ĐẠI HỌC QUỐC GIA HÀ NỘI
TRƯỜNG ĐẠI HỌC GIÁO DỤC

PHẠM ĐỨC LONG

ĐO LƯỜNG NĂNG LỰC HÀNH NGHỀ CỦA SINH VIÊN TỐT NGHIỆP ĐẠI HỌC NHÓM NGÀNH CÔNG NGHỆ KỸ THUẬT: PHÂN TÍCH TỪ QUAN ĐIỂM CỦA NGƯỜI SỬ DỤNG LAO ĐỘNG (MEASURING THE EMPLOYABILITY OF ENGINEERING TECHNOLOGY GRADUATES: AN ANALYSIS FROM EMPLOYERS' PERSPECTIVES)

Chuyên ngành: ĐO LƯỜNG VÀ ĐÁNH GIÁ TRONG GIÁO DỤC
Mã số: 9140115

TÓM TẮT LUẬN ÁN TIẾN SĨ
ĐO LƯỜNG VÀ ĐÁNH GIÁ TRONG GIÁO DỤC

HÀ NỘI - 2024

CÔNG TRÌNH ĐƯỢC HOÀN THÀNH TẠI
TRƯỜNG ĐẠI HỌC GIÁO DỤC, ĐẠI HỌC QUỐC GIA HÀ NỘI

Người hướng dẫn khoa học: PGS.TS. Nguyễn Thúy Nga

TS. Tăng Thị Thùy

Phản biện 1: PGS.TS. Nguyễn Thị Lan Phương
Phản biện 2: PGS.TS. Nguyễn Vũ Bích Hiền
Phản biện 3: TS. Phạm Hùng Hiệp

Luận án đã được bảo vệ trước Hội đồng chấm luận án tiến sĩ họp tại Phòng 401, Nhà G7, Trường Đại học Giáo dục, ĐHQGHN

Vào hồi 8 giờ 30 phút ngày 24 tháng 12 năm 2024

NGHIÊN CỨU SINH **CÁN BỘ HƯỚNG DẪN 1**

CÁN BỘ HƯỚNG DẪN 2

XÁC NHẬN CỦA CƠ SỞ ĐÀO TẠO

Có thể tìm hiểu luận án tại:

- Thư viện Quốc gia Việt Nam
-Trung tâm Thông tin – Thư viện, Đại học Quốc gia Hà Nội.

INTRODUCTION

1. Statement of the Problem

The rapid growth of globalisation, job insecurity, and new university creation have created new challenges preventing fresh graduates from finding and partaking in employment (Neroorkar, 2022). In addition, a mismatch exists between employer requirements and higher education institutions' supplies, which primarily causes a contrasting picture of graduates' employment.

In such an unstable context, employability is "a key factor determining the success" (Neroorkar, 2022, p.844) of fresh graduates and securing their growth in the knowledge-based economy (Finch et al., 2013). Employability is also crucial for employers in recruiting and using high-quality graduates who are ready to work and continuously contribute to their organisations (Neroorkar, 2022).

Employability has been studied worldwide, but in Vietnam, employability seems to be a novel concept, with most studies from undergraduate and graduate perspectives. Few studies have investigated graduate employability from employers' viewpoints and little concern has been paid to engineering technology graduates. The present study fills the gap by measuring the employability of engineering technology graduates from the employer's perspective.

2. Purposes and Research Questions of the study

The study aims to construct and validate an instrument designed to measure the employability of engineering technology graduates. This study has two objectives: (1) to develop the employability scale based on four selected constructs and validate this scale and (2) to measure graduates' employability at a Vietnamese university and test whether the employers' assessments differ according to their age groups and kinds of enterprises. More specifically, the research seeks to answer the two following questions:

Research question 1: How is the instrument to measure engineering technology graduates' employability developed? To what extent is the instrument reliable and valid?

Research question 2: What levels are identified for engineering technology graduates' employability? How do the employers' assessments differ among age groups and kinds of enterprises?

3. Research design and methodology overview

The research was implemented through two phases, as shown in Table I.1. In the first phase, the scale was developed and validated. Scale development involves three steps: (i) identification of scale constructs, (ii) selection of items from previous studies and items proposed by the researchers from personal enterprise and university partnership experience and (iii) adjustment of items via the Delphi method. The validation of scale items acts as a pilot test for scale modification. SmartPLS 4.0 software was employed to test the scale's reliability and validity. In the second phase, the questionnaire was used to collect the assessments from employers for each ET graduate from a Vietnamese university (University A). Descriptive and inferential statistical analyses on graduate employability were reported before comparing them with the previous studies.

3.1. Participants

Employers who recruited and hired graduates from seven engineering technology majors at a Vietnamese university were selected to join the study. Employers belong to two groups. The first group involves hiring managers, who are directly involved in recruiting and evaluating employees. The second group includes technical managers and supervisors who evaluate, advise, and educate employees.

Employers in this study were restricted to geographical location. Specifically, employers who recruited university engineering technology graduates from a Vietnamese university and worked for enterprises in 10 provinces in Northern Vietnam and one province (Thanh Hoa) in the North Central Coast were selected to take part in this study.

3.2. Data collection and analysis

The study follows an exploratory sequential design combining qualitative and quantitative research design. Exploratory sequential design starts with qualitative data collection. This study employed the Delphi technique as a qualitative data collection method. Based on the exploration of primary qualitative data, the design and development of an instrument were reported. Then, quantitative data collection was carried out by online survey questionnaire.

Qualitative instrument: Focus group discussions were useful in the early stages of scale construction. Focus group discussions were applied “to strengthen the design of the survey and develop a more valid instrument”

(Hennik, 2014, p.17). In this study, three group discussions were conducted by participants from the manufacturing industry and university lecturers to reach a consensus on adjusting constructs and items of the scale.

Quantitative instrument: A survey questionnaire was conducted to validate the scale after focus group discussions. The questionnaire administration was effective in the “preliminary examination of construct and criterion-related validity” (Hinkin et al., 1997. p.107) of the scale. Furthermore, another set of employer data was collected to measure each graduate’s current competencies based on the validated scale. When employers’ assessment data for each graduate was collected, inferential statistics could be exploited to "test hypothesis about the differences in the groups or the relationships of variables" (Creswell, 2015, p. 181). In this study, inferential statistics were applied to test whether the differences were found in employers' assessments of employability means based on the participants' characteristics, namely employers’ age groups and two kinds of enterprises.

4. Significance of the Study

To the best of my knowledge, no single study has been published on the employability of graduates of engineering technology disciplines. This thesis can obtain the following contributions. Firstly, the instrument of employability was developed due to the primary efforts of employers who work in enterprises. Secondly, the study applied the Delphi method, which was less exploited in the education sector, to agree among experts on criteria and items to assess graduates’ employability. Third, PLS-SEM, a modern technique, was exploited to validate structural and measurement models of employability.

5. Organization of the thesis

The introductory part presents the background for this thesis. Chapter 1 clarifies critical terms for the study and reports the employability framework and employability components selected for the thesis. Chapter 2 reports on research methodology. Chapter 3 shows the validation of the measurement instrument of graduate employability. Chapter 4 presents the measurement of graduate employability at University A. The conclusion summarises the study’s contributions, limitations, and implications

CHAPTER 1: LITERATURE REVIEW

1.1. Key terms

1.1.1. Employability

Employability is a multidimensional terminology, which makes it difficult to precisely identify the contents of employability. Furthermore, Chen et al. (2018, p.269) argue that employability has no consolidated view because it is "a complex construct" that cannot be identified comprehensively and briefly. So far employability definitions have been diverse among organizations (e.g. Confederation of British Industry, the Australian Chamber of Commerce and Industry, and the European Higher Education Area) and authors (e.g Hillage & Pollard, Moreland, Thijssen et al. and Cheng et al.). This thesis selected the employability definition stated by Moreland (2006) and Confederation of British Industry (2009) to develop the measurement instrument. Accordingly, employability is defined as "a set of skills, knowledge and personal attributes that make an individual more likely to secure and be successful in their chosen occupation(s) to the benefit of themselves, the workforce, the community and the economy" (Moreland, 2006, p.21).

1.1.2. Engineering technology

The second term is engineering technology, which refers to transforming basic knowledge of mathematics and science to operate engineering systems (Sadiku et al., 2015). Engineering technology was also documented in the Decision by Vietnamese Prime Minister to be the area of study which includes groups of majors and occupations mainly applying engineering principles and technical skills in technical support and related projects (Thủ tướng Chính phủ [Prime Minister], 2017). Engineering technology programs emphasise application and implementation, which supply students with practical skills for working in the industry (ABET, 2022). Engineering technology programs focus more on the operation of technologies and processes. Engineering technology programs in Vietnam cover seven groups of majors (MOET, 2022). The present study focused solely on two groups: the mechanical group of engineering technology and the electric, electronic and communication group of engineering technology.

1.1.3. Employer

The third term is employer. Cheng et al. (2021) state that the employer was identified to be an influential stakeholder in setting developmental directions for higher education and creating opportunities for students to explore their full potential. Labor Code (2019) defines an employer to be "an enterprise, an agency, an organisation, a cooperative, a household, or an individual that can hire and use employee(s) to work for them according to their

agreement" (The National Assembly, 2019). As the Labor Code explains, employers can range from a narrow range of qualified individuals to a broader range of enterprises, organisations, agencies, and households. In the scope of this thesis, employers are defined as enterprises that recruited and used engineering technology graduates to work for them based on labour contracts.

1.2. Employability approach, model

Secondly, this study follows a competence-based approach to employability with employers' assessment of graduates who had their employment positions in the enterprises. A competence-based approach to employability concerns competencies that university graduates must possess during school to meet employers' requirements. Such an approach focuses more on graduates (the supply side). In this case, universities are responsible for producing employable or ready graduates. A competency-based approach to employability is advantageous to measure "different components, to explore their interrelatedness, and to examine how employees may make progress in their employability" (Froehlich et al., 2018, p.231).

The USEM employability model is regarded as the most famous model and has been cited widely (Yorke & Knight, 2006). Although the USEM model has been the popular framework in higher education literature, it has also been criticised for not enough consideration of individual characteristics (attitude as an example) and shortage of clarity, which leads to little understanding and difficulty in exploiting (Römgens et al., 2020. p.2595). Metacognition can be evaluated from students' self-perceived assessment, but metacognition is hard to understand and assess by employers in the enterprise environment, so it is not included in the thesis' employability model. After careful consideration of the USEM model, the adjusted USEM employability model in the thesis covers (i) knowledge (subject knowledge and how to operate in the enterprise) (ii) skills (generic skills and specific skills). Specific skills in engineering technology majors refer to technical skills and (iii) attitude and some personal qualities.

1.3. Employability constructs

Employability is a multidimensional terminology, making it challenging to identify the constructs of employability precisely. Graduates' employability "must be conceptualized broadly" with knowledge, skills, and attitudes, which help graduates exceed organizational borders and work effectively in related industries (Steurer et al., 2023). L. T. Tran et al. (2022) interviewed five graduates in different disciplines (IT, teaching, business, economics, and agriculture) in the Northern mountainous region on graduate employability. They proposed graduates' employability with knowledge, employability skills (or generic skills), and attributes. However, they did not

develop a questionnaire to measure the employability levels of graduates. Similarly, P. Vrat and S. Sangwan (2016) proposed the employability constructs, which included attitude, knowledge and skills for master graduates in business administration and developed a regression model of employability (Vrat & Sangwan, 2016). They admitted that their model of employability constructs were only applied to business graduates and suggested that "similar models can be developed for engineering and other graduates" (Vrat & Sangwan, 2016, p.330). Various categories of graduate employability have been reported by several studies. The noticeable similarity is such studies mentioned knowledge, skills and attributes. Table 1 is the summary of studies on graduate employability with the four constructs: (1) technical knowledge, (2) technical skills, (3) generic skills, (4) attitudes and other attributes:

Table 1. Four employability constructs and their reference sources

No.	Constructs	Source
1	technical knowledge	Ye & Jiang, (2014), Zaharim et al. (2010), Osmani et al. (2015), Khoo et al. (2020), Aliu & Aigbavboa, (2020), Tran et al. (2022), Tong & Gao (2022), García-Aracil et al. (2022)
2	technical skills	Hysong (2008), Osmani et al. (2015), Hanapi et al. (2018), Hosain et al. (2021), Steurer et al. (2023), Pažur Aničić et al. (2023)
3	generic skills	Jackson, (2014b), Osmani et al. (2015), McArthur et al. (2017), Khoo et al. (2020), Leandro Cruz & Saunders-Smits (2022), L. T. Tran et al. (2022), Tong & Gao (2022), Pažur Aničić et al. (2023), Steurer et al. (2023)
4	attitudes and other attributes	Su & Zhang (2015), Osmani et al. (2015), Tran et al.(2022), Steurer et al. (2023)

1.4. Prior studies on development and validation of employability scale

A reliable and valid employability scale was formed based on seven steps (Hinkin et al., 1997). Items creation and content adequacy assessment are the two initial steps in a seven-step process. Items generation can be conducted deductively or inductively, but the minimum number of items is required so that the domain of interest can be measured adequately. For each subconstruct, four or more items are gathered to ensure internal consistency (Hinkin et al., 1997). Content adequacy assessment can involve the participation of panelists. The questionnaire can be sent quickly to experts to

collect assessments extensively, but the questionnaire provides a limited assessment of contents which are under conflict. Thus, qualitative interviews can be conducted as a follow-up activity to review the results of the previous step. Group discussions need to be implemented so that the group decision can be made.

Some academic works on the construction and validation of the employability scale have been carried out. Senan & Sulphey (2022) developed an employability scale for accounting graduates in Saudi Arabia. Yusof et al. (2012) validated the employability skills measurement model for engineering students in Malaysia. Hanapi et al. (2018) combined the Delphi technique and CFA to develop a measurement scale of technical skills in Malaysia. Awwad (2021) also applied PLS-SEM to confirm the factors in the measurement scale of employability skills for students at a college level in the United States.

1.5. Previous studies on measurement of graduate employability

Graduate employability studies have been implemented in many countries, such as Vietnam, Malaysia, New Zealand, Belarus and Colombia. In Vietnam, Nguyen & Nguyen (2015) studied graduate employability assessments from different kinds of enterprises that recruited graduates from engineering and engineering technology majors. Dang et al. (2019) evaluated the competence of graduates from non-public universities from the viewpoints of employers. Mai (2018) conducted a questionnaire survey to explore 25 employers' evaluations of the employability of VNU School of Law. Cheong et al. (2016) investigated employers' perceptions of graduates in Malaysia. Khoo et al. (2020) measured the current competency level of new science and engineering graduates in New Zealand from the viewpoints of employers and teaching staff. García-Aracil et al. (2022) shared that young graduates to compare graduates' present competencies and their required competencies for their current work from employers' perception in the Belarusian context. Yepes Zuluaga's (2024) studied the employability skills of engineering graduates from the perspectives of students, graduates and employers in Colombia.

1.6. Proposed model of the present research

Therefore, the present study develops and validates the employability model of engineering technology graduates. Firstly, a competence-based approach to employability was applied in the current study. Secondly, the present study exploited and adjusted constructs in the USEM model for the employability measurement model for engineering technology graduates, which include knowledge, generic skills and technical skills, and personal qualities.

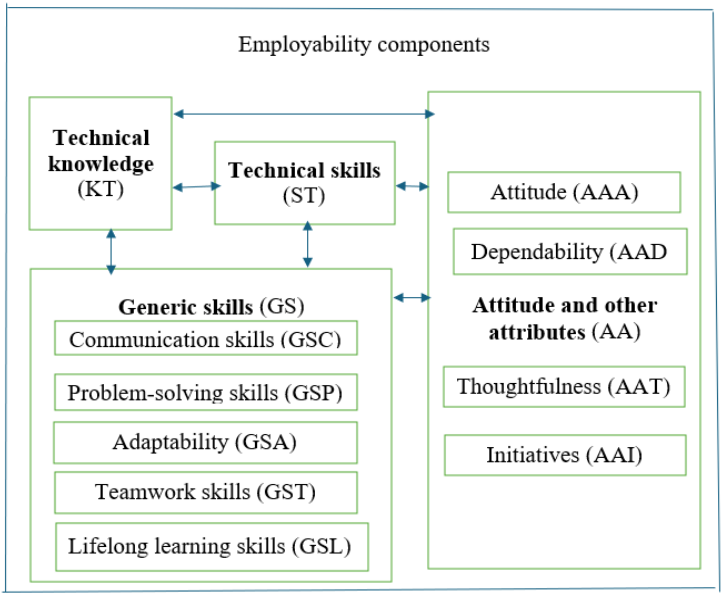

Figure 1. Proposed measurement model of the present research

Figure 1 displays this study's employability components model. Four sources of employability include technical knowledge (KT), technical skills (ST), generic skills (GS), and attitude and other attributes (AA), which act as separate exogenous sources. GS and AA are first-order constructs with dimensions acting as second-order constructs. GS has five second-order constructs: communication skills (GSC), problem-solving skills (GSP), adaptability (GSA), teamwork skills (GST) and lifelong learning skills (GSL). AA has four second-order constructs: attitude (AAA), dependability (AAD), thoughtfulness (AAT) and initiatives (AAI). Only second-order constructs: GSC, GSP, GSA, GST, GSL, AAA, AAD, AAT, AAI, KT and ST were analysed for validity and reliability of the scale.

1.7. Conclusion

CHAPTER 2: RESEARCH DESING AND METHODOLOGY

2.1. Research design

This study exploits a mixed-methods approach, including using and integrating both qualitative and quantitative methods (Tashakkori & Creswell, 2007). The present study applies the type of exploratory sequential design for mixed methods. Table 2.1 summarized the research process.

Table 2. 1. Research process

Phase 1: Developing and validating an assessment scale	**Contents**
Step 1.1 (Chapter 1)	Building a theoretical model
Step 1.2 (A proposed scale)	Items generation
Step 1.3 (Qualitative method)	Receiving feedback from 20 experts
Step 1.4 (Qualitative method)	Analyzing experts' opinion to adjust items
Step 1.5 (Quantitative method)	Collecting data for a pilot test
Step 1.6 (Quantitative method)	Analyzing and adjusting research mo
Phase 2: Measuring	
Step 2.1	Measuring the employability
Step 2.2	Difference testing

2.2. The proposed scale

The employability scale for engineering technology graduates was proposed based on the USEM model, competence-based approach to employability, human capital theory, and empirical employability studies in several countries. The proposed scale included four first-order constructs. The distribution of constructs and items in the competency framework is shown in Table 2.2.

Table 2. 2. Components in the proposed employability scale

No.	**First-order constructs**	**Second-order constructs**	**Items**
1	Technical knowledge	1	7
2	Technical skills	1	5
3	Generic skills	5	21
4	Attitude and other attributes	4	18
	Total	11	51

The scale was adjusted through the Delphi method. The reliability and validity of the scale were examined through the pilot questionnaire.

2.3. Qualitative method

2.3.1. Sampling

A questionnaire was adjusted by exploiting the expertise method. The Delphi technique does not rely on "a statistical sample that attempts to be representative of any population" (Okoli & Pawlowski, 2004, p.6). Fifteen employers and five lecturers were invited to attend the group discussions. Criteria for selecting experts was presented in Table 2.3.

Table 2. 3. Criteria for selecting experts to answer the draft question

No.	Title	Criteria	Number of experts
1	Head/Deputy head of technical division	- Working in foreign-owned enterprise. - Current job: supervising and guiding ET graduates - Qualification: Bachelor of Arts related to engineering technology - Number of years of practical experience in the field: 5 – 20 years. - Technical skill: master technical knowledge and technical skills for career growth of ET graduates.	10
2	Human resource recruiting team leader	- Working in foreign-owned enterprise. - Current job: recruiting new ET graduates (Understanding vital soft skills and attributes for ET graduate development) - Qualification: Bachelor of Arts related to human resource - Number of years of practical experience in the recruiting field: 5 – 15 years + Feedback experience: prefer those who have previously participated in group interviews with ET program accreditation experts.	5
3	University lecturer or both university lecturer and department leader	- Qualification: Doctor - Current job: managing and operating ET programs (Professional experience in teaching ET courses, developing, operating or preparing for the accreditation of an ET program). - Number of years of teaching experience: 5 – 15 years.	5

2.3.2. Data collection

The study was conducted at a Vietnamese university based in Hanoi. University A (pseudo name) has 1.500 lecturers and support staff and over 30.000 students at three levels. Among higher education programs at University A, engineering technology disciplines attracted the most significant number of students to enrol each year.

In terms of enterprise cooperation, University A established a functional unit supporting employment for undergraduates in 2014. Enterprises

that recruit engineering technology graduates maintain win-win long-term relationships with University A.

The first round of applying the Delphi method

Twenty experts were asked to give their feedback by selecting "Agree", "Neutral", or "Disagree" to decide whether the item from the proposed scale is suitable for evaluation of graduate employability.

The second round of applying the Delphi method

The Zoom platform was exploited to implement group interviews. Following the guide by Onwuegbuzie et al. (2009), twenty participants who joined the first round, were invited for group interviews. Participants were asked to clarify the statements below 75% agreement. They were asked whether they changed their ratings in the first round and revised the scale by answering the following questions: Are such constructs appropriate? Do any constructs need to be added/deleted? For each dimension, is the number of items enough to reflect each dimension? Which items are not clear? Why? How to adjust? Which items should be removed? Why? Which items should be added? Why?

2.3.3. Data analysis

If one item reached the agreement with 75% of participants, such items were accepted for further use. The next round is completed when a consensus among experts is reached.

2.4. Quantitative method

2.4.1. Sampling

For a pilot test, the entire process of inviting participants and taking the survey responses by the 153 employers from technical groups was conducted in January and February 2024. Among these 153 participants, 135 (or 88.24%) were male, and 18 (n=11.76%) were female. Most participants worked for private and foreign enterprises (54.25% and 37.25%, respectively), while the rest served state-owned companies (n=8, 8.50%). Regarding working location, most respondents worked in enterprises which are in Hanoi, Bac Ninh, and Bac Giang. Enterprises recruited graduates from 7 ET majors.

Participants in the official test were different from the respondents for the pilot test. Participants who joined the pilot test recruited and used ET graduates in general without worrying about graduation year and specific ET discipline. The participants in the official test were chosen based on the report by graduates in 2023 about their workplace and their employers. For an official test, the questionnaire was sent to the employers who recruited and employed the graduates from 7 ET majors at the University A with following discipline codes and names:

7510201: Mechanical ET, 7510203: Mechatronic ET,
7510205: Automotive ET, 7510206: Thermal ET

7510301: Electric, electronic ET
7510302: Electronics and telecommunication ET
7510303: Control and automation ET

The graduates' employment survey in August 2023 showed that 2.241 graduates attended the compulsory survey, in which 555 graduates confirmed to have gained jobs, and the other (above 75%) did not intend to find jobs or wanted to pursue a master's degree. The thesis focused on the assessment of employers who managed 555 ET graduates. The number of enterprises that recruited 555 ET graduates of seven engineering technology majors is 307.

The official questionnaire was sent to 350 employers in three months in 2024. The 234 valid responses were used to analyze.

The participants were involved in the official test from 26th February to 3rd April 2024. Most participants were male. They almost earned Bachelor's degrees before entering enterprises and maintained their qualifications until the survey time. Regarding enterprise address, respondents reported working for enterprises located in 11 provinces in Vietnam.

2.4.2. Instrument

The thesis used the 5-point Likert scale to measure items. The pilot and official questionnaire include two parts. The first part covers items rated by employers and the second is participants' demographic information. Because of its simple administration and easy access, Google Form was exploited.

2.4.3. Data collection

For a pilot test

The survey questionnaire includes an introductory part and two content parts. Part one involves 52 items. For each item, the employers were required to select one number from one to five, equivalent to the increasing competence assessment level from "Very low" to "Very high". Part two covers the participants' personal information and their enterprises' characteristics. The online survey questionnaire (http://bit.ly/SVTN-CNKT) was designed online in Vietnamese and took the participants 10 minutes to complete.

The questionnaire was sent to participants in two different ways. The first way was to email the enterprise's human resources department. The second way was to call the technical divisions guiding the final-year undergraduates for internships. After two weeks, from 19th January to 2nd February 2024, 153 usable responses were used for analyzing the data.

For an official test

The online questionnaire (https://bit.ly/KSSVTN2023) was sent to 350 participants in two ways. The first way was to call and email the enterprise's HR department and ask them to send the questionnaire to technical group leaders. The second way was to call graduates to contact the head of technical groups.

After six weeks, from 26th February to 3rd April 2024, 234 usable responses were used to analyze the data. This sampling size exceeds the minimum of 228 from a population size of 555 (Calculator.net, 2024).

2.4.4. Data analysis

For a pilot test, the current study uses the partial least squares (PLS) technique to test the model because the PLS-SEM technique is appropriate when the sample size is relatively small (Hair et al., 2019). Furthermore, the PLS-SEM technique can work well with complicated structural models. Thirdly, the PLS-SEM technique does require data with nonnormal distribution (Dash & Paul, 2021, p.8).

Assessing measurement model

The measurement model developed in the study was the reflective measurement model, which covers four steps: indicator loadings, internal consistency reliability assessment, convergent validity, and discriminant validity (Table 2.3) (Hair et al., 2019**)**.

Table 2. 3. Acceptance criteria for measurement model assessments

Criteria	Acceptance criteria
Indicator loadings	≥ 0.7
Internal consistency reliability	0.70 - 0.95
Convergent validity	AVE ≥ 0.50
Discriminant validity	HTMT < 0.90

(Source**:** Hair et al., 2019 and Hair et al., 2014)

Assessing structural model

After the measurement model satisfies the requirement of the model's reliability and validity, the structural model can be assessed. This is an additional part of the thesis. Table 2.4 shows steps to assess: Collinearity (VIF), R^2 value.

Table 2. 4. Acceptance criteria for structural model assessments

Criteria	Acceptance criteria
Collinearity (VIF)	Probable (i.e. critical) collinearity issues when VIF ≥ 5 Possible collinearity issues when VIF ≥ 3-5 Ideally show that VIF < 3
R^2 value	R^2 values of 0.75, 0.50 and 0.25 are conside substantial, moderate and weak.

(Source**:** Hair et al., 2019 and Hair et al., 2014)

Measuring the employability of graduates

SPSS software was applied to analyse employers' assessment results on graduates' employability and test differences among employers' characteristics regarding age range and kinds of enterprises and the participants' assessment of gradautes' employability (Table 2.5).

Table 2. 5. The data analysis technique to measure graduates' employability

No.	Content	Sub-content	Data analysis
1	Employability constructs	4 first-order constructs, 11 second-order constructs	Descriptive statistics: mean, SD.
2	Analysis of variance	Difference test towards employability components	Inferential statistics: Difference testing

2.5. Research ethical consideration

The consent forms were given to the participants in the Delphi process. The researcher contacted the intended participants and sent them the invitations.

For group discussions via Zoom meetings, the researchers introduced the results of the prior round, contents to discuss and expected results before asking permission to record the online working session. The researcher contacted enterprise representatives to ask for permission for the head or deputy head of technical groups and human resource recruiting team leaders to join the study. After the name and contact information were sent back through email or Zalo-based application, the researcher contacted the intended participants and sent them the invitations. In the invitation email, the research explained the aims of the study, tasks of participants, planned time, expected outcomes, and request for agreement to participate in different rounds. When the participants refused to join the study, the researcher accepted and contacted the enterprise representatives to introduce new experts.

For group discussions via Zoom meetings, the researchers introduced the results of the prior round, contents to discuss and expected results before asking permission to record the online working session. The participants were asked to open their video image if they were comfortable. In case they worked in their office or expected to turn off the camera due to rules of enterprise data security, they could turn on the audio voice only when they stated.

The study data for the scale validation and employability measurement of graduated students in 2023 were collected and analyzed with the approval of participants and the leader of University A.

2.6. Conclusion

CHAPTER 3. RELIABILITY AND VALIDITY OF THE SCALE

Research question 1: How is the instrument to measure engineering technology graduates' employability developed? To what extent is the instrument reliable and valid?

3.1. Development of employability scale

3.1.1 Expert feedback results in the first round

There were 43 items which received high agreement from at least 75% of experts. On the other hand, eight items reached the lower agreement, from 50% to 70% experts, so they needed to be clarified to keep or remove in the next round.

For technical knowledge, KT_1 was assessed to be the highest, followed by KT_5. Three items, including KT_3, KT_6, and KT_7, ranked third in expert consensus. KT 2 received the second lowest agreement with the highest neutrality, while KT_4 obtained the lowest agreement and the highest disagreement.

All items regarding technical skills were assessed to be suitable, with agreement levels ranging from 75% to 80%, which met the standard set by Keeney et al. (2006).

Among the five lower levels of generic skills was teamwork with all items, which received agreement from over 95% of experts. The remaining four sub-constructs of generic skills obtained high consensus from experts and contained four items (GSC_3, GSP_4, GSA_4, and GSL_4), which reached agreements at a lower level than 75% with high levels of neutrality.

Furthermore, attitude and other attributes covered four lower levels of "Attitude", "Dependability", "Thoughtfulness", and "Initiative". Sixteen out of 18 items were accepted by 75% of specialists or more. Two items (AAA_5 and AAT_4) received below 75% of the experts' agreement level. The two sub-constructs of "dependability" and "initiative" contained the items with good internal consistency. On the other hand, two other sub-constructs of "attitude" and "Thoughtfulness" involved one item with high neutrality for each.

3.1.2 Expert feedback results in the second round

Three groups of experts who had attended the initial round were invited to participate in the second round for group discussion.

The expert discussion group: there were five items that needed to be adjusted. The construct "technical knowledge" changed from seven to six items after the second round.

Similarly, expert group discussions were implemented for technical skills. The construct "technical skills" was kept stable with five items after the second round.

The expert viewpoints on generic skills: the construct "generic skills" increased in 2 items in the second round. Specifically, problem-solving skills and teamwork changed 4 to 5 items per sub-construct. Communication skills, adaptability, and lifelong learning preserved their items after the second round with 5, 4, and 4 items, respectively.

The number of items in the construct "attitude and other attributes" in the second round is the same as in the first round (18 items). Seven out of 18 items were modified. The four lower levels of the construct were kept like the first round.

3.1.3. Scale components after taking expert feedback

After two rounds of receiving feedback from three groups, the employability scale included four first-order constructs and an increase of one item from 51 to 52 items (Table 3.1).

Table 3. 1. Scale components after taking feedback

Components	**Second-order constructs (Before)**	**Second-order constructs (After)**	**Items (Before)**	**Items (After)**
Technical knowledge	1	1	7	6
Technical skills	1	1	5	5
Generic skills	5	5	21	23
Communication skills			5	5
Problem-solving skills			4	5
Adaptability			4	4
Teamwork			4	5
Lifelong learning			4	4
Attitude and other attributes	4	4	18	18
Attitude			6	6
Dependability			4	4
Thoughtfulness			4	4
Initiative			4	4
Total	**11**	**11**	**51**	**52**

3.2. Validation of employability scale

The reliability and validity of the employability scale were assessed through measurement and structural models.

3.2.1. Measurement model of 4 first-order constructs and 52 items

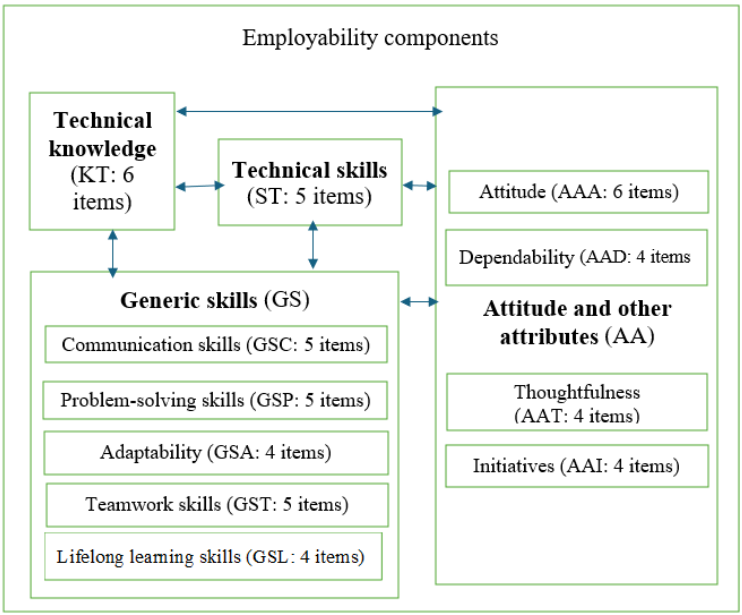

Figure 3. 1. Measurement model with 52 indicators

The measurement model with 52 indicators (Figure 31.) was evaluated by internal consistency reliability, outer loading, and convergent and discriminant validity.

Internal consistency reliability

Eleven second-order constructs have good internal consistency reliability. Their composite reliability, which is between 0.82 and 0.9, outweighs the acceptance value of 0.7. So, the eleven scales are reliable.

Outer loading

There are 46 outer loadings which meet the standard, and six other outer loadings are below the standard. Therefore, six outer loadings should be removed from the lowest outer to the higher outer. After removing 5 indicators AAD4, KT4, GSC1, AAA3, and AAA4, respectively and performing the analysis, the reliability and convergent validity of the scale were established.

Convergent validity

Eleven constructs' AVE value is superior to the required lowest threshold value of 0.50. Accordingly, the scales to measure the eleven second-order constructs have reached high levels of convergent validity.

Discriminant validity

HTMT indicators are below 0.9, so all paths are discriminant. It is noticeable that HTMT for AAD-AAI (0.85), GSP-GSC (0.87) and ST-KT (0.85) are near 0.9, so these paths might have potential issues of being not discriminant from other ones.

3.2.2. Measurement model of 4 first-order constructs and 47 items

Figure 3.2 displays this study's measurement model of 47 items after removing five items of KT4, GSC1, AAA3, AAA4, and AAD4.

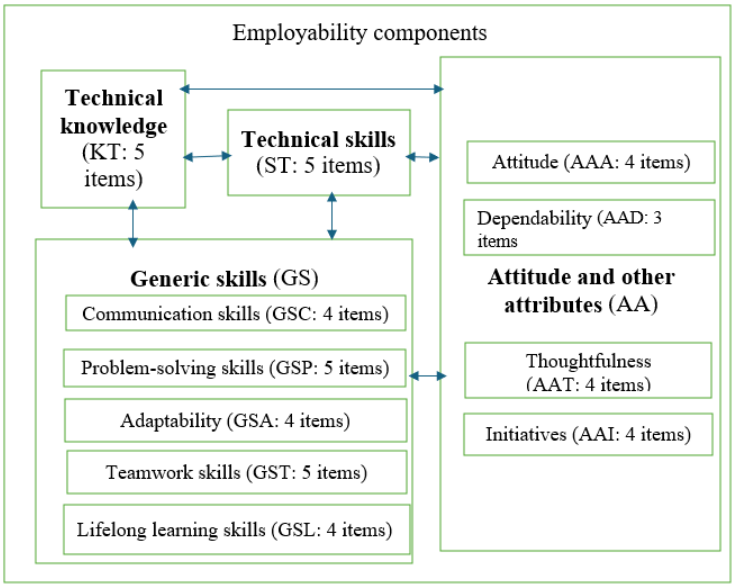

Figure 3. 2. Measurement model with 47 indicators

Internal consistency reliability

Cronback's alpha of eleven constructs ranges from 0.72 to 0.86, and the composite reliability indicator lies between 0.84 and 0.9. It can be concluded that all eleven scales have an acceptable internal consistency. Moreover, 47 outer loadings met and outweighed the standard.

Convergent Validity

The convergent validity met the respective criteria: CR> 0.70, CR > AVE and AVE > 0.50. Thus, it can be concluded that the individual constructs were valid and reliable.

Discriminant Validity

HTMT indicators are smaller than 0.9, so these variables are discriminant against other variables.

3.2.3. Assessing structural model

There are two proposed structural models to be assessed by SmartPLS 4.0. This is an additional part of the thesis. These exploratory study results of assessing structural models need to be enriched by future studies.

a. The first structural model

The first employability structural model (Figure 3.3) was assessed through R^2 for model explanation power and Path coefficients. VIF values were not assessed in the formative model of employability.

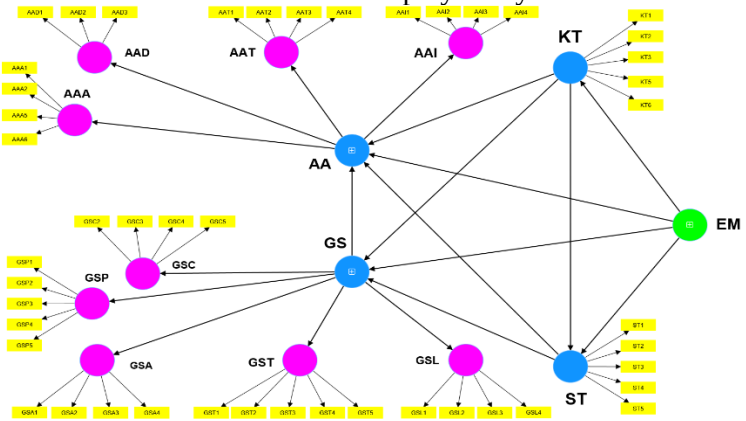

Figure 3. 3. The first structural model with 47 indicators

b. The second structural model

The second employability structural model (Figure 3.4) was assessed through VIF values, R^2 for model explanation power and Path coefficients.

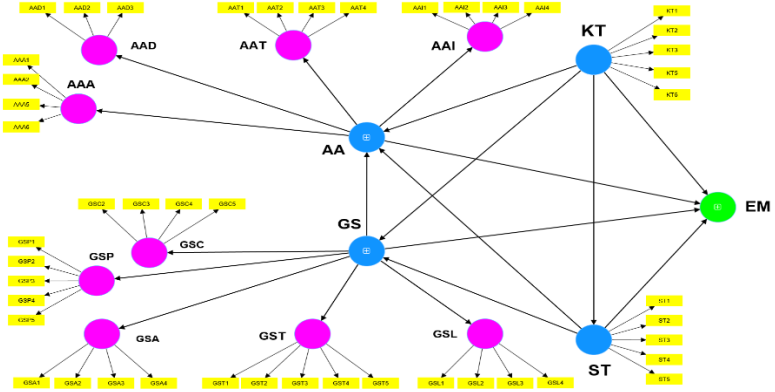

Figure 3. 4. The second structural model with 47 indicators

CHAPTER 4. MEASUREMENT OF GRADUATES' EMPLOYABILITY

Research question 2: What levels are identified for engineering technology graduates' employability? How do the employers' assessments differ among age groups and kinds of enterprises?

4.1. Graduates' levels of employability

4.1.1. First-order constructs of graduates' employability

Engineering technology graduates received a positive assessment of general employability (Mean = 3.54, SD=0.48). Attitude and other attributes were evaluated to the highest (Mean= 3.65, SD=0.53), followed by technical skills (Mean=3.55, SD=0.50) and generic skills (Mean=3.51, SD=0.52). Technical knowledge (Mean=3.45, SD=0.55) was assessed to achieve the lowest level of employability among the four constructs.

4.1.2. Second-order constructs of graduates' employability

Among eleven employability subconstructs, the graduates' attitude (Mean=3.73, SD=0.56) obtained the highest judgement from employers' perspectives. Furthermore, graduates' dependability (Mean= 3.69, SD=0.58) and adaptability (Mean=3.65, SD=0.59) were ranked the second and third highest in the employability competencies. It was noteworthy that graduates' thoughtfulness and their technical skills were all rated to be in the sixth position. Their mean values are the same (Mean = 3.55).

4.1.3. Assessment of graduates' employability levels

Firstly, graduates' technical knowledge was assessed at a medium level of employability (Mean=3.45, SD=0.55). Employers assessed KT2 as the highest (Mean=3.50, SD=0.66), followed by KT1, KT3 (Mean=3.44, SD=0.65), KT5 (Mean= 3.43, SD=0.73). KT4, was assessed as the lowest (Mean=3.39, SD=0.69).

Similarly, graduates' technical skills were assessed at a medium level of employability. Employers assessed ST4 to be the highest (mean= 3.61, SD=0.64) and ST2 to be the lowest (mean=3.45, SD=0.66) among five indicators of technical skills.

Thirdly, for graduates' generic skills, graduates' adaptability received the best assessment (mean=3.65), and their problem-solving skills were at the lowest level (mean=3.39).

Finally, graduates' attitudes and other attributes were assessed to be highest by attitude (mean=3.73), followed by three different attributes, AAD (mean= 3.69), AAI (mean= 3.64), and AAT (mean=3.57).

4.2. Difference testing

4.2.1 Difference in the age range to graduates' employability

The Sig of the Levene test is 0.004 < 0.05, so variances were found the difference between the age groups. However, the Sig of the Welch test is 0.66 > 0.05, indicating that no significant differences in employability assessment were recognized among participants who belonged to four age groups. Employability means for the four groups of age are closer to each other, which means that employers at all age groups highly adjusted graduates' employability.

4.2.2. Difference in enterprise kinds to graduates' employability

The Sig of the Levene test is 0.16 > 0.05, so there were no differences in variance between the two kinds of enterprises. However, Sig of F test = 0.003 < 0.05, so significant differences were shown between participants from foreign-owned and private-owned enterprises for employability assessment. The employability means for two kinds of enterprises are both high (>3.4), and significant differences in assessment were recognized among participants who worked for private-owned and foreign-owned enterprises.

4.3. Discussions

The study found that ET graduates' employability competencies were very positive. These results seem to differ from Nguyen & Nguyen's (2015) employability of engineering-technology graduates assessed by enterprises in Northern and Southern Vietnam. However, in the Belarusian context, García-Aracil et al. (2022) shared a similar result regarding graduates' employability competencies.

The study findings showed that graduates' technical and generic skills were assessed higher than their technical knowledge. This result reconfirmed the findings in the previous study. Mai (2017) ascertained that generic skills, in several situations, are "more important than graduate's technical knowledge" (Mai (2017, p.140).

Among 11 second-order constructs, graduates' attitudes were evaluated at the highest level. There are similarities between the roles of attitudes found in this study and those described by Su & Zhang (2015) in China and Steurer et al. (2023) in South Africa. The study's findings on employers' assessment of Vietnamese public university graduates are similar to those of Vietnamese non-public university graduates by Dang et al. (2019).

Vezi-Magigaba and Utete (2023) reported that employers regarded problem-solving as the most important non-technical skills. However, ET graduates' problem-solving skills were the weakest generic skills among the 11 second-order constructs. This finding was also reported by Khoo et al.

(2020). Employers confirmed that problem-solving skills were among the ten biggest gaps in graduates' competency. They also predicted that problem-solving skills could be ranked in the top five competencies in terms of importance in 2030.

In Vietnam, English has been accepted as a crucial competence, so the foreign language, including English, is a compulsory subject for students from grade 3 to grade 12 in MOET's 2018 General Education Program (V. Van Hoang, 2022). However, the item GSC1, "Communicate in a foreign language at the basic level at work", by engineering technology graduates was assessed to be the lowest among generic skill items by employers. This result is similar to that found in Nguyen & Nguyen (2015), who figured out that foreign language competence and applying specialized knowledge in practice were the two lowest-rated skills by 386 industry employers for Vietnamese graduates in engineering and technology disciplines.

No significant differences in employability assessment were recognised among participants who belonged to four age groups. This finding does not align with the study by Yepes Zuluaga (2024). She asserted that age was significantly linked with the growth of engineers' employability skills.

Significant differences were shown between participants from foreign-owned and private-owned enterprises for employability assessment. This finding is consistent with that of Nguyen & Nguyen (2015) in Vietnam and Cheong et al. (2016) in Malaysia.

The measurement results of graduates' employability showed some issues which need to be considered for better preparation to foster graduates' employability. Firstly, graduates' technical knowledge was assessed to achieve the lowest level of employability among the four first-order constructs. Secondly, the graduates' attitude obtained the highest judgement from employers' perspectives among eleven second-order constructs. Thirdly, communication skills in a foreign language at the basic level at work received the lowest assessment from employers among 22 items for generic skills.

Three proposals are given to prepare for undergraduates' employability. The first proposal is to implement experiential learning via field trips for undergraduates. The second proposal is to implement industrial field trips for university lecturers. The third proposal is to organize the training programs taught in English.

4.4. Conclusion

CONCLUSION

Summary of main findings

Research question 1: How is the scale to measure engineering technology graduates' employability developed? To what extent is the scale reliable and valid?

This study exploited the Delphi technique to develop a measurement scale of employability. There are two rounds to achieve agreement among experts on the proposed 51-item measurement scale. The result is to delete 2 items, to add 3 items, and to adjust 23 items. The questionnaire, after expert feedback, includes 52 items for four first-order constructs.

The scale's validity and reliability were tested through the confirmatory factor analysis method using PLS-SEM method. The study's employability scale was validated to cover four components: 5 items for technical knowledge, 5 items for technical skills, 22 items for generic skills, 15 items for attitude and other attributes.

Research question 2: What are the levels of engineering technology graduates' employability? How do the employers' assessments differ among age groups and kinds of enterprises?

Employability was classified into four first-order constructs. Employers' assessments showed that graduates' technical knowledge scored the lowest level of employability. Attitude and other attributes were evaluated to be the highest. Technical skills and generic skills ranked second and third. Employability was further broken down into eleven second-order constructs. the graduates' attitude received the highest evaluation from employers, followed by graduates' dependability and adaptability, which ranked second and third, respectively. Conversely, problem-solving skills, technical knowledge and communication skills were identified as the three lowest second-order constructs in employability.

The analysis revealed no significant differences in employability assessments among employers across the age groups. However, significant differences were shown between participants from foreign-owned and private-owned enterprises in terms of employability assessment.

Significance of the study

The study is one of the first academic works which primarily focused on developing an employability scale specifically for engineering technology graduates. Furthermore, the study is the first survey that implemented employers' employability measurement for each ET graduate.

Recommendations for practice

Employers' assessment of graduates' employability can supply valuable sources for University A in developing training programs to meet the industry's and society's requirements. The employability scale developed in the thesis is likely to be used by human resource managers for assessment of fresh staff after each year working in the enterprise. Moreover, the measurement results might give two proposals to enterprises. Firstly, foreign language proficiency was identified as the graduates' lowest competence. It is recommended that enterprises can supply undergraduates with scholarships which include budgets for intensive foreign language training. Secondly, collaborations between industry and universities need to be installed to address skill gaps. The thesis's results of graduates' employability levels might provide undergraduates with better perceptions of learning English, plans for improvement of problem-solving skills and technical knowledge.

Limitations and recommendations for further research

Limitations of the research

The study has three following inevitable limitations:

Firstly, the study's scope is restricted. The present study focused on two engineering technology discipline groups. Secondly, the study is limited to its sampling. The first sampling limitation is the number of experts in the Delphi process. The second sampling limitation is 153 participants in a pilot test. The third limitation is the sample size for the official test, in which 234 responses were recorded. Thirdly, data collection was implemented in Vietnamese for the Delphi process, pilot, and official tests. Afterwards, the participants' answers were interpreted into English by back translation technique. Despite the researcher's efforts and experts' expertise in linguistics and educational assessment, the nuances of respondents' expressions cannot be translated with absolute accuracy.

Implication for future Research

The study has the following implications for future research. Firstly, further studies could be conducted using data collected from several universities in Vietnam. Secondly, future research could involve employers who recruited graduates before or after the COVID-19 pandemic. Thirdly, further studies using semi-structured interviews could discover the reasons for differences in the evaluation of foreign-owned and private-owned enterprises. Future studies should be carried out from the perspectives of other stakeholders, Finally, future studies could examine the employability-related issues in Vietnamese universities by exploiting other employability models.

LIST OF PUBLICATIONS

1. Pham Duc Long, Nguyen Thuy Nga. 2021. The key factors for employment opportunities of university graduates in Vietnam. *Proceedings of 1st Hanoi Forum on Pedagogical and Educational Studies* ***(ISBN: 978-604-342-795-0)***, p.294-394. Hanoi: Vietnam National University Press, Hanoi.
2. Pham Duc Long, Nguyen Thuy Nga, 2021. The stakeholders' roles in enhancing undergraduate students' employability skills in Vietnam. Proceedings of the 2nd International Conference on Innovation in Learning Instruction and Teacher Education (ISBN: **978-604-54-8739-6**), p.390-398. Hanoi: University of Education Publisher.
3. Pham Duc Long, Nguyen Thuy Nga. 2022. Students' evaluation on field trips as a means to prepare for graduate employability in a Vietnamese university. *Humanities and Social Sciences Letters*, 10(2), 198-212. https://doi.org/10.18488/73.v10i2.3011 (**Scopus Q3**, Online ISSN: 2312-4318, Print ISSN: 2312-5659).
4. Pham Duc Long, Nguyen Thi Ha Thuy. 2022. Experiential learning through field trips: a perspective from students at Hanoi University of Industry. *Hanoi National University of Education: Journal of Science* (**ISSN: 2354-1067**), 67 (4), p.173-180. DOI: 10.18173/2354-1067.2022-0072
5. Pham Duc Long, Nguyen Thuy Nga, Tang Thi Thuy. 2023. Application of the Delphi framework to develop a measurement instrument of employability. *Proceedings of the 3rd Hanoi Forum on pedagogical and educational sciences* **(ISBN: 978-604-369-697-4)**, p.539-551. Vietnam National University Press, Hanoi.
6. Pham Duc Long, Nguyen Thuy Nga, Tang Thi Thuy, Nguyen Thi Ha Thuy. 2024. Employability of Engineering Technology Graduates at a Vietnamese University: An Assessment from Employers' Perspectives. Vietnam Journal of Education ***(ISSN: 2588-1477)***, 8 (3), p.190-202, *https://doi.org/10.52296/vje.2024.394*.
7. Pham Duc Long, Nguyen Thuy Nga, Tang Thi Thuy, Nguyen Thi Ha Thuy. 2024. Employability Model Evaluation of Engineering Technology Graduates: A PLS-SEM Approach. VNU Journal of Science: Education Research ***(ISSN: 2588 1159)***, 40 (4), p.44-60, https://doi.org/10.25073/2588-1159/vnuer.4973.
8. Pham Duc Long, Nguyen Thuy Nga, Tang Thi Thuy. 2024. Applying the Delphi Technique in Developing the Employability Scale for Engineering Technology Graduates. Vietnam Journal of Education **(ISSN: 2588-1477)**, (Acceptance letter on 30 October 2024).