GRADUATE CAREER TRACKING SYSTEMS OF HIGHER EDUCATION INSTITUTIONS – A SYSTEMATIC LITERATURE REVIEW

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Purpose: The aim of the present paper is twofold: firstly, to provide a review of the extant research on systems used by higher education institutions to monitor the professional careers of their graduates, and, secondly, to identify gaps in the current body of knowledge in this field.

Design/methodology/approach: The study employed the systematic review methodology. It consists of a review of thirty-one refereed articles on graduate career tracking systems derived from the Scopus database.

Findings: Four predominant areas of research have been recognized: (1) a rising trend in the computerization of graduate tracking systems, (2) a common use of surveys, (3) a gradual progression towards centralized systems, and (4) a growing prevalence of hybrid systems. The main finding of the research is that a comprehensive system for monitoring graduate employability is still to be established. However, it is important to acknowledge the development of effective systems for tracking graduates in the medical field.

Research limitations/implications: The scope of the study was limited by the parameters of the selected Scopus database and the predefined search criteria.

Practical implications: The findings may prove useful in the development of graduate career tracking systems in higher education institutions worldwide.

Social implications: Acquiring insightful feedback on educational outcomes can help higher education institutions better organize their studies, update their curricula, and modernize their teaching strategies in order to successfully meet the rapidly shifting demands of society.

Originality/value: The study has contributed to the expanding corpus of knowledge on graduate employability and proposed venues for future research. It has presented an array of graduate career tracking tools that are being used and can be benchmarked, as well as signaled the main challenges connected with their implementation.

Keywords: higher education; graduate career tracking system; employability; systematic literature review; Scopus.

Category of the paper: Literature review.

1. Introduction

Since their medieval beginnings, higher education institutions have played many important societal roles. As Sporn and Godonoga (2024) noticed, they "have responded to various societal demands, from reproducing religious administrators and educating elites to manage trade, to developing economically useful knowledge and supporting democracy" (Sporn. Godonoga, 2024, p. 1). Their missions and organization of studies have been subject to changes, following the changes in their environments. Thus, in the Medieval Ages, the first European universities – Bologna and Paris – concentrated on the preservation and teaching of the existing knowledge, with the focus on the art of conducting theoretical disputes in Latin. In contrast, in the 19th-century preindustrial German states, at the University of Berlin, original research became academicians' main point of interest, later integrated with classroom teaching at Humboldtian German universities. And in the second half of the 19th century, American universities developed the idea of the "public service mission", i.e., service to the public of the nation-state being one of the main tasks of higher education institutions. It was understood as providing useful knowledge and academic research to society. One of the consequences of adopting this mission was the establishment of a new type of universities and colleges, namely institutions that specialized in teaching agricultural engineering and mechanics (e.g., Massachusetts Institute of Technology) rather than conducting basic research (Matusiak, 2010; Scott, 2006). Thus, one can conclude that throughout the ages, higher education institutions have gradually shifted the focus from being purely "temples of knowledge" to becoming active partners for government, business, and industry.

Nowadays, the tasks of higher education institutions are even more complex, and the societal demands they are supposed to meet are on the increase. As defined by UNESCO (United Nations Educational, Scientific and Cultural Organization), higher education "is a rich cultural and scientific asset which enables personal development and promotes economic, technological and social change. It promotes the exchange of knowledge, research, and innovation, and equips students with the skills needed to meet ever changing labor markets. For students in vulnerable circumstances, it is a passport to economic security and a stable future" (UNESCO, 2025). An important conclusion that can be drawn from the above definition is that one of the main concerns of higher education institutions is the employability of their graduates. In other words, academic decision-makers should organize their educational offer to effectively equip students with the knowledge and skills useful in their future careers, and later obtain reliable and constructive feedback about the real value of their educational outcomes.

These are not easy tasks. First, because the very concept of employability, especially in the context of higher education, has been a much-debated question, and the consensus is far from being reached. Bridgstock and Jackson (2019) identified three main strategic approaches to defining and measuring employability by higher education institutions: (a) short-term graduate

employment outcomes, (b) readiness to enter a profession through professionally accredited degree pathways, and (c) living and working productively and meaningfully across the lifespan. Each of them has its advantages and disadvantages. The first "employability aim" is the most popular one and concentrates on measuring "tangible" key performance indicators for graduate employability, such as the percentages of graduates obtaining full-time jobs and their salary levels, a few months after course completion. It does not, however, take into consideration the information concerning other types of employment, such as project-based or entrepreneurial ways of working, or the long-term professional progress. The second one is based on organizing studies to meet the requirements of external accreditation bodies. This approach is mandatory in "regulated" professions where public safety needs to be ensured, such as medicine; it may also apply to some "non-regulated" professions, e.g., accountancy. Its main advantage is providing the quality and safety ensured by professional standardization, and the main disadvantage consists of lowering the flexibility of the curricula to meet the external standards, and educating students in very narrow specializations, which may limit their future career options. Finally, the third approach is the broadest in meaning, and at the same time, the most difficult to define precisely. Here, employability is „the capacity to employ or use one's capabilities in ways that are personally meaningful and appropriate, and contribute to the contexts with which the graduate interacts" (Bridgstock, Jackson, 2019, p. 474). This approach takes into account the possibility that graduates may have, e.g., other personal goals and needs than merely obtaining a well-paid job soon upon graduation; for some, the priority may be to balance work and non-work activity, and others decide to study just for the sake of learning new knowledge. If one adopts this "employability aim", measuring educational outcomes will be demanding.

The second challenge for academic decision-makers connected with the employability issue is more technical and concerns the establishment and use of ways of obtaining and processing information on the professional fates of graduates. Regardless of which of the strategic employability aims a higher education institution has decided to focus on, it should be able to find out whether it has achieved this aim. And it seems that, though the – much disputed - topic of defining graduate employability has been quite extensively researched, there is still uncertainty about whether higher education institutions have managed to build effective, procedure-based systems of collecting and processing feedback on their educational outcomes, as many researchers point out a phenomenon of competency gap among graduates and lack of working communication channels between the business and academic worlds (Suleman et al., 2021; Arranz et al., 2022; Mohd Noor et al., 2024; Scandurra et al., 2024). This indicates a clear research gap, as little is known about the actual efficiency, scope, and institutionalization of graduate career tracking systems, as well as the challenges higher education institutions face when attempting to assess the long-term value of their educational outcomes.

Therefore, the main objectives of this study are to examine the current state of knowledge on the types of graduate employability tracking methods higher education institutions use now, as well as problems and challenges they encounter during attempts to assess the real value of their educational outcomes. And it is worth emphasizing that acquiring insightful feedback on educational outcomes can significantly help higher education institutions better organize their studies, update their curricula, and modernize their teaching strategies in order to meet the rapidly shifting demands of society successfully. Therefore, the findings of the study should be of interest to both academic decision-makers, as they can help them develop efficient graduate employability tracking systems in their institutions, and researchers, who will be provided with the information on gaps within the research area and directions for future studies. To the best of current knowledge, this appears to be the first review consolidating research objectives, methodologies, and findings in this category into a structured overview.

2. Methods

The authors decided to use the qualitative Systematic Literature Review (SLR) method to analyze the current state-of-the-art knowledge and to identify the gaps in the field of systems of monitoring the employability of graduates of higher education institutions. The SLR method was chosen as it is more formal, rigorous, reproducible, and focused than a standard literature review, whose aim is to provide context for a new piece of research rather than to find specific answers to a 'clinical question' (Tranfield et al., 2003; Carrera-Rivera et al., 2022). Examples of some prominent areas where SLR is commonly utilized include healthcare (e.g., Ungaro et al., 2024), education (e.g., Schildkamp et al., 2020), engineering (e.g., Dasaklis et al., 2022), as well as environmental and agricultural sciences (e.g., Datta et al., 2024).

The authors adopted the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure a transparent, structured, and replicable review process. This approach was chosen to clearly document the identification, screening, eligibility, and inclusion stages of the literature selection, allowing readers to understand how the final set of studies was determined and to enhance the methodological rigor of the systematic literature review.

The SLR began with the formulation of three research questions (RQ), which the authors intended to answer in the course of the review:

- RQ1: Which graduate career tracking systems topics are currently well-researched, and which are not?
- RQ2: Which research methods were used in the studies on graduate tracking systems?
- RQ3: What are the main findings concerning the graduate tracking systems?

The three RQs outlined in the SLR were designed to provide a comprehensive, structured understanding of the current state of research on graduate career tracking systems, with both academic and practical relevance. By asking which topics are well-researched and which remain underexplored (RQ1), the authors aimed to identify areas of strength and gaps within the existing body of knowledge. This is particularly important for guiding future academic inquiry and ensuring that institutional and policy-level decisions are grounded in a well-mapped evidence base.

The second question (RQ2), which examines the research methods employed in the reviewed studies, allows for a critical evaluation of how the field is being studied. Understanding the methodological approaches provides insight into the robustness and diversity of existing research and helps identify potential limitations, such as overreliance on specific methods or lack of longitudinal data.
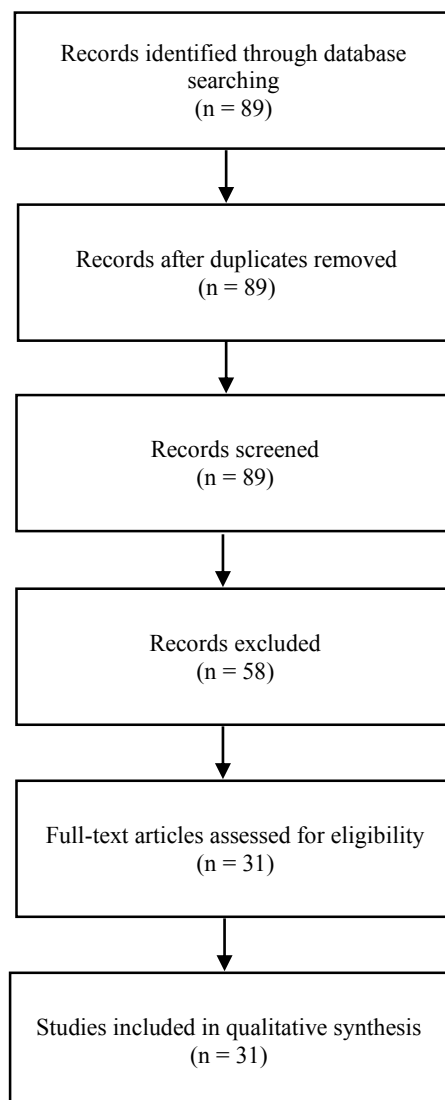
The third question (RQ3) seeks to synthesize the main findings of the literature, offering a clear picture of what is currently known about graduate career tracking systems. This is particularly valuable for higher education institution managers and public policymakers, who can use these findings to inform the development of tracking mechanisms, improve employability strategies, and align educational offerings with labor market needs.

Together, these questions ensure that the review is not only academically rigorous but also practically useful. They reflect a commitment to bridging research with real-world application, offering insights that can enhance institutional decision-making, policy design, and strategic planning in higher education and beyond.

The authors decided to use the Scopus database for the search. The selection of Scopus as the primary repository for this study was largely influenced by its ease of access and comprehensive coverage. In the current landscape of scientific research, online databases have become the dominant means of acquiring scholarly information. Scopus, in particular, encompasses a significant number of high-impact publications pertinent to the research topic. Additionally, Scopus offers a robust and extensive collection of abstracts, making it a favored choice among scholars conducting SLRs, who often cite its reliability and breadth (e.g., Lim et al., 2022).

The data search was carried out on 26 October 2024. The document type was limited to articles, conference papers, book chapters, and the English language within the time limit of the last decade (2014-2024), as in 2014, Pavlin and Svetlik (2014) signaled a lack of efficient graduate employability monitoring systems search was conducted within: Article title, Abstract, Keywords, and the search terms were formulated as: (('monitoring' OR 'tracking') AND ('employability' OR 'career') AND 'graduate'). Then the authors conducted a supplementary search focused on: (TITLE-ABS-KEY ('graduate' AND 'career' AND 'tracking' AND 'system' AND 'higher' AND 'education') and combined it with the first string. Altogether, they obtained eighty-nine papers, and after scrutiny, they decided to progress thirty-one for further study. The authors determined to study each paper that contained information relevant to the

research questions, even if the issue of graduate employability tracking systems was not specified as the main subject matter of the paper. The articles that were excluded were irrelevant to the main topic of the study or were not written in English. Figure 1 presents the PRISMA diagram used in the study.

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┌─────────────────────────────────┐
│ Records identified through database │
│            searching            │
│            (n = 89)             │
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│  Records after duplicates removed │
│            (n = 89)             │
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│        Records screened         │
│            (n = 89)             │
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│        Records excluded         │
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│ Full-text articles assessed for eligibility │
│            (n = 31)             │
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┌─────────────────────────────────┐
│ Studies included in qualitative synthesis │
│            (n = 31)             │
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Figure 1. PRISMA diagram of the study.
Source: Own elaboration.

The detailed description of the database selection, search strings, inclusion and exclusion criteria, and PRISMA flow diagram ensures that the process is transparent and replicable. This allows other researchers to reproduce the review or to update it in the future with new studies.

3. Results

The following section presents the main results of the systematic review. The findings are focused on the distribution of studies by type, subject area, and publication form, as well as the qualitative synthesis of their content.

Most of the papers were articles (23) conference papers (6), published mainly within the subject areas of: social sciences (21), computer science (8), business, management and accounting (5), engineering (4), decision sciences (3), health professions (3), mathematics (3), or medicine (3). Only two publications were prepared in the form of book chapters. It is worth noting that these publications were interdisciplinary and represented more than one field of study, which is why their total does not add up to 31.

The qualitative results of the analysis are summarized in Table 1 and discussed in the next chapter.

Table 1.
Literature on Graduate Career Tracking Systems.

Category: Central systems				
Author(s), publication year	**Journal/Conference**	**Research objective(s)**	**Methodology**	**Main contributions/ Findings on graduate career tracking systems (GCTS)**
Kosztyán et al., 2021* * The article contains information also from the IT-supported tools category.	Applied Network Science	To present how to measure the role of higher education institutions in the spatial mobility of their graduates by combining economic and network models.	A statistical analysis of information obtained from the countrywide employability tracking system (HCSTGC) and Central Statistical Office in Hungary, an anonymized student application database, and Eurostat.	There is a possibility to use combined data-driven gravity-like economic models and a mobility network model in measuring graduate employability.
Pavlin, 2019	European Journal of Education	To analyze the current reality of tracking graduates' employability in Europe and to discuss the issues of developing graduate career monitoring system(s), with a focus on Slovenia.	Literature review	A national graduate employability monitoring system should be capable of obtaining and processing data from administrative records and from surveys completed by graduates and employers, taking into consideration possible disciplinary particularities.
Zając et al., 2018	Polish Sociological Review	To analyze the differences in labor outcomes between graduates from public and non-public higher education institutions.	A thorough analysis of data derived from ELA - The Polish Graduate Tracking System.	The Polish Graduate Tracking System should be developed by comprising data from other resources, such as higher education institutions' internal databases which collect data on graduates' study successes. Linking data from a number of registers in Poland should be an easy task, as all those registers use the citizens' unique PESEL (personal identity number) numbers as identifiers.

Cont. table 1.

Pavlin & Svetlik, 2014	International Journal of Manpower	To present an overview of the employability of graduates of European higher education institutions from a global perspective.	Literature review.	With a few exceptions, European higher education institutions have neither built comprehensive graduate employability tracking systems nor are willing to use the information from occasionally conducted surveys to change their curricula.
Category: IT-supported tools				
Author(s), publication year	**Journal/Conference**	**Research objective(s)**	**Methodology**	**Main contributions/ Findings on graduate career tracking systems (GCTS)**
Gonzales et al., 2024	2024 IEEE 15th Control and System Graduate Research Colloquium (ICSGRC).	To create a graduate tracker monitoring platform.	Decision Support System and mapping recommendation analysis using a rule-based algorithm to evaluate the results of alumni program evaluation on five areas: curriculum, faculty, facility, laboratory, and student services.	A prototype of a Graduate Tracer Monitoring Platform with Decision Support Feature and Mapping Recommendation Analysis using a Rule-Based Algorithm that would provide Alumni Registration, Employment Records, Program Evaluation, Job-Matching, Tracer, Report Generation, and Content Management System.
Hristova et al., 2023	2023 4th International Conference on Communications, Information, Electronic and Energy Systems (CIEES), Plovdiv, Bulgaria, 2023.	To present a concept of a blockchain tool designed for collecting and processing data on technical competencies gained during both studies and work experience.	Presentation of a blockchain technology model.	There is a possibility to use an automated blockchain instrument for tracking and sharing data on competencies (certificates) earned during both academic training and professional career) – all eligible stakeholders, including employers and universities, could have access to the data inserted.
Sanusi et al., 2023	2023 6th International Conference on Applied Computational Intelligence in Information Systems: Intelligent and Resilient Digital Innovations for Sustainable Living, ACIIS 2023 – Proceedings	To examine the academic and professional progress of graduates at a university in Malaysia.	A mixture of data analysis techniques visualized with a Power BI Dashboard and used to foresee future educational and professional career steps of graduates.	Data analysis techniques and machine learning algorithms may be of assistance in gaining insights into predicting graduate employability.
Pico-Saltos et al., 2021	Sustainability.	To define objective and subjective graduate career success factors.	A statistical analysis of a graduate survey, followed by the development and validation of a graduate career success prediction model built with the use of Waikato Environment for Knowledge Analysis (WEKA).	A survey-based, mathematically validated career success measuring instrument has been proposed.

Cont. table 1.

Scandurra et al., 2024* * The article contains information also from the Constructing, collecting, and analyzing surveys category.	Studies in Higher Education.	To examine the current body of knowledge on employability activities in HEIs aimed at facilitating graduate employability.	Systematic review.	Higher education institutions should conduct more empirical research on their graduates' employability instead of focusing only on the projected benefits of their Work-Related Learning programs.
Tecilazić et al., 2024* * The article also contains information from the Constructing, collecting, and analyzing surveys category.	Education Sciences.	To examine the influence of approaches to learning on career readiness and social/entrepreneurial skills of graduates in Austria, Croatia, Czechia, Lithuania, Malta, and Norway.	A pilot graduate survey launched by the European Commission.	Further studies are required to analyze the characteristic features of higher education systems and the cultural aspects of learning and teaching in various countries.
Courtial, Garrouste, 2014	Proceedings of the 19th World Congress The International Federation of Automatic Control Cape Town, South Africa. August 24-29, 2014	To equip universities in France with an instrument capable of matching their graduates' competencies with the European labor market demand, focusing on Earth Sciences.	Building a new model of forecasting graduate employability – a combination of predictive control and econometric models.	There is a possibility to use a sophisticated computer-assisted model to predict and measure the employability of graduates.

Articles that contain information from the IT-supported tools category that have been presented in another category: Kosztyán et al., 2021 (the Central systems category).

Categories: **Countrywide and cross-national surveys and surveys of individual higher education institutions**   **Constructing, collecting, and analyzing surveys***   ***The articles in the two categories have been grouped as a vast majority of them overlap and contain valuable information concerning both topics.**

Author(s), publication Year	**Journal/Conference**	**Research objective(s)**	**Methodology**	**Main contributions/ Findings on graduate career tracking systems (GCTS)**
Tseng et al., 2024* * The article also contains information from the Personal Data Protection Category.	Studies in Higher Education.	To analyze the impact of long-term interdisciplinary learning on graduates' employability in Taiwan.	Analysis of data from National Tsing Hua University in Taiwan (NTHU) administrative records, graduate surveys and employability data obtained from the Ministry of Education in Taiwan.	There has been proposed a model that integrates internal administrative data of a higher education institution with the information from the (high response) Graduation Survey and employability data obtained from the Ministry of Education.
Mohd Noor et al., 2024	International Journal of Evaluation and Research in Education.	To diagnose personal and technical competencies important for employability in the Malaysian electrical and electronic industry.	Statistical analysis (t-test) on an online structured questionnaire survey completed by representatives of higher education institutions and the industry.	There has been presented a description of the authors' own survey on graduates' soft and hard skills.

Cont. table 1.

Connell et al., 2023	BMC Medical Education.	To evaluate the impact of participant non-response rates on career tracking studies of medical school graduates in New Zealand.	A statistical analysis of demographic variables of medical graduates in New Zealand.	There are significant differences in response rates and representativeness of survey results depending on the type of survey – (highly representative) entry and exit surveys versus (under-representative) post-graduation survey.
Reinhardt et al., 2023	Journal of Dental Education.	To analyze demographic data of dentistry graduates of a university in Nebraska and factors that influenced their rural or urban practice site choices in a 10-year long span.	A statistical analysis of data obtained from a survey conducted by the Health's Health Professions Tracking Service (HPTS) and the internal data of the dentistry college.	The data obtained annually by the survey is verified and updated by HPTS, which acquires and processes information from state licensure and Postal Service records, the media, and obituaries. In case of questions about practice locations, HPTS contacts the practices directly.
Acero et al., 2023	Proceedings of the 7th Brazilian Technology Symposium (BTSym'21). BTSym 2021. Smart Innovation, Systems and Technologies.	To analyze the graduate employability tracking programs developed by higher education institutions in Peru.	A statistical analysis of data on graduate monitoring and labor insertion programs.	Higher education institutions should have and regularly update databases of their students and graduates – they would serve as an essential tool for graduate employability tracking.
Comunian et al., 2023	Arts and Humanities in Higher Education.	To analyze the employability of graduates of Arts & Humanities in comparison to graduates of other fields of study in Europe.	An analysis of the pilot Eurograduate survey conducted in 2018.	The response rate of the pilot European Graduate Study conducted in eight countries and sent to over sixteen thousand graduates was only 12 per cent.
Jackson, Li, 2022	International Journal of Manpower.	To analyze how factors determining graduate employability change over time.	A statistical analysis of data on over forty thousand graduates of Australian universities surveyed twice - after 4 months and then after 3 years following their graduation.	Graduate Employability Tracking systems should also analyze longer-term outcomes.
Pico-Saltos et al., 2022	Applied Sciences.	To develop a graduate career success prediction model.	A statistical analysis of a graduate survey followed by the development and validation of a graduate career success prediction model based on a genetic algorithm.	The graduate employability monitoring system should measure objective and subjective success factors and take into consideration the business environment. HEIs should also try to establish and foster both formal and informal communication with professionals.
Arranz et al., 2022	Studies in Higher Education.	To analyze the impact of the university-business cooperation on the employability of students.	A statistical analysis of the information obtained from a telephone survey organized by the European Commission in thirty-one countries, which collected responses from over seven thousand companies.	Enterprises with a higher degree of satisfaction with the employability of graduates develop a wide array of cooperation channels with higher education institutions, especially internship programs.

Cont. table 1.

Hynninen et al., 2022	UKICER '22: Proceedings of the 2022 Conference on United Kingdom & Ireland Computing Education Research.	To analyze recommendations obtained from graduates concerning key skills and competencies needed in the information technology industry.	A statistical analysis of a countrywide graduate survey completed five years after graduation.	Information obtained from employability tracking surveys on recent graduates can be a valuable indicator of the efficacy of the educational program in preparing graduates for the industry.
Sutton et al., 2021	Rural and Remote Health.	To research the practice intentions of graduates of nursing and allied health fields of study in Australia.	An analysis of the Nursing and Allied Health Graduate Outcomes Tracking (NAHGOT) study.	The graduate employability tracking model should combine many variables, such as demographics, educational and professional accomplishments as well as changes in career and life priorities.
Zhang et al., 2021	BMC Medical Education.	To research the quality of clinical training of recent MD graduates in China.	Analysis of a graduate online survey.	Respondents received financial remuneration for completing the survey.
Gatt et.al., 2021	Teaching and Learning: Symposium.	To analyze the employability of graduates of the political science field of study in Austria.	Analysis of data obtained from the Graduate Monitoring system and interviews with university graduates.	Scholars (of political science) tend to assess the importance and value of studies only from the academic point of view and lack empirical evidence and information on the influence of learning outcomes on the professional careers of their graduates.
Balogh, Sipos, 2020	International Journal of Educational Management.	To analyze possible differences in employability between graduates who did and did not change their field of study while making the second-degree study choices, focusing on Hungarian HEIs.	Analysis of employability data of three groups: generalists, specialists, and field changers. The data was taken from the Hungarian central systems and an individual higher education institution' internal administrative records.	One can obtain valuable data on graduates' salaries (correlated to such variables as the degrees obtained) from countrywide sources such as the Graduate Career Tracking System and the higher education institution specific Integrated Administrative Databases.
Jackson, Bridgstock, 2018	Higher Education Research & Development.	To summarize and critique ways of measuring graduate employability.	A literature review critical analysis of tools of tracking and measuring graduate employability (with the focus on graduate tracking surveys, specifically in Australia).	There is a need for a more nuanced approach to measuring employability outcomes that would take into account other factors apart from (overeliant) full-time employment figures, such as socio-cultural and economic values.
Larkins et al., 2018	BMC Medical Education.	To analyze correlations between various demographic variables and the practice choices of entry and exit groups of students at medical schools.	A statistical analysis of a survey-based study conducted in six countries.	The graduate employability study is based on a series of surveys conducted first at the beginning of medical studies and then a few times after graduation.
Burnasheva et. al., 2016	2016 IEEE V Forum Strategic Partnership of Universities and Enterprises of Hi-Tech Branches (Science. Education. Innovations).	To discuss existing solutions used in graduate employability tracking and present a new efficient model that can be used by universities in Russia.	An analysis of data from the ministerial databases, especially from the Pension Fund and the data obtained from the higher education institution' internal graduate survey.	The central graduate employability tracking system based on data from the Pension Fund is the most objective, but its main disadvantage is a significant time lag in providing the data to other stakeholders.

Cont. table 1.

Woolley et al., 2015	Rural and Remote Health.	To evaluate the performance of regional medical schools in Australia.	An analysis of a medical school graduate tracking system in Australia.	An efficient graduate tracking system consists of exit surveys, a Facebook page that can be used to access graduates more efficiently than by email, and data from the website of the National Health Practitioner Regulation Agency.
Weller et al., 2015	Journal of Food Science Education.	To assess the effectiveness of studies conducted at a university in the United States in the field of food science.	An analysis of an online alumni survey and companies' websites.	The comprehensive graduate employability analysis comprised data obtained from alumni surveys, their employers' websites, and the university's internal records.
Articles that contain information from the Constructing, collecting, and analyzing surveys category that have been presented in another category: Scandurra et al., 2024, Tecilazić et al., 2024 (the IT-supported systems category).				
Category: Personal Data Protection				
Author(s), publication year	**Journal/Conference**	**Research objective(s)**	**Methodology**	**Main contributions/ Findings on graduate career tracking systems (GCTS)**
Proteasa, Vertes-Olteanu, 2022	In: Curaj, A., Salmi, J., Hâj, C.M. (eds) Higher Education in Romania: Overcoming Challenges and Embracing Opportunities	To research the challenges connected with the development of institutional graduate employability tracking systems and data protection legislation.	Analysis of two case studies: Sweden and Romania.	Proper legislative and coding solutions can help to overcome the problem of personal data protection in graduate tracking systems.
Articles that contain information from the Personal Data Protection category that have been presented in another category: Tseng et al., 2024 (*the Countrywide and cross-national surveys and surveys of individual higher education institutions, and Constructing, collecting, and analyzing surveys categories*).				

Source: Own elaboration based on the literature review.

The studies examined graduate employability and career outcomes, evaluated institutional tracking systems and monitoring tools, and developed models or frameworks for assessing competencies, skills, and career success. They also analyzed influencing factors such as education, learning approaches, demographics, and institutional practices, as well as reporting on methodological challenges and system development issues.

Methodologies included statistical analyses of large administrative and survey datasets, literature and systematic reviews, pilot surveys, case studies and interviews, and the development and validation of predictive and decision-support models. Additional approaches comprised rule-based mapping, visualization and dashboard implementations, and computational techniques such as econometric, machine-learning, and genetic-algorithm methods.

Reported contributions on GCTS included the integration of administrative, institutional, and survey data; the application of models (economic, mobility, ML, blockchain) for measurement and prediction; observations on response-rate and representativeness issues; the measurement of both objective and subjective outcomes in short- and long-term perspectives; and references to employer engagement, legal safeguards, and data linkage. The next chapter presents a discussion of these findings.

4. Discussion

The review shows that there have been numerous studies to investigate the following main topics: computerized employability tracking and analyzing systems, survey/interview-based tracking systems, nationwide/international systematized tracking systems, individual academy-to-graduate feedback collecting systems, and combinations of the above; some of the topics overlap.

4.1. Central systems

Some studies presented frameworks of country-central employability monitoring systems, e.g., ELA (Polish Graduate Tracking System) in Poland (Zając et al., 2018). Most researchers seem to be critical of the slow development of such systems. Kosztyán et al. (2021) remarked that currently, there are very few central graduate tracking systems (Hungary, Estonia and Italy being noticeable exceptions), such as the Hungarian HCSTGC (Hungarian central system for tracking graduates' careers), which includes anonymized information on the location of residence (the region), the city (or subregion) of the higher education institution, the county and subregion of the workplace, and starting salary of all graduated employees. They called for establishing such a system at the European Union level (or higher). A similar observation was made by Pavlin (2019), who stressed the need to develop comprehensive national graduate employability tracking systems. As he noticed, 'Yet the typical graduate in most EU countries currently has very limited reliable information on which career paths normally follow particular higher education programs, whilst academics are not sure if more practical-based ways of teaching and learning truly contribute to better career development. Very few understand the complex transition from education to the labor market' (Pavlin, 2019, p. 262). It seems that the situation in Europe has not improved significantly since 2014, when Pavlin and Svetlik remarked that, 'With some exceptions, higher education institutions in Europe still do not have comparative systematic systems in place to trace their graduates from education to the labor market. In general, they have neither the knowledge nor the motivation to transfer the results gained from occasional surveys into their curricular practices' (Pavlin, Svetlik, 2014, pp. 422-423).

4.2. IT-supported tools

A significant number of studies focused on the construction and use of various IT-supported graduate tracer monitoring platforms. Thus, Gonzales et al. (2024) presented a Decision Support System and mapping recommendation analysis using a rule-based algorithm to evaluate the results of alumni program evaluation on curriculum, faculty, facility, laboratory, and student services. Hristova et al. (2024) discussed the possible uses of an automated blockchain instrument for tracking and sharing data on competencies acquired by graduates

during both studies and professional careers. A Power Business Intelligence Dashboard-based combination of data analytics techniques and machine learning algorithms was created to predict graduate employability in Malaysia (Sanusi et al., 2023). Courtial and Garrouste (2014) presented a model combining an econometric model of employability and a predictive control approach to measure graduate employability in France. Pico-Saltos et al. (2021, 2022) came up with a prediction model of alum career success based on the use of a genetic algorithm that was used in Ecuador, and Kosztyán et al. (2021) proposed a model that combined gravity-like economic models and a mobility network model to measure graduate employability in Hungary.

4.3. Countrywide and cross-national surveys and surveys of individual higher education institutions

Most research discussed survey-based instruments of employability tracking, either mentioning them as a part of a general framework or concentrating on their technical form. Graduate employability tracking systems can be broadly divided into two parts: countrywide, or cross-national surveys, such as the Eurograduate Pilot Survey launched by the European Commission in eight EU countries in 2018 (Comunian et al., 2023; Tecilazić et al., 2024), 'Employers' perception of graduate employability' study by Flash Eurobarometer, coordinated by the European Commission, which covered the 27 EU Member States, Norway, Iceland, Croatia, and Turkey in 2011 (Arranz et al., 2022), Nursing and Allied Health Graduate Outcomes Tracking study and the Graduate Outcomes Survey (GOS) in Australia (Jackson, Bridgstock, 2018; Sutton et al., 2021; Jackson, Li, 2022), the Destinations of Leavers from Higher Education (DLHE) in the United Kingdom (Jackson, Bridgstock, 2018), The Medical Schools Outcomes Database and Longitudinal Tracking Project (MSOD) in New Zealand (Connell et al., 2023), the THEnet Graduate Outcome Study (GOS) conducted in Australia, Belgium, Sudan, Philippines, Canada, and South Africa, (Larkins et al., 2018), Finland (Hynninen et al., 2022), and China (Zhang et al., 2021), and surveys conducted by individual higher education institutions, e.g. in Malaysia (Mohd Noor et al., 2024), Ecuador (Pico-Saltos et al., 2021, 2022), Peru (Acero et al., 2023), and the USA (Weller et al., 2015; Reinhardt et al., 2023). Jackson and Bridgstock (2018) produced a general description of several central graduate employability tracking systems, e.g., in Australia, New Zealand, the USA, and Europe. They noticed the growing need and popularity of searching for longitudinal data on graduate outcomes. Some of the studies described models that are based on a combination of data from countrywide registrars and surveys commissioned by individual higher education institutions, e.g. in Austria (Gatt et al., 2021), Taiwan (Tseng et al, 2024), Russia (Burnasheva et al., 2016), Hungary (Balogh, Sipos, 2020) or Australia (Woolley et al., 2015). Weller (2015) presented an interesting model that used information from internal university data (e.g. the class size or Graduate Record Examination scores of students) and information obtained directly from graduates concerning the classification of employment by industry and job title that, in turn, should be checked against information obtained from each company's website.

4.4. Constructing, collecting, and analyzing surveys

As it has been already mentioned, several studies gave insight into the surveys' technical form, e.g. the type of questions, and /or measures and control variables (Gatt et al., 2021; Zhang et al., 2021; Arranz et al., 2022; Hynninen et al., 2022; Jackson, Li, 2022; Comunian et al., 2023), specific variables of 'the recruitment and data collection process at each stage, from university admission, undergraduate attendance at university and after graduation' (Sutton et al., 2021), details of the admission and undergraduate data, e.g. student identification number, hometown at application to the higher education institution, date of birth, gender, ethnicity, interview score, Tertiary Entrance Score (an Australian rank – ordered, school-leaving), then Honors (if awarded) or placement locations in Years 2, 4 and 6 (Woolley et al., 2015), variables used in the Medical Schools Outcomes Database (MSOD) survey-based national project in Australia and New Zealand, which included even data generally considered highly sensitive, such as ethnic identity and relationship status (Connell et al., 2023), variables used in the Eurograduate Pilot Survey, which concerned, among others, lectures, group assignments, internships and work placement, teacher being 'the main source of information, project- and/or problem-based learning', 'extra work above exam requirements', 'non-study-related work experience in the country of studies', 'non-study-related work experience abroad', or 'labour market experience before study program (at least 6 months)' (Tecilazić et al., 2024). Tseng (2024) presented detailed variables of an integrated model made to measure 'the influence of interdisciplinary learning on post-graduation plan choices' based on data from the university's internal administrative records, graduation surveys, and career-tracking data obtained from the Ministry of Education. Mohd Noor et al. (2024) introduced their own survey designed to analyze the soft and hard skills of graduates. Also, Pico-Saltos et al. (2021) discussed an array of objective and subjective career success variables used in their model, distributed in three levels: successful, moderately successful, and unsuccessful. As far as the issue of survey responsiveness is concerned, Connell et al. (2023) noticed the differences in survey representativeness between (highly representative) entry and exit surveys versus (under-representative) post-graduation surveys. Hynninen et al. (2022), in turn, observed that one should be aware of a selection bias in graduate employability surveys, as less professionally successful graduates may not be as willing to complete the surveys as their more successful colleagues. An interesting solution aimed at increasing the survey response rate was presented by Zhang et al. (2021), who mentioned that medical school graduates who took part in the study received compensation in the form of ¥10.00 on the website.

Despite the problem of decreasing survey responsiveness over time, several authors (Jackson, Bridgstock, 2018; Larkins et al., 2018; Sutton et al., 2021; Jackson, Li, 2022) stressed the need to continue tracking down graduates' professional careers not only upon their graduation but also later, to find out how factors change over time. Sutton et al. (2021), for example, recommended building a comprehensive graduate employability model that would

include a considerable number of variables, among them changes in values and aspirations that may evolve over time. Therefore, cohorts of students-graduates should be surveyed during studies, then each year for 10 years after graduation. That came quite in line with the methodology presented by Larkins et al. (2018) based on a number of surveys conducted first with entering medical students, then at their exit from medical school, next at postgraduate years 1, 4, 7, and finally 10 years after graduation. Jackson and Bridgstock (2018) found out that skills, personal characteristics, and degree-related factors mattered most in the initial career stage, whereas in the medium-term, discipline was more important. They also recommended using not only objective, hard data, such as full-time job salary figures of graduates, but also more nuanced subjective indicators, such as social and economic value, career satisfaction, and graduates' well-being. They, however, noticed problems with reaching out for standardized and comparable data on employability as a number of successful graduates, e.g. of such disciplines as the arts, choose to remain self-employed or part-time employed rather than seek a full-time job and pointed out the need to use social media and professional networking platforms, such as LinkedIn to study and analyze graduate employability outcomes. A similar observation was made by Woolley et al. (2015), who concluded that an efficient graduate tracking system should include the following elements, apart from data from a public regulatory body: an exit survey conducted immediately before graduation (it should also be used to collect each graduate's details and consent to be contacted later to obtain the employability data), and a Facebook page to be able to access even the hard-to-trace graduates, as using Facebook is more efficient and effective in contacting graduates than more traditional phone books, or emails. The data should be stored in a longitudinal tracking database by the higher education institution. Also, Acero et al. (2023) signaled the need to keep and manage updated databases of students and graduates in order to be able to track their employability.

Weller et al. (2015), in turn, pointed out problems with surveying employers of graduates connected with identifying and contacting direct supervisors of the graduates and language barriers present in the case of international employment of graduates. Due to these challenges, researchers have to rely on information concerning students' salaries at their first job following graduation and current job titles of graduates as indirect measures of employer satisfaction. Nevertheless, the information obtained from employers would be very valuable, as Scandurra et al. (2024) recognized the need for more empirical research on the graduate labor market outcomes of higher education institutions and noticed that most studies follow a simple qualitative research design based on a limited amount of interviews (sometimes accompanied by surveys) with students, representatives of higher education institutions, but less frequently with the graduates' employers.

4.5. Personal Data Protection

Proteasa and Vertes-Olteanu (2022) pointed out another problem: personal data protection in European Union legislation. They analyzed, on the basis of two case studies, Romania and Sweden, questions connected with building a comprehensive graduate mobility tracking system that would combine and analyze information from two key sources of different kinds, i.e., administrative data and surveys. They pointed out at the following problems arising during the construction process: creating and storing the administrative, or registry data in different databases and by different entities, difficulties in linking the data sources and processing information due to the personal data protection legislation, and lack of important personal details in the registry data, as some of them can be collected only during more personal contacts, such as interviews. They recommended creating and applying algorithms for computing indicators to the law-protected data to de-identify the microdata, thus making it possible to allow analysts to access electronic platforms with comprehensive, objective, up-to-date, and accurate statistical information on graduate employability on national and European levels. The same research challenge is present in Taiwan, where, as Tseng (2024) noticed, privacy and personal data protection laws prevent researchers from obtaining individual records for the analysis – they only have access to program-level career-tracking data.

5. Conclusions

This paper has reviewed thirty-one Scopus-indexed research papers that contained information on higher education institutions' systems of tracking down the employability of their graduates to find answers to questions concerning the state of the existing body of knowledge, the remaining gaps, methods used in the studies, and their main findings. To address the first research question (RQ1), the literature review has identified four main areas that were addressed and discussed in the literature on the subject: an increasing computerization of the systems, a wide use of surveys in collecting and analyzing data, a (gradual) development of nationwide/international systems, and a rising trend of building hybrid systems that combine information from different sources by individual HEIs. The second research question (RQ2) focused on the methods used in the studies. The articles used literature review methodologies, survey-based instruments, statistical analyses, and presentations of information technology solutions. Quite interestingly, some of the articles (e.g., Reinhardt et al., 2023; Comunian et al., 2023; Gatt et al., 2021) analyzed, though they contained valuable information on graduate career tracking systems, defined other topics as their primary research questions, e.g., they strove to analyze the situation on the labor market of specific groups of graduates,

and the information on graduate employability tracking systems seemed to be a kind of by-product of their research.

The third research question (RQ3) explored the main findings concerning the issue of graduate career tracking systems. The most important conclusion of the study is that a fully informative, reliable system of tracking down graduate professional careers has not been developed yet. Big, centralized systems use objective data from reliable national registrars such as pension funds, but cannot, because of data protection legislation, provide higher education institutions with detailed information on individual graduates. Moreover, they publish the results of their analyses with a significant time delay and do not usually capture information on other forms of employment than full-time jobs. Individual higher education institutions, in turn, though they increased their efforts to establish some graduate tracking procedures, are still struggling to find effective ways of collecting sufficient amounts of reliable data from graduates and their employers on a regular basis. Quite interestingly, there is one group of graduates whose professional careers can be monitored smoothly. This exception to the rule is graduates of some medical fields, as it is relatively easy to find up-to-date information on their employment in widely accessible institutional repositories. Most higher education institutions, however, have to rely on surveys (supplemented by interviews and information from internal and external administrative registrars), whose responsiveness is far from satisfactory and diminishing over time. It is the time factor that seems to be a topic of increasing importance for researchers, as some of them noticed that factors determining graduate employability may change over time. It should also be stressed here that there is an ongoing discussion concerning the type of information on employability that is worth searching for, as some researchers tend to rely on income-based data for measuring professional success, whereas others also value non-financial factors, such as career satisfaction or well-being.

Several questions regarding the development of the internal parts of graduate employability tracking systems of individual higher education institutions remain to be addressed. First of all, though there are many detailed descriptions of questions and variables used in surveys, far too little attention has been paid to the existence in higher education institutions of (or a lack of thereof) procedures and tools designed to analyze and use the obtained feedback in decision-making concerning changes in the curricula, teaching methods, or staff selection. In other words, there is very little scientific understanding of the academic mechanisms of examining the graduate employability data (e.g., whether the survey results are studied regularly by a standing committee or randomly, by the dean, which data, connected with financial or non-financial factors, is given priority, etc.) or the way it may impact the quality of studies of the next cohorts of students (e.g., by introducing the procedure of automatic revision of the curriculum of a given study program in case of obtaining unsatisfactory information concerning the employment rates of its graduates). Moreover, as far as the channels of collecting information on the professional careers of graduates are concerned, very little attention has been paid so far to the role of social media, such as Facebook and LinkedIn. There is little available

literature on the topic of organizing alumni clubs that can serve as a valuable source of information on graduate careers, either. Moreover, only one study mentioned an example of rewarding the graduates for their time and effort devoted to completing surveys, and there were no attempts to investigate factors that would effectively motivate employers to provide feedback on their employees to their Alma Maters. These are important issues for future research.

As far as information technology solutions, such as decision support systems, Business Intelligence tools, or blockchain technologies are concerned, they seem, because of their novelty, to be still in the early stage of development, but certainly pose another important and promising path for future research.

While providing some valuable insight into the topic of tracking down graduate employability, the study is not without limitations. Its scope was limited in terms of the selected database and the defined search criteria. Although Scopus is a widely recognized search platform, one should be aware of the existence of other databases, such as Google Scholar, that store articles from journals, which, though not indexed in Scopus, may be of value. Furthermore, there is a possibility that a number of articles that did not meet the inclusion criteria, e.g., the defined keywords, do contain relevant information on the topic in question.

In addition, certain methodological imbalances across the reviewed studies should be acknowledged. A considerable proportion of the included studies relied on survey-based approaches, which may limit the generalizability of their findings due to response-rate and representativeness issues. At the same time, longitudinal research designs were relatively underrepresented, restricting the possibility of assessing graduates' career outcomes over longer time horizons. Integrating graduate career tracking systems with professional networking sites (e.g., LinkedIn) can enable continuous and passive monitoring of career trajectories, reducing reliance on survey responses. Automatically updated profiles improve data timeliness and accuracy, while aggregated analytics reveal mobility patterns and skill demands. Engagement campaigns via social platforms may increase alum participation, though strict safeguards and transparent governance remain essential for compliance with data protection regulations.

Despite these limitations, the authors believe that the present study has added to the growing body of knowledge on graduate employability and suggested venues for future research.

Most importantly, the insights gained from this research may be of assistance to higher education decision-makers in their attempts to build efficient graduate career tracking systems, as the study has presented an array of graduate career tracking tools that are being used and can be benchmarked, as well as it has signaled the main problems connected with their implementation. And, though as the study has highlighted, there are many challenges with the development of graduate employability tracking systems, including strategic, legal, technical, and procedural issues, higher education institutions will benefit from undertaking the effort, as obtaining reliable, valuable feedback on their educational outcomes can help them develop

and revise curricula, modernize teaching methods, and improve organization of studies to be able to respond successfully to the dynamically changing societal demands.

References

1. Acero, J.F.C., Velasquez, O.C., Apaza, F.B.C., Callata, L.V., Lloclla, H.S. (2023). Current Situation of the Monitoring of Graduates and Labor Insertion in the Electrical Mechanical Engineering Career. In: Y. Iano, O. Saotome, G.L. Kemper Vásquez, C. Cotrim Pezzuto, R. Arthur, G. Gomes de Oliveira (Eds.), *Proceedings of the 7th Brazilian Technology Symposium (BTSym'21).* Cham: Springer International Publishing, 561-568. https://doi.org/10.1007/978-3-031-04435-9_59

2. Arranz, N., Arroyabe, M.F., Sena, V., Arranz, C.F.A., de Arroyabe, J.C.F. (2022). University-enterprise cooperation for the employability of higher education graduates: a social capital approach. *Studies in Higher Education*, *47(5),* 990-999. https://doi.org/10.1080/03075079.2022.2055323

3. Balogh, G., Sipos, N. (2020). Is it worth for bachelor graduates to diversify study programme for master level? *International Journal of Educational Management, 34(9),* 1387-1401. https://doi.org/10.1108/IJEM-01-2020-0020

4. Bridgstock, R., Jackson, D. (2019). Strategic institutional approaches to graduate employability: navigating meanings, measurements and what really matters. *Journal of Higher Education Policy and Management*, *41(5),* 468-484. https://doi.org/10.1080/1360080X.2019.1646378

5. Burnasheva, S.N., Zhuravleva, I.I., Kustov, T.V., Pantukhova, N.S. (2016). Internal monitoring of ETU "LETI" graduates' employment as an effective tool for planning of the university activity. *2016 IEEE V Forum Strategic Partnership of Universities and Enterprises of Hi-Tech Branches (Science. Education. Innovations). 2016 IEEE V Forum Strategic Partnership of Universities and Enterprises of Hi-Tech Branches" (Science. Education. Innovations).* Saint Petersburg, Russia: IEEE, 87-90. https://doi.org/10.1109/IVForum.2016.7835864

6. Carrera-Rivera, A., Ochoa, W., Larrinaga, F., Lasa, G. (2022). How to conduct a systematic literature review: A quick guide for computer science research, *MethodsX, 9, 101895.* https://doi.org/10.1016/j.mex.2022.101895

7. Comunian, R., Jewell, S., Sunmoni, A., Dent, T. (2023). For what it's worth: European Arts & humanities graduates' employability and their engagement in society. *Arts and Humanities in Higher Education*, *22(2),* 211-232. https://doi.org/10.1177/14740222231156892

8. Connell, C.J.W., Salkeld, A.J., Wells, C., Verstappenet, A.C., Poole, P., Wilkinson, T.J., Bagg, W. (2023). Sample representativeness and influence of attrition on longitudinal data collected as part of a national medical career tracking project. *BMC Medical Education*, *23(1),* 532. https://doi.org/10.1186/s12909-023-04472-1

9. Courtial, E., Garrouste, C. (2014). Model Predictive Control Strategy to Forecast Employability in Earth Sciences. *IFAC Proceedings Vol., 47(3),* 10731-10736. https://doi.org/10.3182/20140824-6-ZA-1003.02563

10. Dasaklis, T.K., Voutsinas, T.G., Tsoulfas, G.T., Casino, F. (2022). A Systematic Literature Review of Blockchain-Enabled Supply Chain Traceability Implementations. *Sustainability*, *14, 2439*. https://doi.org/10.3390/su14042439

11. Datta, P., Behera, B., Rahut, D.B. (2024). Assessing the role of agriculture-forestry-livestock nexus in improving farmers' food security in South Asia: A systematic literature review. *Agricultural Systems*, *213, 103807*. https://doi.org/10.1016/j.agsy.2023.103807

12. Gatt, S., Hayek, L., Huemer, C. (2021). Two sides of the same coin: political science as professional and civic education. *European Political Science*, *20(3),* 440-452. https://doi.org/10.1057/s41304-020-00280-z

13. Gonzales, J.G., Lagman, A.C., De Angel, R.M., Raguro, M.C.F., Bulacan, R.C.A., Canlas, J.D. (2024). Graduate Tracer Monitoring Platform with Decision Support Feature and Mapping Recommendations Analysis Using Rule-Based Algorithm. *2024 IEEE 15th Control and System Graduate Research Colloquium (ICSGRC)*. SHAH ALAM, Malaysia: IEEE, 261-266. https://doi.org/10.1109/ICSGRC62081.2024.10691266

14. Hristova, T., Stoyanov, I., Mitev, I., Aleksandrov, R. (2023). Automated Tracking of Electrical Engineer Competencies through Blockchain Technology. *2023 4th International Conference on Communications, Information, Electronic and Energy Systems (CIEES). 2023 4th International Conference on Communications, Information, Electronic and Energy Systems (CIEES)*. Plovdiv, Bulgaria: IEEE, 1-8. https://doi.org/10.1109/CIEES58940.2023.10378781

15. Hynninen, T., Knutas, A., Hujala, M. (2022). What can we learn from recommendations of early-career engineers? Assessing computing and software engineering education using a career monitoring survey. *Proceedings of the 2022 Conference on United Kingdom & Ireland Computing Education Research. UKICER2022: The United Kingdom and Ireland Computing Education Research Conference.* Dublin Ireland: ACM, 1-7. https://doi.org/10.1145/3555009.3555017

16. Jackson, D., Bridgstock, R. (2018). Evidencing student success in the contemporary world-of-work: renewing our thinking. *Higher Education Research & Development, 37(5),* 984-998. https://doi.org/10.1080/07294360.2018.1469603

17. Jackson, D., Li, I. (2022). Transition to work, mismatch and underemployment among graduates: an Australian longitudinal study. *International Journal of Manpower*, *43(7),* 1516-1539. https://doi.org/10.1108/IJM-03-2021-0195

18. Jesson, J., Matheson, L., Lacey, F.M. (2011). *Doing Your Literature Review: Traditional and Systematic Techniques*. London: SAGE.

19. Kosztyán, Z.T., Csányi, V.V., Banász, Z., Jakobi, Á, Neumanné-Virág, I., Telcs, A. (2021). The role of higher education in spatial mobility. *Applied Network Science*, *6(1),* 88. https://doi.org/10.1007/s41109-021-00428-w

20. Larkins, S., Johnston, K., Hogenbirk, J.C., Willems, S., Elsanousi, S., Mammen, M., Van Roy, K., Iputo, J., Cristobal, F.L., Greenhill, J., Labarda, C., Neusy. A-J. (2018). Practice intentions at entry to and exit from medical schools aspiring to social accountability: findings from the Training for Health Equity Network Graduate Outcome Study. *BMC Medical Education*, *18(1),* 261. https://doi.org/10.1186/s12909-018-1360-6

21. Lim, W.M., Rasul, T., Kumar, S., Ala, M. (2022). Past, present, and future of customer engagement, *Journal of Business Research*, *140*, 439-458. https://doi.org/10.1016/j.jbusres.2021.11.014

22. Matusiak, K. (2010). *Budowa powiązań nauki z biznesem w gospodarce opartej na wiedzy. Rola i miejsce uniwersytetu w procesach innowacyjnych*. Warszawa: Wydawnictwo SGH.

23. Noor, N.N.M., Rodzalan, S.A., Abdullah, N.H., Saat, M.M., Othman, A., Singh, H. (2024). Skills of future workforce: skills gap based on perspectives from academicians and industry players. *International Journal of Evaluation and Research in Education (IJERE)*, *13(2),* 774. https://doi.org/10.11591/ijere.v13i2.25163

24. Pavlin, S., Svetlik, I. (eds.) (2014). Employability of higher education graduates in Europe. *International Journal of Manpower, 35(4),* 418-424. https://doi.org/10.1108/IJM-05-2013-0104

25. Pavlin, S. (2019). Time to reconsider the strategic role of system(s) for monitoring higher education graduates' careers? *European Journal of Education*, *54(2),* 261-272. https://doi.org/10.1111/ejed.12313

26. Pico-Saltos, R., Bravo-Montero, L., Montalván-Burbano, N., Garzás, J., Redchuk, A. (2021). Career Success in University Graduates: Evidence from an Ecuadorian Study in Los Ríos Province. *Sustainability*, *13(16),* 9337. https://doi.org/10.3390/su13169337

27. Pico-Saltos, R., Garzás, J., Redchuk, A., Escandón-Panchana, P., Morante-Carballo, F. (2022). Role of Alumni Program in the Prediction of Career Success in an Ecuadorian Public University. *Applied Sciences*, *12(19),* 9892. https://doi.org/10.3390/app12199892

28. Proteasa, V., Vertes-Olteanu, A. (2022). How to Cope with GDPR for Graduate Tracking: A Discussion at the Intersection of Law and Policy and Two Solutions. In: A. Curaj, J. Salmi, C.M. Hâj (Eds.), *Higher Education in Romania: Overcoming Challenges and Embracing Opportunities* (pp. 193-210). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-94496-4_10

29. Reinhardt, J.W., Moncrief, K.Q., Koch, J.E.J., Samson, K.K., Yu, F. (2023). Maintaining a strong rural dental workforce. *Journal of Dental Education*, *87(1),* 86-92. https://doi.org/10.1002/jdd.13093

30. Sanusi, D.M., Sujairi, N.S., Lufti, S.L., Mohd Kharunizan, A.I., Amir Feisal, S.D.S.A. (2023). An Interactive Alumni Tracking Dashboard. *2023 6th International Conference on Applied Computational Intelligence in Information Systems (ACIIS)*, Bandar Seri Begawan, Brunei Darussalam: IEEE, 1-6. https://doi.org/10.1109/ACIIS59385.2023.10367325

31. Scandurra, R., Kelly, D., Fusaro, S., Cefalo, R., Hermannsson, K. (2024). Do employability programmes in higher education improve skills and labour market outcomes? A systematic review of academic literature. *Studies in Higher Education*, *49(8),* 1381-1396. https://doi.org/10.1080/03075079.2023.2265425

32. Schildkamp, K., van der Kleij, F.M., Heitink, M.C., Kippers, W.B., Veldkamp, B.P. (2020). Formative assessment: A systematic review of critical teacher prerequisites for classroom practice. *International Journal of Educational Research*, *103*, 101602. https://doi.org/10.1016/j.ijer.2020.101602

33. Scott, J.C. (2006). The Mission of the University: Medieval to Postmodern Transformations. *The Journal of Higher Education 77(1),* 1-39. https://doi.org/10.1080/00221546.2006.11778917

34. Sporn, B., Godonoga, A. (2024). Higher education institutions as change agents in society: perspectives on adaptation and impact. *European Journal of Higher Education*, *14 (sup1),* 1-9, https://doi.org/10.1080/21568235.2024.2412764

35. Suleman, F., Videira, P., Araújo, E. (2021). Higher Education and Employability Skills: Barriers and Facilitators of Employer Engagement at Local Level. *Education Sciences*, *11(2),* 51. https://doi.org/10.3390/educsci11020051

36. Sutton, K.P., Beauchamp, A., Smith, T., Waller, S., Brown, L., Fisher, K., Woodfield, M., Major, L., Depczynski, J., Versace, V.L., Maybery, D., Wakely, L., Mitchell, E.K., Drumm, D.W., Langham, R., May., J. (2021). Rationale and protocol for the Nursing and Allied Health Graduate Outcomes Tracking (NAHGOT) study: a large-scale longitudinal investigation of graduate practice destinations. *Rural and Remote Health* [Preprint]. https://doi.org/10.22605/RRH6407

37. Tecilazić, A., Ogrizek Biškupić, I., Balković, M. (2024). Impact of Teaching and Learning Modes on Graduates' Social and Entrepreneurial Skills Development: A Comparative Analysis. *Education Sciences*, *14(5),* 443. https://doi.org/10.3390/educsci14050443

38. Tranfield, D., Denyer, D., Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, *14(3),* 207-222. https://doi.org/10.1111/1467-8551.00375

39. Tseng, Y.-W., Rowe, F., Lin, E.S. (2024). An Elon Musk generalist or a specialist? The impacts of interdisciplinary learning on post-graduation outcomes. *Studies in Higher Education*, *49(4),* 782-807. https://doi.org/10.1080/03075079.2023.2252889

40. UNESCO (2025). *Higher education. What you need to know about higher education. https://www.unesco.org/en/higher-education/need-kno*w. https://www.unesco.org/en/higher-education/need-know

41. Ungaro, V., Di Pietro, L., Guglielmetti Mugion, R., Renzi., M.. (2024). A systematic literature review on transformative practices and well-being outcomes in healthcare service. *Journal of Service Theory and Practice*, *34(3),* 432-463. https://doi.org/10.1108/JSTP-03-2023-0071

42. Weller, D., Robbins, J., Elmore, A., Wiedmann, M. (2015). Master of Professional Studies in Agriculture and Life Sciences offered through the Field of Food Science and Technology at Cornell University: A Model for the Development of a Course-Based Graduate Degree in Food Science and Technology. *Journal of Food Science Education*, *14(1),* 10-17. https://doi.org/10.1111/1541-4329.12047

43. Woolley, T., Hays, R.B., Barnwell, S., Sen Gupta, T., McCloskey, T. (2015). A successful longitudinal graduate tracking system for monitoring Australian medical school graduate outcomes. *Rural and Remote Health* [Preprint]. https://doi.org/10.22605/RRH3542

44. Zając, T., Jasiński, M., Bożykowski, M. (2018). Early Careers of Tertiary Graduates in Poland: Employability, Earnings, and Differences between Public and Private Higher Education. *Polish Sociological Review*, *2*, 187-208. https://doi.org/10.26412/psr202.03

45. Zhang, X., Li, C., Yue, C., Jiang, X., Cao, J., ten Cate, O. (2021). Why clinical training in China should improve: a cross-sectional study of MD graduates. *BMC Medical Education*, *21(1),* 266. https://doi.org/10.1186/s12909-021-02647-2