higher education management

1. Introduction

The adoption of the Sustainable Development Goals (SDGs) has accelerated the design of two university functions: educational (SDG 4) and technological (SDG 9). Government and societal requirements for universities were also specified.

The first requirement is for universities to support high-tech economic growth (Muljono and Setiyawati, 2022). In recent decades, higher education has been at the heart of economic growth that post-industrialization implies. The development of society depends on the service sector, where human resources fulfill a crucial role. With the advent of the Fourth Industrial Revolution and post-industrialization 4.0, economic growth has become increasingly dependent on various high-tech segments of industries (Popkova, 2022; Sergi and Popkova, 2022).

The second requirement supports strategic academic leadership, defined in this article as the advanced knowledge and technology of national universities and their standing in international universities rankings (Bellantuono et al., 2022; Elbawab, 2022; Véliz and Marshall, 2022).

The technological function of universities is essential for conforming to the two requirements since they are associated with technologies and innovations. However, while the 17 Sustainable Development Goals are equally important, it seems unacceptable to assign SDG 4 a secondary role, given that it can be performed exclusively by universities. Furthermore, there needs to be more clarity as to which function of universities contributes to high-tech economic growth and strategic academic leadership (Phiri and Tough, 2018; Saiti et al., 2018; Andrades et al., 2021; Wolhuter, 2022).

In the Decade of Action, it is unclear how universities should be managed and which function they should focus on the most. This article thinks of the university as an organization that carries out science and higher education activities where academic leadership wins and keeps leadership positions in the international university ratings.

Higher education faces a considerable challenge due to the change in economic systems. Universities have consistently carried out a crucial role in the past, but the nature of this role is changing. In the post-industrial era, universities served the vital function of providing higher education to train highly qualified personnel. In post-industrialization 4.0, universities have become more critical in creating knowledge and technology (Muktiyanto et al., 2020; Kim and Lee, 2021; Yusriana et al., 2021).

The extant literature, for example, Turginbayeva et al. (2018), Zarea et al. (2021), and Maxyutova et al. (2022), points to the importance of human and technological resources for neo-industrialization 4.0. Let us clarify which part of higher education is more substantial to fill the gap in the literature.

For achieving the neo-industrialization 4.0 goals, which university function is the most fundamental? It looks at universities' educational and technological processes and how they can help the country achieve external advantages. How university management affects the science and higher education system is also considered from a creative perspective.

After this introduction, we will look at the extant literature, find a literature gap, and look at how higher education can help academic leadership and high-tech economic growth. We examine higher education and technology separately to see how they contribute to neo-industrialization 4.0. Then, we sequentially address the two research objectives. First, we will perform a factor analysis of strategic academic leadership and high-tech economic growth. Another purpose is to provide suggestions for improving university management and explain why it is essential for strategic visionary leadership and high-tech economic development. It ends with a discussion and conclusion.

2. Literature review

The literature has extensively studied strategic academic leadership (Jahanmehr et al., 2022; Kaidesoja, 2022) and high-tech economic growth (Gil et al., 2019; Scott et al., 2021; Wang et al., 2022). These both shape the spheres of digital competitiveness and sustainability under neo-industrialization 4.0. Nevertheless, the significance of higher education and university management for neo-industrialization 4.0 is not well-researched and remains unclear.

This gap in the literature raises two research questions (RQs).

> *RQ1*: What is the role of universities in supporting neo-industrialization 4.0? Chen et al. (2022), Doan et al. (2022), and Polidoro et al. (2022) link the role of universities to the creation of new knowledge and technology. This would apply through the automation of business processes. Human resources are becoming less important as machinery and technology are more critical (Ma and Li, 2022). Full-automated smart factories that operate autonomously using robots and artificial intelligence are an example of this process (Chen et al., 2022). Although automation is not a spontaneous process, it involves highly qualified personnel. In this regard, Alipanga and Kohrt (2022), Krassadaki et al. (2022), Nunfam et al. (2022), Siri et al. (2022), and Yu and Wang (2022) point to the importance of higher education for neo-industrialization 4.0. Based on this assumption, this article proposes hypothesis H_1, that higher education plays an equally significant role in supporting the neo-industrialization 4.0 as it does in creating new knowledge and technology. Universities perform two equally valuable educational and scientific functions throughout this process.

> *RQ2*: How can higher education be managed to be a leader in academics and high-tech economic growth? In Nawaz et al. (2020), Ruangpermpool et al. (2020), Gonzalez-Perez et al. (2021), Ismail et al. (2022), and Veltri et al. (2022), universities should generate new knowledge and technology and execute their technological function and support high-tech economic growth.

The causes and effects of universities' role in neo-industrialization 4.0 are not explained fully in the literature. After analyzing the literature and systematizing the accumulated knowledge, we highlighted three principal areas of university management that contribute to the development of higher education.

The first direction is the vastest availability of higher education (Alexander et al., 2022; Hassan et al., 2022; Suyadi et al., 2022). Implementing this direction means that the more highly qualified personnel in the economy, the greater its human potential (Al-Tammemi et al., 2022; Palmisano et al., 2022; Sanz and López-Iñesta, 2022). The second direction is the training of scientific and engineering staff by universities, most of whom are IT specialists (Btoush, 2022; Leible and Ludzay, 2022). This direction directly forms the staffing of neo-industrialization 4.0 (Karpefors and van Riemsdijk, 2020; Wasilah et al., 2021). The third direction is the establishment of mobility in higher education (Grant, 2018; Knight and Motala-Timol, 2021). Intercity and international internships for faculty and students and opportunities for students to choose and change majors as they pursue their higher education are relevant to the considered area (Burmann and Delius, 2017). This direction ensures the flexibility of universities and the higher education system and the system's openness, stimulating the quality of higher education and contributing new knowledge and technologies (Bobrytska et al., 2021).

Based on the extant literature review, we formulate hypothesis H_2: in the process of ensuring strategic academic leadership and supporting high-tech economic growth, university management should aim at (1) raising the mass availability of higher education, (2) training scientific and engineering & technical personnel, and (3) mobility in higher education and universities' accomplishment their educational function.

Undoubtedly, these management areas are essential for developing higher education. However, each highlighted area's contribution to strengthening strategic academic leadership and accelerating high-tech economic growth needs in-depth study. Due to the lack of scientific elaboration, RQ_2 requires further scientific search.

To test our hypothesis H_1, we compare the creation of new academic knowledge and technology with higher education services to strategic academic leadership and high-tech economic growth. This illustrates how universities' technological and educational function contributes to their goals in the Decade of Action: high-tech economic growth and progress in international university rankings.

To test hypothesis H_2, we model the prospects for strengthening strategic academic leadership and accelerating the high-tech economic growth rate based on higher education development. Our method models university management in the unity of its functions. High-tech economic growth (high-tech manufacturing) and strategic academic

leadership (QS university ranking) are set by the performance of the educational function – in the unity of three directions: (1) Raising the mass accessibility of higher education (tertiary enrolment), (2) Training of scientific and engineering & technical personnel by universities, most of which are IT specialists (graduates in science and engineering), and (3) Mobility in higher education (tertiary inbound mobility) – and technological function: knowledge creation.

3. Materials and methods

In order to avoid significant gaps in the dataset, we employed a sample of 123 countries, for which most of the values of the studied indicators are available. Data for the whole totality of countries were initially collected from WIPO (2022). The countries with the most data were chosen, and a research sample was made with no gaps in the data. The data were taken from the WIPO report for 2022, but they show the results for 2021. The statistics are combined into a common dataset publicly available in Mendeley Data (Popkova, 2022). The indicators were sourced from the WIPO (2022) report and in the score (0–100, 100-the best; assigned scores by WIPO experts through international comparisons and reflect the country's efficiency and comparison with other countries). This simplifies the logical treatment of the results of econometric modeling and increases its precision.

A classification of local and leading universities was adopted. Local universities and their branches are oriented toward internal markets and rely on the government for support. These universities rank low in national ratings and are not usually included in international ratings. Leading universities actively attract foreign lecturers and students and are included in international and top national ratings. They can receive government support and benefit from high flexibility and entrepreneurial activity. This article focuses on universities of the second type.

A regression analysis of strategic academic leadership and high-tech economic growth is employed to model the dependence of strategic academic leadership and high-tech economic growth – high-tech manufacturing (HTM) and QS university ranking (QSR) – on the factors of higher education – tertiary enrolment (te), graduates in science and engineering (gs), tertiary inbound mobility (tm), and knowledge creation (kc).

The variables reflect the university management's corresponding direction. The variable "high-tech manufacturing" was selected because it allows for quantitative measuring of high-tech economic growth. The variable "QS university ranking" reflects the results of countries on their way to strategic academic leadership and "tertiary enrolment" university management's outcome in guaranteeing mass accessibility of higher education services. This variable is a statistical reflection of the first direction of university management. It considers highly qualified personnel and their human potential as described in several works (Alexander et al., 2022; Al-Tammemi et al., 2022; Hassan et al., 2022; Palmisano et al., 2022; Sanz and López-Iñesta, 2022; Suyadi et al., 2022).

The educational function's "graduates in science and engineering" reflects university management's results in training scientific and engineering & technical personnel, most of whom are IT specialists. This variable is a statistical reflection of the second direction of university management described in (Karpefors and van Riemsdijk, 2020; Wasilah et al., 2021; Btoush, 2022; Leible and Ludzay, 2022). The logic of using this variable consists of staffing neo-industrialization 4.0, ensured by universities.

The variable "tertiary inbound mobility" reflects university management's result in mobility in higher education and the third direction of university management (Burmann and Delius, 2017; Turginbayeva et al., 2018; Bobrytska et al., 2021; Knight and Motala-Timol, 2021). This variable considers the flexibility of universities and the system of higher education overall, as well as its openness to increasing the quality of higher education and stimulating better creation of new knowledge and technologies.

The variable "knowledge creation" reflects university management's performance in the technological function by creating new knowledge, technologies, and other innovations.

The research model takes the form of the following system of multiple linear regression equations:

$$\begin{cases} HTM = a + b_{te(htm)}{}^{*}te + b_{gs(htm)}{}^{*}gs + b_{tm(htm)}{}^{*}tm + b_{kc(htm)}{}^{*}kc, \\ QSR = a + b_{te(qsr)}{}^{*}te + b_{gs(qsr)}{}^{*}gs + b_{tm(qsr)}{}^{*}tm + b_{kc(qsr)}{}^{*}kc. \end{cases} \quad (1)$$

Model (1) is tested with multiple correlation coefficients and Fisher's *F*-test. The factor variables te, gs, and tm reflect the educational function of universities. Variable kc reflects the technological function of universities.

To verify hypothesis H_1, the regression coefficients are compared to each other. Proving the hypothesis is expressed as $(b_{te(htm)} + b_{gs(htm)+}b_{tm(htm)})/3 > b_{kc(htm)}$ and simultaneously $(b_{te(qsr)} + b_{gs(qsr)} + b_{tm(qsr)})/3 > b_{kc(qsr)}$. This shows a higher significance of universities' educational function than their technological function.

Based on the model (1) results, we insert the maximum possible (100 points) values of the factor variables that characterize universities' educational function. We determine the forecasted growth of the resulting variables (ΔHTM and ΔQSR) with the maximization of factor variables: $b_{te} \rightarrow max$; $b_{gs} \rightarrow max$; $b_{tm} \rightarrow max$.

The benefits of strategic academic leadership and high-tech economic growth are determined using the least squares method based on the model (1). If the maximization in the following spheres is achieved, hypothesis H_2 is accepted: (1) tertiary enrolment, (2) graduates in science and engineering, and (3) tertiary inbound mobility will ensure an increase in high-tech manufacturing and growth of QS university ranking, top 3.

4. Results

4.1. Factor analysis of strategic academic leadership and high-tech economic growth

In the first step, statistics from the dataset (Popkova, 2022) were processed using regression analysis for factor analysis of strategic academic leadership and high-tech economic growth. This refines the following research model:

$$\begin{cases} HTM = 9.8729 + 0.4664^{*}te + 0.0270^{*}gs + 0.1513^{*}tm + 0.0851^{*}kc, \\ QSR = 2.0917 + 0.4297^{*}te + 0.0216^{*}gs + 0.1461^{*}tm + 0.0925^{*}kc. \end{cases} \quad (2)$$

TABLE 1 Regression analysis of the dependence of high-tech manufacturing on university management factors in 2022.

Regression statistics						
Multiple *R*	0.5779					
Standard error	20.8720					
Observations	123					
Variance analysis						
	Df	**SS**	**MS**	***F***	**Significance of *F***	
Regression	4	25777.3903	6444.3476	14.7929	$8*10^{-10}$	
Residual	118	51405.4348	435.6393			
Total	122	77182.8250				
Parameters of the regression model						
	Coefficients	**Standardized error**	***t*-statistics**	***p*-value**	**Lower 95%**	**Upper 95%**
Constant	9.8729	3.5343	2.7934	0.0061	2.8739	16.8718
Tertiary enrolment	0.4664	0.0962	4.8455	$3.9*10^{-6}$	0.2758	0.6569
Graduates in science and engineering	0.0270	0.0287	0.9428	0.3477	−0.0298	0.0838
Tertiary inbound mobility	0.1513	0.0993	1.5243	0.1301	−0.0453	0.3479
Knowledge creation	0.0851	0.0248	3.4280	0.0008	0.0359	0.1342

Source: Authors.

TABLE 2 Regression analysis of QS university ranking, top 3, on university governance factors in 2022.

Regression statistics						
Multiple *R*	0.5299					
Standard error	23.0012					
Observations	123					
Variance analysis						
	Df	**SS**	**MS**	***F***	**Significance of *F***	
Regression	4	24379.5391	6094.8848	11.5203	$6.3*10^{-8}$	
Residual	118	62428.7728	529.0574			
Total	122	86808.3119				
Parameters of the regression model						
	Coefficients	**Standardized error**	***t*-statistics**	***p*-value**	**Lower 95%**	**Upper 95%**
Constant	2.0917	3.8949	0.5370	0.5923	−5.6213	9.8046
Tertiary enrolment	0.4297	0.1061	4.0514	$9.2*10^{-5}$	0.2197	0.6397
Graduates in science and engineering	0.0216	0.0316	0.6840	0.4953	−0.0410	0.0842
Tertiary inbound mobility	0.1461	0.1094	1.3358	0.1842	−0.0705	0.3628
Knowledge creation	0.0925	0.0273	3.3835	0.0010	0.0384	0.1467

Source: Authors.

To check the reliability of model (2), we turn to the detailed regression analysis results in Tables 1, 2.

According to the results from Table 1, the 57.79% change in high-tech manufacturing in 2022 is explained by changes in the values of university management factors, indicating a reasonably strong relationship between the studied indicators. Thus, with a one-point increase in tertiary enrolment, high-tech manufacturing increases by 0.4664 points. A one-point increase in science and engineering increases high-tech manufacturing by 0.0270 points. If tertiary inbound mobility increases by one point, high-tech manufacturing increases by 0.1513 points. A one-point increase in knowledge creation increases high-tech manufacturing by 0.0851 points.

According to the results in Table 2, the change in the QS university ranking, top 3, in 2022 by 52.99% is explained by changes in the values of university management factors, indicating a strong relationship between the employed indicators. If tertiary enrollment increases by one point, the QS university ranking point, top 3, increases by 0.4297 points. If graduates in science and engineering increase by one point, the QS university ranking, top 3, increases by 0.0216 points. If tertiary inbound mobility increases by one point, the QS university ranking,

top 3, increases by 0.1461 points. If knowledge creation increases by one point, the QS university ranking, top 3, increases by 0.0925 points.

In the function for high-tech manufacturing, the arithmetic mean of the regression coefficients for the factor variables that reflect the educational function of universities was (0.4664 + 0.0270 + 0.1513)/3 = 0.2149. The value exceeds the regression coefficient for the variable that reflects the technological function of universities (0.0851).

In the function for the QS university ranking, top 3, the arithmetic mean of the regression coefficients for the factor variables that reflect the educational function of universities was (0.4297 + 0.0216 + 0.1461)/3 = 0.1992. The value also exceeds the regression coefficient for the variable that reflects the technological function of universities (0.0925). Taken together, this confirms hypothesis H_1.

4.2. Recommendations for improving university management and benefits for strategic academic leadership and high-tech economic growth

The second task of this research is to examine the educational function of universities. We maximize the results of all three identified university governance areas within this function: a 223.17% increase in tertiary enrollment, a 107.06% increase in graduates in science and engineering, and a 552.21% increase in tertiary inbound mobility. This will open new prospects for higher education to strengthen its strategic academic leadership and accelerate high-tech economic growth through development (Figure 1).

As shown in Figure 1, our recommendations will increase high-tech manufacturing by 153.46% (from 30.25 points in 2022 to 76.66 points) and a 203.69% increase in the QS university ranking, top 3 (from 21.19 points in 2022 to 64.36 points). This confirms hypothesis H_2 and fits our recommendations in the Decade of Action. Suppose it is hard to maximize the results in all three areas of university management at once. In that case, it is advisable to focus on implementing the most significant area, tertiary enrollment (the regression coefficients are highest for it, at 0.4664 and 0.4297).

5. Discussion

This analysis addresses a literature gap at the interface between university governance and the Fourth Industrial Revolution. We argue that universities' educational functions are more important than the technological functions of neo-industrialization 4.0 (Table 3).

In contrast to Chen et al. (2022), Chen et al. (2022), Doan et al. (2022), Ma and Li (2022), and Polidoro et al. (2022), Table 3 shows that universities in neo-industrialization 4.0 are not the creation of new knowledge and technology, but the provision of educational services. Unlike Nawaz et al. (2020), Ruangpermpool et al. (2020), Gonzalez-Perez et al. (2021), Ismail et al. (2022), and Veltri et al. (2022), to ensure strategic academic leadership and high-tech economic growth higher education management must focus on the educational function.

To ensure strategic academic leadership and high-tech economic growth, management in higher education should focus on the most significant directions of university management for performing the

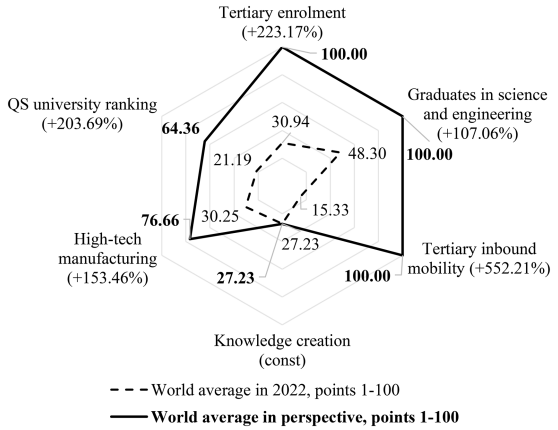

FIGURE 1
Prospects for strengthening strategic academic leadership and accelerating the pace of high-tech economic growth through the development of higher education.

TABLE 3 Comparative analysis of the obtained results with the existing literature in the context of the assigned RQs.

Research question (RQ)	Existing literature		New answer received
	Existing answer	References	
RQ_1: What is the role of universities in supporting the implementation of neo-industrialization 4.0?	Creation of new knowledge and technology (the technological function of universities is key)	Chen et al. (2022), Chen et al. (2022), Doan et al. (2022), Ma and Li (2022), Polidoro et al. (2022)	Provision of educational services (the key function of universities is an educational function)
RQ_2: How to manage higher education to ensure strategic academic leadership and high-tech economic growth?	Through the creation of new knowledge and technologies during the performance of the technical function by universities	Nawaz et al. (2020), Ruangpermpool et al. (2020), Gonzalez-Perez et al. (2021), Ismail et al. (2022), Veltri et al. (2022)	Through the implementation of the directions of university management for their performing the educational function: 1) Increase in mass accessibility of higher education; 2) Training of scientific and engineering & technical personnel by universities; Mobility in higher education.

Source: Authors.

educational function: an increase in mass accessibility of higher education, training of scientific and engineering & technical personnel by universities, and mobility in higher education.

The paper adds to the scientific knowledge of the increasingly rich literature on university management. It builds upon the analyzes of Alexander et al. (2022), Al-Tammemi et al. (2022), Hassan et al. (2022), Palmisano et al. (2022), Sanz and López-Iñesta (2022), and Suyadi et al. (2022) in raising mass accessibility of higher education. The paper also expands on Karpefors and van Riemsdijk (2020), Wasilah et al. (2021), Btoush (2022), and Leible and Ludzay (2022) in the sphere of training scientific and engineering & technical personnel by universities and the works of Burmann and Delius (2017), Grant (2018), Bobrytska et al. (2021), and Knight and Motala-Timol (2021) in the sphere of mobility in higher education.

The educational function of universities must be the subject of further examination. To assist neo-industrialization 4.0, the quality and availability of higher education services must enhance the educational function.

6. Conclusion

This article aims to find ways to make university management more efficient and implement SDGs 4 ("Quality education"), 8 ("Decent work and economic growth"), and 9 ("Industry, innovation, and infrastructure"). According to the findings of this article, neoindustrialization 4.0 must rely on a social and investment model of economic growth, in which higher education plays a key role. This new paradigm relies on universities because of their natural leadership in academics and high-tech economic growth. SDG 9 should be overseen by private businesses and the government, while SDG 4 should be focused on by universities. High-tech economic growth and easy access to higher education are recommended despite the association of the Fourth Industrial Revolution with automation. The quantitative benchmarks of university management should be refined in prospective studies.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

EP and BS jointly developed the idea of the article and its design. EP created a dataset, on the basis of which EP and BS conducted a study and jointly wrote an article. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1108527/full#supplementary-material

References

Alexander, P. A., Gans, N., and Maki, A. J. K. (2022). Relational reasoning in tertiary education: what is its value and how can it be assessed and trained? *Front. Educ.* 7:883370. doi: 10.3389/feduc.2022.883370

Alipanga, B., and Kohrt, B. A. (2022). Competency-based pre-service education for clinical psychology training in low-and middle-income countries: case study of Makerere University in Uganda. *Front. Psychol.* 13:924683. doi: 10.3389/fpsyg.2022.924683

Al-Tammemi, A. B., Nheili, R., Jibuaku, C. H., Al Tamimi, D., Aljaberi, M. A., Khatatbeh, M., et al. (2022). A qualitative exploration of university students' perspectives on distance education in Jordan: an application of Moore's theory of transactional distance. *Front. Educ.* 7:960660. doi: 10.3389/feduc.2022.960660

Andrades, J., Martinez-Martinez, D., and Larrán Jorge, M. (2021). Corporate governance disclosures by Spanish universities: how different variables can affect the level of such disclosures? *Meditari Account. Res.* 29, 86–109. doi: 10.1108/MEDAR-02-2020-0766

Bellantuono, L., Monaco, A., Amoroso, N., Aquaro, V., Bardoscia, M., Loiotile, A. D., et al. (2022). Territorial bias in university rankings: a complex network approach. *Sci. Rep.* 12:4995. doi: 10.1038/s41598-022-08859-w

Bobrytska, V. I., Luzik, E. V., Skyrda, T. S., Tereminko, L. H., and Hurska, O. O. (2021). Fostering tertiary student professional mobility skills via convergence of the professional training and foreign language learning. *Eur. J. Educ. Res.* 10, 1919–1936. doi: 10.12973/EU-JER.10.4.1919

Btoush, M. H. (2022). Online courses quality and distance education amid COVID-19 pandemic: Al-Balqa applied university-IT faculty students' perceptions. *Int. J. Knowl. Learn.* 15, 1–15. doi: 10.1504/IJKL.2022.119913

Burmann, M., and Delius, A. (2017) Student mobility in tertiary education. *CESifo DICE Report*. 15: 48–50. Available at: https://www.ifo.de/DocDL/dice-report-2017-3-burmann-delius-october.pdf (Accessed November 22, 2022).

Chen, H., Song, X., Jin, Q., and Wang, X. (2022). Network dynamics in university-industry collaboration: a collaboration-knowledge dual-layer network perspective. *Scientometrics* 127, 6637–6660. doi: 10.1007/s11192-022-04330-9

Chen, Y., Xu, Y., and Zhai, Q. (2022). Networking of corporate universities in knowledge management: evidence from China. *Manag. Decis.* 60, 3147–3164. doi: 10.1108/MD-05-2021-0679

Doan, D. A., Ho, H. H., Tran, L. D., Nguyen, P. L., Le, A. T. L., and Dinh, D. X. (2022). Knowledge, attitudes, and practices of university students regarding COVID-19: a cross-sectional study in Vietnam. *BMC Public Health* 22:2016. doi: 10.1186/s12889-022-14442-9

Elbawab, R. (2022). University rankings and goals: a cluster analysis. *Economies* 10:209. doi: 10.3390/economies10090209

Gil, P. M., Afonso, O., and Brito, P. (2019). Economic growth, the high-tech sector, and the high skilled: theory and quantitative implications. *Struct. Chang. Econ. Dyn.* 51, 89–105. doi: 10.1016/j.strueco.2019.07.003

Gonzalez-Perez, M. A., Cordova, M., Hermans, M., Nava-Aguirre, K. M., Monje-Cueto, F., Mingo, S., et al. (2021). Crises conducting stakeholder salience: shifts in the evolution of private universities' governance in Latin America. *Corp. Gov.* 21, 1194–1214. doi: 10.1108/CG-09-2020-0397

Grant, C. (2018). Developing global citizenship in tertiary performing arts students through short-term mobility programs. *Int. J. Educ. Arts.* 19, 1–25. doi: 10.18113/P8ijea1915

Hassan, J., Devi, A., and Ray, B. (2022). Virtual laboratories in tertiary education: case study analysis by learning theories. *Educ. Sci.* 12:554. doi: 10.3390/educsci12080554

Ismail, M. D., Abdullah, I. H., and Hassan, M. S. (2022). Which governance mechanism influences the relationship between motivation and performance? An investigation on university and industry collaboration in Malaysia. *J. Appl. Res. High. Educ.* 14, 1160–1174. doi: 10.1108/JARHE-02-2021-0060

Jahanmehr, N., Rashidian, A., Farzadfar, F., Khosravi, A., Shariati, M., Akbari Sari, A., et al. (2022). Ranking universities of medical sciences as public health services provider institutions in Iran: a result-chain analysis. *Arch. Iran. Med.* 25, 214–223. doi: 10.34172/aim.2022.37

Kaidesoja, T. (2022). A theoretical framework for explaining the paradox of university rankings. *Soc. Sci. Inf.* 61, 128–153. doi: 10.1177/05390184221079470

Karpefors, M., and van Riemsdijk, M. (2020). 'We are not free here…'–Palestinian IT students' (im)mobile transition from university to employment or further education. *J. Educ. Work.* 33, 19–32. doi: 10.1080/13639080.2019.1704705

Kim, S. S.-A., and Lee, Y.-M. (2021). Vocational education and training for older workers in aged countries: A comparative study of Korea, Spain, and the UK. *Int. J. Trade Glob. Mark.* 14, 107–114. doi: 10.1504/IJTGM.2021.114059

Knight, J., and Motala-Timol, S. (2021). Tertiary education in Mauritius: increasing access through international program and provider mobility. *J. Stud. Int. Educ.* 25, 207–227. doi: 10.1177/1028315320932321

Krassadaki, E., Tsafarakis, S., Kapenis, V., and Matsatsinis, N. (2022). The use of ICT during lockdown in higher education and the effects on university instructors. *Heliyon* 8:e11214. doi: 10.1016/j.heliyon.2022.e11214

Leible, S., and Ludzay, M. (2022) A snapshot of essential IT-related challenges of universities: a literature analysis. In D. Demmler, D. Krupka and H. Federrath (eds.) Proceedings of the INFORMATIK 2022 (pp. 1365–1377). Bonn, Germany: German Informatics Society.

Ma, Y., and Li, B. (2022). Effect of digitalization on knowledge transfer from universities to enterprises: evidence from postdoctoral workstation of Chinese enterprises. *Technol. Soc.* 71:102102. doi: 10.1016/j.techsoc.2022.102102

Maxyutova, A., Kaliyeva, S., Rakhmetova, R., Meldakhanova, M., and Khajiyeva, G. (2022). Socio-economic factors in labour market regulation. *Migrat. Lett.* 19, 561–570. doi: 10.33182/ml.v19i6.2375

Muktiyanto, A., Hermawan, A. A., and Hadiwidjaja, R. D. (2020). The role of management control systems in the performance of higher education through good university governance. *Int. J. Trade Glob. Mark.* 13, 288–310. doi: 10.1504/IJTGM.2020.108777

Muljono, W., and Setiyawati, S. (2022). Digital economy: the main power for digital industry in Indonesia. *Int. J. Trade Glob. Mark.* 15, 423–444. doi: 10.1504/ijtgm.2022.125908

Nawaz, N., Durst, S., Hariharasudan, A., and Shamugia, Z. (2020). Knowledge management practices in higher education institutions-a comparative study. *Pol. J. Manag. Stud.* 22, 291–308. doi: 10.17512/pjms.2020.22.2.20

Nunfam, V. F., Adjei, N. A. K., Adam, H., and Eshun, J. F. (2022). Industrial attachment and human capital of higher education students: constraints of Ghanaian technical universities. *Educ. Train.* 64, 737–753. doi: 10.1108/ET-06-2021-0241

Palmisano, F., Biagi, F., and Peragine, V. (2022). Inequality of opportunity in tertiary education: evidence from Europe. *Res. High. Educ.* 63, 514–565. doi: 10.1007/s11162-021-09658-4

Phiri, M. J., and Tough, A. G. (2018). Managing university records in the world of governance. *Rec. Manag. J.* 28, 47–61. doi: 10.1108/RMJ-11-2016-0042

Polidoro, F., Lampert, C. M., and Kim, M. (2022). External knowledge sourcing, knowledge spillovers, and internal collaboration: the effects of intrafirm linkages on firm-university co-authorship linkages. *Strateg. Manag. J.* 43, 2742–2776. doi: 10.1002/smj.3412

Popkova, E. G. (2022) The contribution of education to strategic academic leadership and high-tech economic growth. *Mendeley Data, V2*. doi: 10.17632/7hngdknfjr.2

Ruangpermpool, S., Igel, B., and Siengthai, S. (2020). Trust and dynamic governance mechanisms in the university-industry R&D alliances. *J. Sci. Technol. Policy Manag* 11, 171–192. doi: 10.1108/JSTPM-02-2019-0018

Saiti, A., Abbott, I., and Middlewood, D. (2018). University governance: insights from England and Greece. *Int. J. Educ. Manag.* 32, 448–462. doi: 10.1108/IJEM-05-2016-0091

Sanz, M. T., and López-Iñesta, E. (2022). Impact of extracurricular factors on the academic performance of university students during the COVID-19 pandemic. *Front. Educ.* 7:991276. doi: 10.3389/feduc.2022.991276

Scott, T., Walsh, A., Anderson, B., O'Connor, A., and Tassey, G. (2021). High-tech infrastructure and economic growth: the materials genome initiative. *Sci. Public Policy* 48, 649–661. doi: 10.1093/scipol/scab042

Sergi, B. S., and Popkova, E. G. (2022). Towards a 'wide' role for venture capital in OECD countries' industry 4.0. *Heliyon* 8:e08700. doi: 10.1016/j.heliyon.2021.e08700

Siri, A., Leone, C., and Bencivenga, R. (2022). Equality, diversity, and inclusion strategies adopted in a European university Alliance to facilitate the higher education-to-work transition. *Societies* 12:140. doi: 10.3390/soc12050140

Suyadi, , Asmorojati, A. W., Yudhana, A., Nuryana, Z., and Binti Siraj, S. (2022). COVID-19 ambassadors: recognizing Kampus Mengajar at the Merdeka Belajar Kampus Merdeka program humanitarian projects in the tertiary education curriculum. *Front. Educ.* 7:902343. doi: 10.3389/feduc.2022.902343

Turginbayeva, A., Smagulova, G., Ashirbekova, L., and Malikova, R. (2018) Topical issues of management in modern education and ways to solve them. In Proceedings of the IBIMA 2018: 32nd International Business Information Management Association Conference – Vision 2020: Sustainable economic development and application of innovation management from regional expansion to global growth (pp. 3643–3647). Seville, Spain.

Véliz, D., and Marshall, P. (2022). Influence of global rankings on strategic planning from the perspective of decision-makers: a case study of a Chilean research university. *High. Educ. Q.* 76, 638–652. doi: 10.1111/hequ.12333

Veltri, S., Puntillo, P., and Pierri, F. (2022). Investigating the association between universities' corporate governance structure and the knowledge transfer performance outcomes. *Eur. J. Innov. Manag.* 25, 1154–1179. doi: 10.1108/EJIM-01-2022-0003

Wang, Z., Yang, Y., and Wei, Y. (2022). Has the construction of national high-tech zones promoted regional economic growth?—empirical research from prefecture-level cities in China. *Sustainability* 14:6349. doi: 10.3390/su14106349

Wasilah, , Nugroho, L. E., Santosa, P. I., and Sorour, S. E. (2021). Study on the influencing factors of the flexibility of university IT management in education 4.0. *Int. J. Innov. Learn.* 30, 132–153. doi: 10.1504/IJIL.2021.117219

WIPO (2022) *Global innovation index 2022 (15th ed): What is the future of innovation driven growth?*. Available at: https://www.wipo.int/publications/en/details.jsp?id=4622 (Accessed November 22, 2022).

Wolhuter, C. C. (2022). The sustainable development goals as criteria for the global ranking of universities. *Perspect. Educ.* 40, 1–13. doi: 10.18820/2519593X/pie.v40.i3.1

Yu, S., and Wang, D. (2022). Quantitative SWOT analysis on factors influencing the sustainable development of non-academic education in China's open universities: a case study of Beijing Open University. *Sustainability* 14:13016. doi: 10.3390/su142013016

Yusriana, Y., Alamanda, D. T., and Remi, S. S. (2021). The profile of Indonesian workers: How education influences their welfare status. *Int. J. Trade Glob. Mark.* 14, 125–133. doi: 10.1504/IJTGM.2021.114078

Zarea, H., Esmaeelzadeh, I., Jafariyeh, H. S., Buitek, E., and Aliei, M. (2021). Knowledge commercialization framework: factors affecting developing countries. *AD-minister* 39, 217–236. doi: 10.17230/Ad-minister.39.10