ŌTAUTAHI CHRISTCHURCH AOTEAROA NEW ZEALAND
35TH AUSTRALASIAN ASSOCIATION FOR ENGINEERING EDUCATION ANNUAL CONFERENCE
8-11 DEC 2024
THE ENGINEER AND THE WORLD

Enhancing Employability in Engineering Education: A Critical Review of the Existing Measurement Instruments

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ABSTRACT

CONTEXT

Amidst today's dynamic landscape, recent graduates and other employees in the engineering industry demand adaptability to flourish in the face of rapid change. This heightened demand underscores the importance of assessing and enhancing the employability of engineering students and graduates, prompting the need for more refined understanding of the composition of employability and approaches for measuring it. Despite ongoing efforts to develop measurement tools, a noticeable gap persists in comprehensive instruments tailored to the unique requirements in engineering context.

PURPOSE OR GOAL

The purpose of this paper is to review the existing measures in assessing employability within the engineering context. It also identifies current limitations in measuring employability in engineering education.

APPROACH OR METHODOLOGY/METHODS

We conducted a critical review of existing employability measurement instruments. Search terms were applied across diverse databases, including Scopus (comprehensive), ERIC (focused on education), and Engineering Village (focused on engineering). Articles were screened and selected based on predefined criteria to identify existing employability measurement instruments in engineering.

ACTUAL OR ANTICIPATED OUTCOMES

This review highlights several key limitations of current employability measurement instruments, including the absence of specialised tools tailored to the engineering context, reliance on simplistic definitions of employability, limited focus on long-term career development, inadequate validation of instruments, and insufficient involvement of diverse stakeholders in the instrument development process. We provide future research recommendations to address these identified gaps and align instruments with the evolving nature of employability.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

We reviewed the existing employability measurement instruments within the engineering context and identifies current limitations. The analysis reveals significant gaps in existing tools which highlighted a critical need for new, validated instruments tailored to the specific requirements of engineering disciplines. Future research should prioritize the development of these specialised tools, involving diverse stakeholders to ensure comprehensive and contextually relevant measures.

KEYWORDS

Employability, Measurement, Engineering.

Introduction

In our globally competitive knowledge economy, where change is a constant reality, the importance of employability is universally acknowledged by policymakers and scholars alike (Peeters et al., 2019). Higher education institutions are required to prepare students for jobs that do not yet exist, for using technologies that have yet to be invented, and for solving problems that have yet to be conceived (Kumar, 2007). Once they enter the labour market, graduates must continue to enhance their employability to secure and retain jobs (Akkermans et al., 2013). Consequently, economic, political, and social pressures compel policymakers and higher education professionals to prioritize employability in strategic agendas (Römgens et al., 2020).

The field of engineering is no exception to this trend, and the topic of employability has garnered significant attention from researchers and practitioners in recent years. International professional organizations, including accreditation bodies, have emphasised a skill gap between engineering education and the workplace, thereby increasing the focus on employability in engineering education research (Kolmos & Holgaard, 2019).

As attention on employability intensifies, the development of tools or instruments to assess individuals' employability becomes both pivotal and urgent. Assessing students' and graduates' employability can aid in evaluating courses within higher education institutes (Santos et al., 2023), assist in refining curricula for academic staff (Dacre Pool & Sewell, 2007), and empower individuals to manage their employability effectively (Small et al., 2018).

While numerous studies have concentrated on developing generic employability measurement instruments without a specific focus on any particular field or industry (Harvey, 2001; Behle, 2020; Neroorkar, 2022), these instruments often fail to address engineering education and the field's contextual nuances (Tymon, 2013). Additionally, these studies mainly focus on the perspective of a single stakeholder, such as students or higher education institutions, often overlooking the diverse perspectives of multiple stakeholders (Cheng et al., 2022; Magnell et al., 2014; Taylor, 2005), which significantly influence the understanding and scope of employability (Tymon, 2013).

Di Fabio (2017) conducted a review of existing instruments, including the Employability Orientation Scale (EOS, Van Dam, 2004), the Competence-Based Measurement of Employability (CBME, Van der Heijde & Van der Heijden, 2006), the Self-Perceived Employability Scale for Students (SPES, Rothwell et al., 2008), the Dispositional Measure of Employability (DME, Fugate & Kinicki, 2008), and the Employability Attributes Scale (EAS, Bezuidenhout & Coetzee, 2011). While acknowledging these instruments' effectiveness in measuring various aspects of employability, Di Fabio underscored the need for a more comprehensive tool capable of capturing the full complexity of the employability construct. Furthermore, there is a demand for new scales aligned with contemporary definitions of employability.

In the realm of engineering education, despite efforts to develop employability measurement instruments (Bennett & Ananthram, 2022; Idkhan et al., 2021; Rothwell & Arnold, 2007; Saad et al., 2013), reliance on pre-existing frameworks often results in limited coverage of employability dimensions (e.g., Idkhan et al., 2021; Saad et al., 2013) or a lack of solid evidence regarding the suitability of conceptualisations for engineering practice (e.g., Bennett & Ananthram, 2022; Rothwell & Arnold, 2007).

Given the importance of establishing an instrument to measure employability with consideration of multiple stakeholders' perspectives and the need to take in account the disciplinary contexts of engineering, we conducted a critical review of existing employability measurement instruments in the field of engineering education.

Methods

To identify relevant instruments for measuring employability in the engineering context, a search was conducted using search strings that combined keywords related to employability, engineering context, and measurements (Table 1). This search was applied to publication titles,

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abstracts, and indexed keywords across three academic databases: Scopus (comprehensive), ERIC (focused on education), and Engineering Village (focused on engineering). Only conference papers and peer-reviewed journal articles with full-text availability in English were included, and the publication range was set from 2000 to 2024. A detailed analysis of the full texts was then conducted to identify articles that either presented the development or implementation of an employability measurement instrument in the field of engineering. A snowball approach was employed to trace the original papers detailing the development of the instruments, with the aim of gaining a comprehensive understanding of their development processes and theoretical foundations.

Table 1: Summary of keywords used in search strings for this critical review

Employability	Engineering context	Measurements
Employability	Engineering	Measur* Assess* Evaluat*

For this critical review, only employability measurement instruments originally developed within the engineering context were considered. It is important to acknowledge that there are other measures of employability utilised across various disciplines, including engineering, as well as measures not originally developed for engineering but applied to analyse specific phenomena or research problems in this field. For instance, several national surveys established by governmental departments or non-profit organizations, such as the Employer Satisfaction Survey (ESS) as a part of the Quality Indicators for Learning and Teaching survey program in Australia (2023), the Office for Students Annual Survey in the UK (2022), and the College & Career Readiness & Success Centre surveys in the U.S. (2015), aim to cover employability as part of their broader surveys across all disciplines. These national surveys primarily collect extensive data on various aspects of student experiences to enhance transparency for all stakeholders, including higher education institutions, future employers, students, and graduates. Given that these surveys are initiated by governmental agencies or not-for-profit organisations, they have the capacity and authority to gather comprehensive data from diverse groups of students and employers. Moreover, these surveys are managed by organisations that regularly revise their scope to address the changing demands of stakeholders. However, due to their broad coverage, employability is typically just a small component, often focusing on generic skills.

As another example of measures not originally developed for engineering but used to analyse specific phenomena or research problems in this field, Bennett's (2020) employABILITY scale was designed to provide a new understanding and interpretation of employability based on social cognitive theory and the USEM (Understanding, Skills, Efficacy beliefs, and Metacognition) model developed by Knight and Yorke (2004). An online self-assessment tool was developed to enable students to create personalized employability profiles, which they can review and revise over time. The implementation of this tool has facilitated studies based on student data, including research on gender differences in self-perceived employability between STEM and non-STEM disciplines (Bennett et al., 2021), as well as gender differences within STEM disciplines (Bennett et al., 2022). Such initiatives are valuable and demonstrate the demand for instruments to measure employability for investigating various phenomena and research problems. However, there is often insufficient validation to ensure that a generic model is suitable for examining specific problems from a more disciplinary-focused perspective (Tymon, 2013).

Results and Discussion

Ten employability measurement instruments originally developed within the engineering context were identified in this critical review (Table 2). Among these, three (Aboagye & Puoza, 2021; Husain et al., 2010; Saad et al., 2013) were developed as measures of employability to answer specific research questions. The existence of these three studies indicates a demand for instruments measuring employability for various research purposes such as identifying factors that hinder employability among engineering students and graduates. These studies often

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employed existing sets of skills that are not specific to the conceptualization of employability in the field of engineering. For instance, Husain et al. (2010) utilized employability skills adapted from The Secretary's Commission on Achieving Necessary Skills (SCANS) model (2001) developed by the U.S. Department of Labor. However, the SCANS model was originally developed to examine the demands of the workplace and to determine whether the current and future workforce is capable of meeting those demands (Secretary's Commission on Achieving Necessary Skills, 2001). This indicates the necessity for further explanations on the potential linkage between the original purpose of this model and the conceptualization of employability, and more discussion on how to adapt this model in the field of engineering considering the disciplinary contexts. Using such generic models may lead to questions about whether these elements/items align with the working definition of employability for the established instrument and whether the adapted model covers all necessary dimensions of such a definition. This highlights a potential demand for more discussion on better alignment between the generic models and the specific requirements of employability within the engineering context, emphasizing the need for instruments tailored to the unique demands of the field.

Table 2: Summary of the employability assessment instruments in the field of engineering

Authors	Description of the employability assessment instrument developed
Husain et al. (2010)	A 39-item questionnaire instrument measures engineering employers' perspectives across various company types, sizes, and ownership statuses in Malaysia.
Saad et al. (2013)	A 13-item questionnaire instrument assesses employers' perceptions of key hard and soft employability skills and their satisfaction with students' industrial training performance in Malaysia.
Marbouti and Lynch (2014)	A questionnaire instrument evaluates engineering PhD students' self-reported employability and key skills perceptions across four domains critical for careers in industry and beyond (Knowledge and Intellectual Abilities, Personal Effectiveness, Research Governance and Organization, and Engagement, Influence, and Impact).
Agrawal (2019)	An instrument measuring employability outcomes of engineering students in India, consisting of key employability indicators, such as job profile, salary, and job offers.
Bulian et al. (2019)	A questionnaire instrument measures key employability skills among Croatian engineering employees, retaining 29 items across 8 factors.
Wrahatnolo et al. (2020)	A questionnaire instrument evaluates Electrical Power Installation Competencies among Indonesian vocational high school students, using 41 items across 8 latent variables and SEM analysis.
Aboagye and Puoza (2021)	A questionnaire instrument assesses the employment status and unemployment duration of mechanical engineering graduates from Sunyani Technical University, Ghana, through digital platforms.
Idkhan et al. (2021)	An 11-indicator questionnaire instrument based on the Employability Skills 2000+ Framework assesses employability skills of 528 engineering students at Universitas Negeri Makassar, Indonesia.
Khurana and Misra (2021)	A 26-item questionnaire instrument identifies key employability skills among aspiring engineering graduates in India.
Danaher and Maramara (2024)	A questionnaire instrument evaluates employability skills of IT students in the UAE, offering a structured approach to measuring competencies in a realistic industry context.

Adopting the United Nations Conference on Trade and Development (UNCTAD, 2022) definitions where Global North countries are classified as developed economies and Global South countries as developing economies only two of the ten instruments identified in this critical review (Bulian et al., 2019; Marbouti & Lynch, 2014) originated from Global North countries, while the rest were from Global South countries. Studies from Global South countries predominantly focused on traditional definitions of employability, such as job attainment. Theoretically, this presents a gap worthy of further discussion, as more dimensions and aspects of employability should be considered by adopting a diversified definition of employability. However, the working definition utilised should align with the identified research problem. These studies highlight the issue of unemployment among engineering graduates in Global South countries. While using a simple form of employability, such as job attainment, may be appropriate for certain studies, there are notable limitations, including insufficient validation, lack of explanation regarding the conceptualization and dimensionality of employability, and limited involvement of diverse stakeholders during instrument development.

Continuing from this point, six of the instruments (Aboagye & Puoza, 2021; Agrawal, 2019; Danaher & Maramara, 2024; Khurana & Misra, 2021; Marbouti & Lynch, 2014; Wrahatnolo et al., 2020) solely relied on data such as employment status, duration of unemployment, and the number of job offers received to gauge employability outcomes. These studies primarily aimed to identify indicators or factors influencing a student's likelihood of securing employment. It is evident that developing an instrument to measure employability becomes easier with such a simplistic definition. This may explain why there are fewer instruments assessing employability in engineering from Global North countries, where extensive discussions on redefining and conceptualizing employability have taken place. Global North countries often consider a broader range of dimensions and aspects within employability, which may increase the complexity of developing an instrument that includes these dimensions.

Idkhan and co-authors (2021) made an effort to develop an instrument for measuring students' employability, focusing on individual, social, and contextual factors affecting employability skills in new graduates. This aligns with previous discussions on instruments developed for various research purposes. The study particularly emphasized the instrument’s development, adapting three dimensions of employability—Fundamental Skills, Personal Management Skills, and Teamwork Skills—from the Conference Board of Canada's Employability Skills 2000+ (The Conference Board of Canada, 2000). While this adaptation provides a strong foundation, there is a need to validate both the internal structure of the instrument and its alignment with the theoretical foundations of employability. It is also important to note that the Conference Board of Canada's employability skills were not specifically designed for engineering, underscoring the need for thorough validation and theoretical grounding to ensure the instrument's relevance and applicability in the engineering context.

Among the reviewed instruments, only one (Khurana & Misra, 2021) was developed with thorough validation while specifically focusing on a discipline and considering the disciplinary context in measuring employability. In the development procedures, the researchers defined a narrow but precise scope for their work. They limited the subject population to undergraduates pursuing a B.Tech degree in IT or CS streams and focused geographically on engineering institutions in India. An operational definition of employability was derived to guide item generation, refined through literature review and industry expert suggestions. However, there could be more explanations on the process of how this operational definition guided item generation and on the detailed procedures and coverage of item selection from the literature. Additionally, there was an opportunity to add the consideration or explanation of perspectives from academic and relevant governmental organizations on employability. Despite emphasizing the importance of employers in conceptualizing employability, more clarification on who would benefit from improved employability and how they would benefit can be added to the currently adapted operational definition of employability.

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The internal consistency of this instrument developed by Khurana and Misra (2021) was evaluated by the developers using Cronbach's alpha, and its validity was assessed through analyses of convergent validity (i.e., confirming related constructs) and discriminant validity (i.e., confirming distinct constructs). Both convergent and discriminant evaluations provide evidence related to construct validity – that is, the extent to which an instrument assesses a given construct with fidelity. It would be beneficial to also conduct an evaluation of criterion-related efficacy, that is, the relationship between the test scores and those on other relevant measures. This would further confirm the utility of the instrument for predicting meaningful outcomes beyond the test scores themselves.

Conclusion and Future Research Recommendations

In a globally competitive knowledge economy where change is a constant, the importance of employability for engineering graduates cannot be overstated. Higher education institutions are increasingly tasked with preparing students for future jobs, technologies, and challenges that are yet to be defined. This ongoing evolution necessitates that graduates continue to enhance their employability to secure and retain employment. The field of engineering, in particular, has seen a significant focus on employability due to a recognized skill gap between education and industry requirements. Based on the current need for continuous enhancement of engineering student and graduate employability and the importance of suitable measurement in this process, this paper reviewed the existing measures in assessing employability within the engineering context and identified current limitations in measuring the employability of engineering students and graduates.

The findings of this critical review underscore the critical need for specialized instruments to measure employability in the engineering context. Our analysis revealed significant gaps in existing tools, which often rely on generic models that fail to address the unique demands and nuances of engineering education and practice. Among the ten instruments identified, only a few were developed to be context-specific measures, and even fewer were thoroughly validated. This lack of robust, contextually relevant tools highlights a pressing need for new measurement instruments tailored to the specific requirements of engineering disciplines.

Existing instruments from developing countries tend to focus on relatively simple definitions of employability, such as job attainment, which do not fully capture the multifaceted nature of employability. This narrow focus overlooks critical dimensions such as career development skills, self-management, and self-efficacy. Furthermore, as most of the instruments mainly looked at students or new graduates, there is limited focus on long-term career. The development of comprehensive, validated instruments that incorporate a wide array of employability dimensions relevant to engineering is essential for both short-term educational assessment and long-term career preparation of students.

Future research should prioritize the creation of employability measurement instruments specifically designed for the engineering context. These tools should be based on a thorough understanding of the unique skills and attributes required in engineering, as well as the specific challenges faced by engineering graduates in the labour market. Employing rigorous validation methods, including criterion validity, is crucial to ensure that the new instruments accurately measure employability. This involves confirming that the instrument not only assesses relevant constructs but also correlates with real-world employability outcomes. This also necessitates the establishment of a context-specific working definition and conceptualization of employability, agreed upon by multiple stakeholders involved.

Researchers should adopt a comprehensive definition of employability that incorporates a range of metrics beyond simple measures such as job attainment. Involving diverse stakeholders, including employers, academic institutions, and professional organizations, in the development and validation of employability instruments is essential. This ensures that the tools reflect the needs and expectations of all parties involved in the engineering employment ecosystem.

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Conducting longitudinal studies to track the effectiveness of newly developed employability instruments over time can provide valuable insights into their long-term applicability and relevance. This approach helps in refining the instruments based on feedback and evolving industry standards. By addressing these recommendations, future research can contribute to the development of robust, contextually relevant employability measurement instruments that enhance the preparation of engineering graduates for successful careers in a rapidly changing global economy.

Overall, this review highlights the urgent need to develop and validate employability measurement instruments tailored specifically for the engineering field. Addressing the identified gaps and aligning the instruments with the multifaceted and evolving nature of employability will significantly improve the assessment and enhancement of employability in engineering education. This review underscores the necessity to improve current employability measurement instruments in engineering education and to reconsider the conceptualization and definition of employability within the engineering disciplinary context.

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