Proposal Guidelines for University to Enhance the IT Students' Employability Based on Needs Assessment

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ABSTRACT

While IT industry plays a major role in the social and economic development, there is still a phenomenon that IT industry has difficulty in recruitment and IT students are difficult to be employed. It is important to improve IT students' employability to bridge the gap between recruitment and employment. This research focuses on constructing the structural IT student employability indicator model and evaluating IT undergraduate employability from the view of enterprises through the combination of theoretical and empirical research, qualitative analysis and quantitative analysis. This research hopes to provide valuable insight for the improvement of IT undergraduate employability.

Through the literature review of current study, this research first proposes a preliminary employability structure. Then this model is refined through the method of focus group interview. The refined model contains three primary indicators, 11 secondary indicators and 23 third-level indicators. The pre-test survey is conducted for the reliability and validity the test. Then this study conducts empirical study with questionnaire method to evaluate the IT undergraduate employability. This study conducts ANOVA method to study the background variables' influence and interaction effects. The importance-performance analysis and priority need index methods are used to study the employability improvement priority.

This study constructs the employability model that represent the characteristics of IT profession and the demand of the enterprise, which could be the solid foundation for improvement guidelines. The study also reveals that the performance of employability is generally not satisfying and requires improvement. It can also be concluded that significant opinion difference exists between the recipients with different background variable. Through comparing the results from IPA and the PNI ranking, the improvement priority of employability is identified. This study finds that eight employability indicators urgently need improvements. This finding could help training units effectively allocate limited resource and provide guidance for effective employability improvement.

Keywords - IT Students, Employability, Need Assessment, IPA, PNI

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1. INTRODUCTION

As an important engine of the modern economy, the development of IT industry plays a major role in accelerating the adjustment of industrial structure and upgrading the national economy (Economides, 1999). As future practitioners in the IT industry, students of the IT major, with enhanced employability, will lead the development of the industry in level and depth, and be a major guarantee which promotes the employment of the society and pushes the Chinese economy to the world stage (Zou, 2008). Studies on the employability structure of college graduates from the IT major will help to improve their quality of employment, improve their training quality, and improve the efficiency of the IT industry (Harvey, 2002). This study combines theoretical and empirical research and uses qualitative and quantitative research methods to establish an employability evaluation indicator system and its evaluation model for college graduates of the IT major, and studies its composition characteristics, trends and influencing factors, with a view to proposing solutions and suggestions to enhance the employability of IT major students.88

1.1 Problem statements

IT is the application of computers and internet to store, retrieve, transmit, and manipulate data, or information, often in the context of a business or other enterprise. IT industry, as an important part of modern high-end service industry, relying on IT and driven by the information productivity, features low resource consumption, low environmental pollution, high output, high added value and high level of internationalization (Arend & Amit, 2005). It plays an obvious role in promoting economic development and is important for accommodating labours and widening employment channels. At present, the shortage of qualified IT talents, poor talent structure, and scarcity of talents with international views are the major problems facing China's IT industry, which restricts the development of the industry to a great extent (Rickne, 2013). But at the same time, college graduates are facing enormous pressure in finding suitable employers and jobs, making their employment difficult (Robst, 2007). This is directly caused by the mismatch between the employability of IT graduates and industry needs, and indirectly by the deficiencies in cultivation of employability in colleges. A more comprehensive and scientific way is to evaluate the employability of IT graduates, so that it can reflect the competence they demonstrate in the job-finding process. Only by establishing a scientific information technology graduate employment capacity structure system can we objectively evaluate its ability and improve the ability of colleges and universities to cultivate employability. (Mishra， Alseddiqi， & Pislaru, 2009).

1.1.1 Background of study

With the rapid development of IT industry and entry of the economic growth into the new normal, the demand structure of human resources market has also undergone a new change: the traditional low-end job needs are shrinking, while in industries closely related to new technologies, talents fail to meet the growing demand (Yu & Ding, 2011). "A global knowledge and information society is born with the globalization of the world, and knowledge and information are becoming increasingly important factors in the sphere of production and services, and they affect the distribution of international labour forces, determine the competitiveness of enterprises and the development of the entire economy, generate new growth models, and in this process give birth to new products, new employment opportunities and new lifestyles", said Hans D'Orville, Director, IT for Development Program, UNDP. (D'Orville, 2000) This new employment opportunity has brought new opportunities and challenges to IT graduates. As high-end science and technology talents in the process of economic and social development, IT graduates are important human resources for the nation, and their quality of employment is directly related to the realization of their own values and social values. Studies on the employability of IT graduates will help optimize the allocation and efficiency of human resources in the society, promote the development of the IT industry, heighten the quality of IT talent training in colleges, and help the employers improve their human resources management (Harvey, 2002).

(1) From the perspective of colleges: the IT graduates have a low employment rate and there are deficiencies in talent training

Employability is a management philosophy, developed by Sumantra Goshal in 1997, which recognizes that employment and market performance stem from the initiative, creativity and competencies of all employees, and not just from the wisdom of senior management. Employability can be defined as "doing value creating work, getting paid for it and learning at the same time, enhancing the ability to get work in the future". Employment means a choice of value where a person who has the ability and willing to work finds himself a suitable job, creates and realizes value and serves the community. Whether one can be employed when he has the will to work is related to his livelihood and his dignity (Singh, 2009). At present, Chinese IT talents are mainly sourced from the computer science and technology, information management system, information engineering and other majors in colleges. The annual average number of software-related graduates is about 400,000 (Li, 2013). When these majors were set up, there was no systematic ability structure which can serve as reference, and curriculum system was unable to provide students with necessary knowledge of information engineering in a scientific and comprehensive way and make them adapt to the requirements of IT industry (Ghafarian Sisk, 1997). According to the "Chinese College Graduates' Employment Annual Report" released by MyCOS for 6 consecutive years, IT-related majors were red-card majors in 2010 and 2011, and yellow-card majors in 2012 to 2015 (red and yellow card majors are majors of high unemployment risk that have a high unemployment number and an unemployment rate which remains low), with low employment rate, and poor match between majors and jobs (MyCOS, 2015). The direct cause for this is that the employability structure of IT graduates is inconsistent with the needs of the industry, and the indirect cause is that there are deficiencies in the talent training mode of IT majors in colleges (Zainal, 2011).

First, cultivating college graduates' employability is the core of higher education, which runs through the whole process of college education and involves many fields of college (Tan J, 2014). Some researchers believe that college graduates' employability is their ability to acquire a job through study and practice during college life, including the ability to get maintained and promoted, consisting of basic ability, professional ability and differentiated ability. Employability shows the cooperative bonding of professional characteristics, personal adaptability, social and human capital. Many colleges hold a misunderstanding that cultivating the college students' employability is equivalent to employment guidance and entrepreneurship education (Xie, 2005). This misunderstanding is mainly seen as follows: focus on job interviews and recommendations immediately before graduation, lack of substantive design of career development planning for college graduates; focus on job interview skills and techniques, education of actual professional capabilities required for employer's specific positions, lack of systematic education which aims to fully tap the potential of students, develop the basic quality for students' entrepreneurship, and cultivate the comprehensive ability of students; focus on in-campus employment situation report, recruitment and other work, lack of communication and cooperation with external vocational training experts; focus on release of employment policies and information, and lack of individual guidance for students (Sun, 2007).

In addition, the combination of major setup and curriculum system and the structure of teachers are seriously deviated from the students' employability and market demands (Woods & Oradini, 2013). First of all, the setup of majors and curriculum system for existing training objectives in China's universities rarely or even never take into account the internal logic system of discipline development and the associated occupational characteristics, severely deviating from the students' actual withstand capability and demands of the present times of knowledge economy. The result is that some students may have some basic knowledge of theories from the book, but do not have professional ability;

some students even fail to learn anything. Second, the overall structure of teachers is poor, and the teaching quality is low. As a result of multiple deficiencies in teachers' discipline, educational background structure (college of graduation), age, degree, and quantity, the development of discipline, major and teaching quality is hindered. In particular, local colleges do not introduce and cultivate teachers according to the needs of discipline and curriculum system; instead, they operate the college according to their available teachers, which greatly hinders the improvement of students' employability (Gravani & John, 2002). Third, the teaching methods and means are still backward, with poor learning outcome (Johnson, Aragon, & Shaik, 2000). In the process of teaching, the "cramming method" is generally used, with little discussing, targeted social practices and case analysis (Joseph & Kurt, 2005). The unified training mode suppresses the development of students' individuality, interest and specialty, and cannot stimulate their creative thinking. Thus, the students will have ill-structured knowledge and poor humanistic quality, lack employability, and cannot meet the requirements for development of knowledge economy. There are two possible reasons for the low employment rate and difficulty in finding jobs for IT graduates: excess supply of talents in quantity and shortage of talent supply in quality. To solve the above problems, the key is to improve the talent training mode of colleges, for which the key is to cultivate students' employability.

To sum up, from the perspective of talent training in colleges and universities, it is important to understand and clarify the employability structure of IT graduates, and to understand the importance of IT undergraduate employability and the difference in performance level base on the perspective of enterprises. Those measures are the premise to improve the teaching effect and the talent training mode, and are the guarantee to improve the quality of employment, and play an important role in improving the quality of IT personnel training.

(2) From the perspective of the industry: The IT industry is booming and there is a serious shortage of talents

As an emerging industry pillared by modern IT, network technology and high-end talents, the IT industry has become an engine for the new round of industrial restructuring, and for undertaking the international service industry and promoting economic growth (Mosher, 2015). It is an important driver for the international and domestic industrial structure optimization and technological development. Since the 1990s, the State Council and the relevant ministries have issued a number of laws and policies to encourage the development of the IT industry, effectively promoting the rapid development of the industry in China. (Department of higher education of the Ministry of education, 2009) The IT industry has become China's fastest growing "rising industry." However, compared with the world's leading IT countries, in addition to the gaps in business scale, delivery capacity, and brand image, the lack of IT talents has become a major constraint on development of China's IT industry.

The rapid development of IT industry calls for a large number of qualified human resources, because the industry requires not only inter-disciplinary talents who have industry expertise, but also abundant versatile talents who can meet the requirements of enterprises of different sizes, types and technical levels (Celik, Er, & Topcu, 2009). As a major engine for the new round of industrial restructuring, and for undertaking the international service industry and promoting economic growth, the IT industry is severely constrained by the current shortage of talents (Zong, 2012). According to the Yearbook of China's IT industry Development issued by China IT industry Association, "shortage of qualified IT talents, poor talent structure, and serious shortage of IT talents with international view are the major problems faced by China's IT industry, seriously hampering the development of the industry." Although the supply quantity of IT talents in China has seen a substantial increase since 2011 (the annual average number of graduates of information-related majors reaches about 400,000) and the number has a large increase each year, which eases the shortage to some extent, the demand is still not satisfied. According to Chinese Ministry of Human Resources and Social Security, the shortage will reach millions in 2016. However, Digital China Federation (DCF) shows that the rise of the new generation of IT industry characterized by "in-depth development, horizontal extension, and cross-industry synergy" will not only require more basic IT talents, but also raises an unprecedented demand for high-end IT elites. According to statistics released by 51job, in October 2016, more than 560,000 IT-related jobs are posted (computer, Internet, communications, electronic) online, up 44% year on year, manifesting that the IT talent gap in China continues to expand and the IT industry enters a veritable golden age.

Providing a sufficient number of IT graduates to meet the industry needs and improving their employability to enable them to meet industry and job requirements and make them better qualified for the job is of great significance for individuals and the industry. Talent training for the IT industry has also become a major factor that determines whether the industry can continue to grow in a sustainable and healthy manner. The

Ministry of education(MOE), the Ministry of human resources and social security(MOHRSS) and the Ministry of industry and information technology(MOIIT) jointly issued the guidelines for the development of manufacturing talents, which showed that by 2020, China's new generation of information technology personnel had a gap of 7 million 500 thousand, training a large number of qualified talents is an important guarantee to promote the key technologies for "Made in China 2025", "Internet +" Initiative, and promote IT to drive industrialization and industrial transformation and upgrading.(MOE,2016) Obukhova and Lan (2013) study found that the differences between study and use is the main cause of employment difficulties. Lin and Ho (2014) found that starting from the 2010 academic year, the Ministry of Education in Taiwan has started promoting the two "technical and vocational education and recycling programs", where "technical colleges to open campus internship programs" strategy, the main purpose of shortening the gap between graduate school with, provide internship opportunities to students early exposure in the workplace, the accumulated practical experience, let students employability after graduation can meet the needs of the workplace. He also compares the evaluation criteria of college students' internship effectiveness in Taiwan and the United. All these indicate that the gap between teaching and enterprise demand is the main factor affecting the employment of College students.

This shows that China's IT industry is facing an embarrassing situation where although there are abundant human resources, there are in fact insufficient available talents (Tan & Li, 2009). The direct reason is that the employability structure of software talents is inconsistent with the needs of the industry, and the indirect reason is that software talent training mode needs to be improved. Thus, on the one hand, the all-round high-quality human resource needs cannot be met, on the other hand, college graduates are faced with enormous pressure on employment and still cannot find suitable employers and jobs (Duan, 2012). This fully shows that the employability of college graduates obtained from college does not match the employability expected by employers. That is, the most direct factor restricting the rapid development of IT industry is the mismatch between employability structure of supplied talents and required employability of the industry.

In order to promote the development of the IT industry, it is necessary to clarify the employability structure of IT graduates, to clarify the differences in the importance and performance of various underemployment capabilities from the perspective of corporate needs.

(3) From the perspective of IT students: Targeted improve their employability

From the perspective of IT undergraduate, a clear understanding of IT undergraduate's employability structure plays a very important role in their clear understanding and finding its own shortcomings and reinforcement. In addition, in the process of employment selection, college students may have different understandings of the importance and performance of IT undergraduate employability in different regions, different city types, different unit types, size of different units, and different work occupations. It is important to clarify the degree of performance and importance of IT undergraduate employability in different backgrounds. This is very important for IT undergraduate to reinforce this employability in their own learning process.

(4) From the perspective of society: enhancing social productivity and harmony

As a country's high-end human resources, whether the IT graduates can be employed is related to their survival and development, and to the willingness of families to make investment in education and the development of China's higher education, as well as to the implementation of the strategy of rejuvenating the country through science, education and talents (Cohoon, 2007). It is also related to social harmony and stability, involving the overall building of a well-off society in an all-round way. As a type of high-end human resources, the employment process of IT graduates is related to the stable development of society and the need of individuals to realize social value and self-value. It is also related to the efficiency of China's high-end human resource allocation and the national reform and development, as well as the sustainable development of China's economy and the transformation of industrial structure. Therefore, it deserves in-depth study (Qin, 2014).

As high-end human resources, whether the IT graduates can be employed is related to their survival and development, and to the willingness of families to make investment in education and the development of higher education, as well as to social harmony and stability.

First of all, from the perspective of the development of higher education, an important purpose for higher education to appear and develop is to improve the employment quality and level of graduates, not to create new employment conflicts (Watty, 2006). Solving the employment problem of IT graduates will help the colleges break the difficulties restricting their development. Expanded college enrolment has a result that each year a large number of IT graduates go to the job market, and whether they can be employed has become an important indicator for the education authorities to evaluate colleges (Jiang, 2010). The employment of IT graduates reflects the quality and level of education of colleges and an important reference for students to choose college. As such, solving the employment problem of IT graduates can promote the sustainable development of colleges (Ama, 2008). Second, from the perspective of the use of human resources, solving the employment problem of IT graduates is conducive to promoting the rational allocation of human resources (Wang, 2010). Human resources are one of the most important resources in social and economic activities. IT graduates have professional knowledge and special skills, and they have the ability and potential to make creative work and contribute to society. They are an important part of human resources with high quality. Families, the nation and society spend a huge amount of costs and resources on IT graduates. Their insufficient employment means a serious waste of social resources, and thus becomes a fetter of economic growth and social progress (Richards, 2002).

All in all, the employment problem is related to personal career or family life, and to the country's current and future economic and educational resource allocation. The key indicator for quality of employment is whether the employability matches the job needs, so the study on IT students' employability is of great significance.

1.1.2 Significance of study

The study on the employability structure of IT graduates and improvement measures is a specific, theoretical and practical issue. Using the theoretical solution to this issue in the practice of talent training in colleges may meet the social and industrial demand for talents and improve industrial efficiency, and bring about a sense of accomplishment to graduates from their high level of employment, thus promoting the harmonious development of society.

The reason is twofold. On the one hand, the rapid development of IT industry is constrained by human resources shortage; on the other hand, in the context of popularization of higher education, college students receive higher education mainly for easier and better access to employment opportunities, which needs to be realized by the colleges' talent training system by providing them with the necessary capabilities required for their future career development. The development of the IT industry also requires colleges to provide talents in line with its job requirements. The employability of IT graduates refers to the ability of graduates of IT-related majors to obtain career and promote career development. It is a kind of ability related to all kinds of occupations. Therefore, the study on the employability structure of IT graduates can meet the needs of college stakeholders. How to reform in training of IT talents in colleges to improve the employability of college graduates still requires solutions.

1.1.2.1 Theoretical significance

(1) The study will help enrich research on employability of college graduates

The study on the employability of IT graduates will help improve the theoretical system of college graduates' employability. Many Chinese and foreign scholars have studied employability and particularly the employability of college graduates, however, they fail to get down to specific employability for various sectors and fields (Clark & Paran, 2007). Studies on the employability of IT graduates can produce ideas for the improvement of the employability theory and target at the IT industry. There is lack of knowledge in IT students' employability area. Based on the empirical study data, these studies will build scientific and reasonable evaluation indicators and enrich the theoretical research of IT graduates' employability.

(2) The study will help enrich research on the improvement of quality of higher education

Talent training, development of science and technology, and serving the community constitute the three major functions of a college (Flexner, 2001), and training talents for the society and industry is its core function. In the context of popularization and diversification of higher education, the employability of a college graduate is directly reflected by whether he is successful in career choice and career development, and it also shows the level of realization of the goal of college education and the conformity of the goal with the social needs. In addition, it directly demonstrates the level of organizational development or organizational performance of a college, and the employability of college graduates is also an important indicator for the society to evaluate the quality of higher education (Jyung, 2009). Based on the above judgments, whether a college can deliver talents for the society is a reflection of whether it fulfils its basic functions, and whether the graduates can successfully get employed and have a successful career development is a direct reflection of the quality of higher education. Therefore, for colleges, enhancing graduates' employability structure and curriculum should be deemed as an important way to improve the quality of higher education and an important research topic.

(3) The study will help theoretical research for human resources development for the Computing industry

IT graduates are potential practitioners of the IT industry. Their employability will greatly affect the ability to become practitioners. Improving employability of college graduates by college is one of the major ways for the IT industry to see a rise in both the quantity and quality of human resources. The ability cultivation of IT graduates can be considered as the early stage of the human resource development of IT industry. Therefore, the study on the employability development of IT graduates is helpful to enrich the theoretical research on human resources development in IT industry. By defining the concept of employability of IT graduates and studying the employability structure and its influencing factors, this paper analyses the status quo of the cultivation and promotion of IT graduates' employability, and puts forward the improvement plan for curriculum of IT majors in colleges. This paper is expected to provide some value in improving and enhancing the employability of IT graduates, enriching higher education theories, and guiding colleges on the training practices of IT talents. Therefore, the IT graduates may transit smoothly from the higher education system to the occupation system, and become actual human resources in the IT industry.

1.1.2.2 Practical significance

(1) Combined with the structure of employability, this study will promote cultivation of employability on their own

The study on the employability of college graduates will help IT-related majors adjust the curriculum and talent training mode according to a scientific employability system, and at the same time, encourage college graduates to recognize their own ability level. Colleges and the society only play an auxiliary role in enhancing the employability, and the most important thing is the sense of self-awareness of college students. Professional institutions can help students enhance their employability, respond to the challenges in the job market, and improve their competitive advantage according to the industry and job characteristics in a targeted manner. In addition, the study on employability has positive significance to the lifelong development of college graduates' career (Asai, Inamura, Nakai, & Chiyohara, 2011). It can make IT graduates understand the specific employability that needs to be enhanced, so that they can be more targeted and directed in the career growth process, face the industry requirements while they are still students, develop career development plan, exercise competences for future career needs, and always look at knowledge learning and project research with a long-term professional perspective, enhance their job fitness and employment competitiveness, and improve the quality of employment.

(2) This study will improve the quality and efficiency of college talents training and promote the further development of higher education

Colleges play an important role in the output of IT talents. It is also an ultimate goal and of practical significance for colleges to cultivate high-quality college graduates who meet the industry requirements. However, at present the colleges only have a vague concept about employability, without a sound employability training system (Alves, 2013). The study on the employability of IT graduates fails to keep up with the development trend of the industry and the demand of the market. Some majors and courses fall behind the demand, which makes graduates face difficulties in the job market.

Therefore, the study on the employability of college graduates will help the colleges to formulate targeted talent cultivation plan, firmly keep abreast of the demand of the industry and target position for graduates' ability, set up majors and courses on justified grounds, and improve the quality and efficiency of talent training. And combined with strengthened employment education and career education, these may help college graduates realize high-quality employment. Market-oriented talent training program is a positive reform for colleges, and it will promote the further development of higher education to a great extent.

(3) This study will help improve the employment quality of college graduates and ease the employment pressure

At present, college graduates face a tough situation in the employment market, featuring high employment pressure and low employment quality (Liu & Wu, 2010). The study on the employability of college graduates is beneficial to the market-oriented cultivation of talents for colleges, and will help them figure out the capabilities actually needed for the IT industry. As a result, the college graduates will have the capabilities required for the industry and position, and are actively engaged to enhance their quality and capability building. This will heighten the quality of college graduates, aligning their ability with that required by the company. This way the quality of employment will be improved, thereby alleviating the employment pressure faced by college graduates in the market.

(4) This study will help give full play to the role of talents and promote enterprise value creation and development of the IT industry

The IT industry is a rapidly growing industry in the process of economic globalization. To establish technical superiority and realize a better industrial structure, all countries need more talents to support the industry development, with certain requirements for both quantity and quality of talents. Different background variables, (such as different regions, different city types, different unit types, different size of working units and different work occupations, different genders, different age groups, and different academic levels), the importance level and performance level of IT undergraduate employability Evaluation has different effects. However, for variables like different genders, different age groups, and different academic levels, because these variables are objective and cannot be changed, these variables have no guiding significance for IT undergraduate after analysing IT undergraduate employability. Therefore, we will discuss the importance requirements and performance evaluation of IT undergraduate employability in variables such as different regions, different city types, different unit types, different size units, and different work occupations. Targeted at suitable employers and jobs, the college graduates enhance their employability and quality, and the diversified human resources required in the market will be fully and reasonably used. In this case, the enterprises will be able to recruit suitable talents and accomplish better development, the entire IT industry will also be pushed forward by the driving force and the value created by talents, achieving sustained and stable development.

1.2 Purpose of the study

Based on the above research motivations, the research objectives proposed in this study are listed below:

1. Establish IT undergraduate employability structure and conduct validity test.

2. Understand the opinion of importance and performance of IT undergraduate employability indicators.

3. Identify the background variables' influence and their interactions' influence on the opinion of importance and performance of IT undergraduate employability indicators

4. Identify the IT undergraduate employability indicators that require improvement and classify the indicators according to their improvement priority.

1.3 Research questions

According to the above research purposes, the issues to be explored in this study are as follows:

1. What is the structure of IT students' employability?

2. What are the opinions of corporate IT practitioners on the importance and performance of IT undergraduate employability?

3. Do business IT practitioners with different background variables have different views on the importance and performance of IT undergraduate employability?

4. What is the priority of IT undergraduate employability?

1.4 Summary of this chapter

As an outstanding talent in the process of economic and social development, the IT College students are the important human resources, their employability is directly related to the realization of their own value and social value. On College Students' employability of IT industry structure and improving path configuration and efficiency, the research helps to optimize the human resources of the society, to help solve the employment problem of IT major’s employment rate decline is helpful to solve the IT industry development talent bottleneck, contribute to the promotion of talent information professional high school training, help to improve the quality of the employer to improve the level of human resources management. This research combined theory research with empirical research, using qualitative and quantitative analysis methods to construct the employability structure of college students. Based on the perspective of the company, this study explores the opinions of corporate IT practitioners on the importance and performance of IT undergraduate employability. This study also explores the differences between the two and looks for employability that is in urgent need of improvement, and then provides advice and countermeasures for improving IT undergraduate employability.

2. COMPREHENSIVE LITERATURE REVIEW

Last chapter introduced the brief information of this study, including the background information and research purpose. This chapter will further explore the research topic. Firstly, the current research on relevant aspects of this study will be reviewed, such as employability structure, IT professional employability, competency theory. Secondly, basic concepts like IT student and undergraduate employability will be defined. Thirdly, the conceptual framework is proposed to demonstrate the related research issues. Lastly the preliminary construction of IT undergraduate employability is conducted through literature analysis. This chapter will form the theoretical foundation of this study.

2.1 Current studies on employability structure

2.1.1 Connotation of employability

The concept of employability was first proposed by British scholars in the 1950s (McQuaid & Lindsay, 2005), when the focus was on the underprivileged people, mostly people at the bottom of society. In the 1970s, the economic development was highly uncertain, the number of unemployed people was increasing, and the government paid attention to employability for purpose of maintaining economic development and promoting employment. The research was gradually extended to the public on how to improve their working ability as much as possible and promote full employment; since 1980s, due to fierce competition in the market and changing industry environment, research on employability was carried out at enterprise or organization level. By arranging adaptive employability to achieve performance objectives and enhance flexibility in work arrangements and organization, the human resources can produce the most optimal results; Since the 1990s, the actual contribution of employees in work was more valued, specific training and courses began to appear, with efforts trying to integrate the cultivation of employability into them. Since the 1990s, more and more researches on employability began to emerge (Hopkins & Maglen, 2000). More scholars made different interpretations of the concept of employability from different perspectives and theoretical bases, making the concept diversified, vague, and controversial. (McQuaid & Lindsay, 2005). And so far, there is no uniform definition for employability. At different times many scholars interpret employability from different perspectives, giving it rich connotation.

Fugate (2004) thinks that employability can be understood as a kind of adaptability, which enables workers to show a certain enthusiasm, gain access to internal and external career opportunities and identify and take hold of their own career. Brenda Little (2004) points out that employability refers to a range of skill achievements, perceptions, and personal characteristics with which a worker can have better job opportunities and career successes in the chosen career area. Zheng (2002), based on the existing research framework, attempts to put forward an idea on employability, that is, the ability of college graduates obtained by learning basic and professional knowledge and developing their comprehensive quality and capacity, which may help achieve their employment ideal, meet social needs, and realize personal values in social life. In addition, some organizations have put forward their views on the connotation of employability. For example, the UK Commission for Employment and Skills (2000) points out that employability is an ability of workers to obtain and maintain the job, that is, the potential of the workers to seize the employment opportunity and get employed in the job market. The International Labor Organization argues that employability is the ability of workers to obtain and maintain continuous employment in the labour market, and to be proactive in responding to changes and challenges during employment and to gain development and progress.

McQuaid and Lindsa (2005) uses the analytic hierarchy process to study the differences of various employability definitions and finds that the existing definitions can be divided into three categories: The first category, expressing the core definition of employability: the ability of individual workers to do a variety of tasks and perform their functions in a particular labour market, with the focus on the individual's actual employability; The second category, expressing the extended definition of employability: focusing on not only the actual employability of workers, but also the personal wills, attitudes, tendencies, psychological expectations, and actual behaviors they show in enhancing and using such employability; The third category, expressing the comprehensive definition of employability: the employability not only covers the scope of the core and extended definition, but also some scenario-related factors that may promote or hinder the use of employability, such as corporate training opportunities, labour market employment environment and employment promoting policies. All these definitions have some rationality and limitations.

2.1.2 Elements of employability

Many scholars hold different academic points of view on the elements of employability. Dearing (1997) argues that regardless of what type of job the college graduates will take in the future, there are four key enabling factors for their future employment success: communication, IT, IT, and learning. Hillage and Pollard (1998) add that the employability of individuals depends on their own knowledge, skills, and professional attitude, and puts forward four main elements of employability: knowledge, skill and other existing employability capabilities, resource allocation and dispatching capability (including career management and information search capabilities), performance and presentation capability (capability of obtaining jobs), as well as individual factors and external factors for graduates. McQuaid and Lindsay (2005) believe that the composition of employability consists mainly of the essential attributes of workers (basic social skills, trustworthiness), their individual qualities (diligence, self-confidence, and attitude), convertible skills (basic, key and high-level skills) and relevant educational background (education, mastery of skills, work experience). However, Dacko (2006) concludes that, no matter what the current academic research thinks employability is composed of, the college graduates always have too much theoretical knowledge and too little practical skills.

Many scholars use the method of empirical analysis to study this issue. For example, Michael (2010) surveys the employability structure of college students using questionnaires. The results show that college students' employability includes three dimensions: inner qualities, work processing ability and social leadership ability. The internal qualities include honesty and integrity, dedication, hard-working, sense of responsibility and initiative; work processing ability includes judgment and analysis ability, thinking ability, problem solving ability, independent working ability, adaptability, learning capability and team collaboration; and social leadership ability includes ability to express, leadership, social activities, organization and coordination, interpersonal skills and entrepreneurship. Liu and Wu (2010), through questionnaire and exploratory factor analysis, finds out that college graduates' employability includes five elements: thinking ability (innovation ability, openness ability, information processing ability, analysis and judgment ability, problem solving ability, social insight ability, and adaptability), social adaptability (endurance, psychological adjustment, anti-frustration, anti-pressure ability, modifiability), autonomy (hard-working quality, planning capability, dedication and self-learning capability), practice and innovation ability (social ability, communication skills, cooperation skills, organizational skills), job-applying ability (competitive awareness, marketing ability, self-confidence and ability to express).

On the whole, enterprises are not satisfied with college graduates' practical ability, innovation ability, social ability and devotion, and have high expectations for their practical ability, sense of responsibility and innovation awareness. Some other scholars also have compared the college graduates' ability and employer demands.

While in discussions on the employability of IT graduates, VK and Menon (2014) summarize previous studies and hold that more in-depth knowledge is required for employees of the IT industry, which knowledge mainly integrates some social factors and stems from the actual use and technology in work. These employees need to have professional skills for work and comprehensive qualifies for the society. To choose from science and engineering graduates, employers mainly consider their fitness to the company, personal characteristics and convertible skills and professional strength and other hard skills. The fitness includes the individual maturity, cultural understanding, and language skills; convertible skills include innovation ability, potential leadership, problem solving ability, teamwork and personal attitude and motivation; hard skills include a variety of professional and job-related techniques.

After viewing the engineering education reform in the US in early 21st century, Tan (2014) believes that the reform focuses on training students' comprehensive ability and attaches importance to strengthening the foundation of mathematics and science, and on this basis, the reform places more emphasis on employment-related quality and ability, such as engineering practice ability, communication ability and teamwork, lifelong learning capability, professional responsibility, and social morality. At the same time, innovation awareness and ability are also an important factor in the employability of new engineering talents.

2.1.3 Employability model

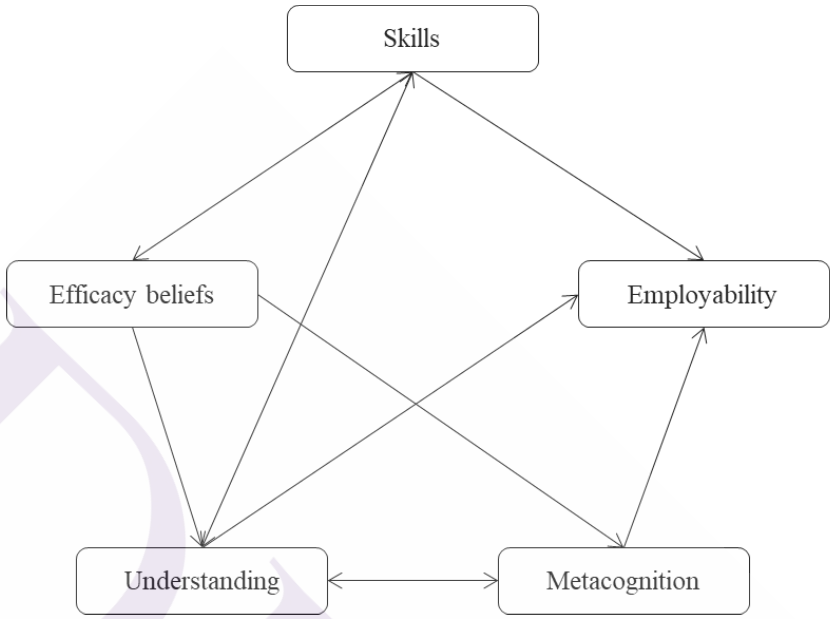


Figure 2.1 The USEM model proposed by Peter Knight and Mantz Yorke (2004)

The USEM model constructed by Peter Knight and Mantz Yorke (2002) is the most classical in employability models and the most widely cited one by scholars. The USEM model is composed of four elements: Understanding - the ability to understand professional technology and mastery; Skills - including the general skills and professional skills appropriate to the position; Efficacy beliefs - the employee's individual quality, the confidence and belief in work; Metacognition - the self-reflection of employees based on sufficient and profound understanding of employability. The four elements promote and interact with each other and are closely related to Efficacy Beliefs, as shown in Figure 2.1.

The CareerEDGE-The Key to Employability Model by Pool and Sewell (2007) (Figure 2.2) is based on a study of the USEM model, which they believe is more operational and provides clearer interpretation and generalization. The model shows the interaction and mutual influence between employability, five basic skills and three elements. The five basic skills are Career Development Learning, Experience: Work & Life, Degree Subject Knowledge, Understanding & Skill, Generic Skills, and Emotional Intelligence. In the continuous reflection and evaluation of these five skills, three elements appear, namely, Self-efficacy, Self-Confidence and Self-Esteem.

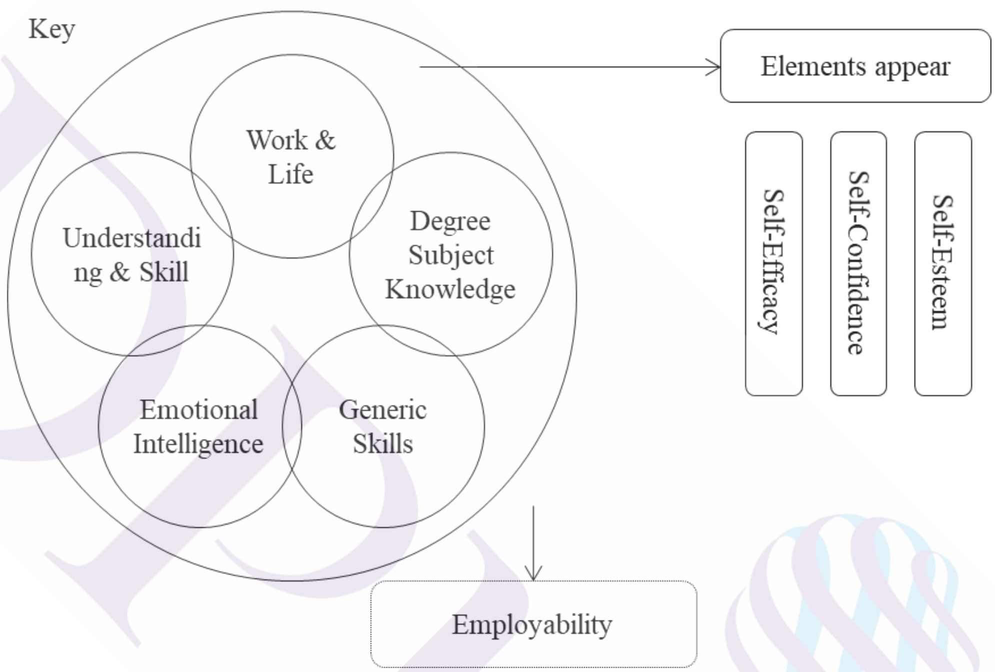


Figure 2.2 The CareerEDGE model proposed by Pool and Sewell (2007)

In addition, the perspectives of other scholars which use dimensions as the categorization standards are summarized as follows:

Dichotomy (two-dimensional) model. It is proposed based on the dialectical thinking, this model categorization is clear, but the content is too simple and the operability is poor (Fabbri & Johnson, 2000). Zheng (2002) thinks that the model of employability can be composed of two parts: intellectual and non-intellectual factors, namely, IQ and EQ, or intellectual capital and capacity capital, which influence each other and are both indispensable. Gao and Zhou (2014) propose a model for college graduates' employment influencing factors. They point out that the interaction of external and internal factors would affect the employability of college graduates. Bakar, Mustapha, and Nasir (2013) points out that the employability model of college graduates consists of two parts: the general employability and special capabilities required for an occupation, that is, the basic personal ability to cope with the rapidly changing market and occupational ability such as professional knowledge, experience, and skills.

Ternary model: These models are widely used in the research of employability. They focus on the personal development of employees and the needs of the society. But the focus is different for scholars, and the concrete content of the model is quite different. For example, Wang (2005) divides the employability model elements into basic skills, individual management skills and teamwork skills. The employability of college graduates can be composed of three parts: the job-seeking ability, social adaptability and work practice ability. Sun (2007) points out that the three dimensions of college graduates' employability model includes basic working ability, good professional ethics, professional consciousness and professional spirit, professional skills and job-seeking skills.

Quartic model: These models are further refined on the basis of three-dimensional models to provide more profound research significance and stronger operability. For example, Wang Yuan (2005) points out that college graduates' employability includes four factors, namely, cognitive ability, individual reliability, self-awareness and communication and cooperation.

Quintile and above model: These models further refine the study, but involve too many factors, which may lead to unclear structure.

Overall, the studies on employability are comprehensive and diversified, from general social employment to the cultivation of individual employability, from improvement of individual employability to study at the college and social level, from influencing factors of employability to studies on employment structure. They provide much reference to the study on employability of IT graduates in this paper.

Analysis of existing research results shows that the employability of college graduates has attracted academic attention. However, a careful review shows that most of the existing research results are still carried out for the entire group of college students, few for the employability of IT graduates and being non-systematic. Therefore, based on the existing theoretical achievements and preliminary models, this study carries out in-depth theoretical analysis and evaluation indicator establishment for employability of IT graduates, investigates its influencing factors, and on this basis, puts forward measures for reference for enhancing the employability of IT graduates.

2.2 IT industry and IT graduates' employment

2.2.1 Overview of IT industry

2.2.1.1 Definition of IT industry

Information technology (IT) is the use of computers to store, retrieve, transmit, and manipulate data, or information, often in the context of a business or other enterprise (Daintith, 2009). IT is considered to be a subset of information and communications technology. The IT industry is the product of the third technological revolution. Simply put, it is an industry related to information technology, involving information technology, information services, information equipment and product production. American scholar Mark Lupu proposed in the article "The Production and Distribution of Knowledge in the United States" (1962) that the information technology industry is "an organization that produces knowledge, engages in information services, or produces information products." Porat (1977) proposed the concept of a two-level information department based on whether the information product or service entered the market. With the development and maturity of the IT industry, the IT industry has had a relatively clear definition since the late 1980s.

In a narrow sense, the IT industry includes information industry manufacturing, software industry, telecommunications and information services, etc. The IT industry is the industrial groups mainly engaged in development and application of computer and communications technology. In a broad sense, the IT industry also involves related industries such as education, media, intermediary consulting and scientific research institutions. Table 2.1 lists some of the industries covered by the IT industry. The IT industry involved in this research mainly refers to the information technology industry in the narrow sense, that is, the industry based on computer technology and communication technology, involving information technology development and application, especially including electronic equipment and hardware industry, software industry, communication industry, network industry and information services (Leng,2014) as Table 2.1 and Table 2.2.

Table 2.1 Sectors covered by some national IT industries

Country	Industry covered by the IT industry
United States	Hardware industry, software service industry, communication equipment industry, communication service industry
Russia	Communications, computers and other equipment, software, e-commerce, the Internet
Japan	Japan's IT industry concept is slightly different from that of the United States. Japan has included information support industries such as printing and office supplies in the information industry.
Korea	IT service industry, IT hardware (telecom equipment, information equipment, broadcasting equipment, components) software industry
India	Software industry and its service industry, telecommunications industry, e-commerce, IT equipment manufacturing

Table 2.2 IT industry list

Hardware industry	Software service industry
Computer and equipment	Computer programming service
Wholesale of computers and equipment	Pre-installed software
Computer and equipment retailing	Software wholesale industry
IT and office equipment	Software retail
Magnetic and optical storage media	Computer integrated system design
Electronic tube	Computer processing, data preparation
A printed circuit board	Information retrieval service
Semiconductor	Computer service management
Passive electronic components	Computer rental and leasing
Industrial measuring instruments	Computer maintenance and repair
Electrical measuring instrument	Computer related services
Experimental analysis instrument	
Communication equipment industry	Communication service industry
Home audio visual equipment	Telephone, telegraph communication
Telephone telegraph equipment	Wireless and television broadcasting
Broadcast television and communication equipment	Cable and other pay TV services

2.2.1.2 Feature of IT industry

(l) IT industry is an emerging strategic industry with high level of innovation and rapid growth.

After the Second World War, the rapid development of advancing and new technology greatly changed the industrial structure. When high-tech industries successively produce and form new industrial clusters, the IT industry is an industry with navigation and promotion functions in emerging industrial clusters (Chen, 2017).

The update rate of information technology is doubled every three years. The number of information technology patents exceeds hundreds of thousands each year. Therefore, the IT industry is a highly innovative, fast-changing industry. The key to the development of IT companies lies in technological innovation, and whoever succeeds in technological innovation can gain competitive advantage (Chen, 2017). Unlike traditional industries that rely on market demand to drive technological innovation and industrial development, the IT industry often leads market demand through the development and application of new technologies. Take the mobile phone industry as an example, from purely mobile communications in the 1G era, to the simultaneous use of voice and graphic information in the 2G era, to the integrated use of voice, graphics, and the Internet in the 3G era, and the forthcoming 4G era of Online video, global positioning, etc. This series of huge changes only took ten years, and this drastic change is result of the constant innovation and development of mobile communication technology.

(2) The IT industry is a high-permeability, high-value-added industry with strong sustainable development capabilities.

Due to the decentralized mechanism and feedback mechanism of information, due to the high affinity of information technology, the IT industry can penetrate into all areas of society, industries, or products, and its impact may involve a department, a region, or even the entire country. IT industry is also a high value-added industry. Because the value of information has multidimensional and indirect features, it has both direct economic and indirect economic effects after the information is used. That is to say, various departments and industries of the national economy can obtain much higher economic benefits than the original once they receive timely and accurate information services.

Moreover, on the one hand, it can achieve a structural role in saving material resources and energy by optimizing social structure, increasing productivity, and creating more social benefits. Thus the information industry enables various non-IT industries to save material resources and energy.

(3) The IT industry is an intellect-intensive industry with strong employment absorption capabilities

From an industrial perspective, IT industry is an intellect-intensive industry, which is higher than labour-intensive industries and capital-intensive industries (Yang, 2010). It is mainly mental workers such as scientists, engineering technicians, and software designers, which means the industry demand high intellectual qualities of workers. As an IT industry that uses mental labor and creative thinking as the basic value creation method, the requirement of employees' knowledge, technology, creativity, energy, and physical strength are very strict, even to the harshest point. At the same time, due to the high permeability of the IT industry, it has promoted and stimulated the transformation of traditional industries and improved the employment structure of traditional industries. From the perspective of the development of the IT industry in Western developed countries, the labor force in the IT industry sector accounts for an increasing proportion of the social employment structure.

2.2.2 IT industry talents' demands and employment

2.2.2.1 Strong demand for IT industry talents

(1) Shortage of IT Industry talents

Although the number of IT graduates has shown growth in recent years, it is still unable to meet the rapidly expanding talent needs of the industry, the growth of IT graduates in China is still a drop in the bucket, and there is a huge gap in talent supply. In 2012, there were about 900,000 IT graduates; in 2017, the number of IT graduates was about 1.05 million, an increase of 16.7% (Hua, 2017). However, in 2012-2017, the annual demand for new talent in the IT industry increased from 2.4 million to 2.9 million (Hua, 2017). In addition to the mismatch between supply and demand in quantity, the overall quality of IT industry personnel is not high. High-end talents, especially the Experts with innovation and leadership skills as well as Comprehensive management talent with international perspective and familiar with the development of the industry, are in shortage.

By 2020, the demands for personnel in the new generation of information technology industry are 18 million people and currently have a shortfall of 7.5 million people. By 2025, China needs 20 million people for a new generation of information technology, with a gap of 9.5 million people which is a huge gap (Hua, 2017). The rapid, comprehensive, and continuous development of the IT industry requires many highly qualified knowledge workers.

(2) The employment scope of IT graduates has become wider

The total demand for computer talents in the society has increased steadily (Zou, 2008). Graduate employment positions and post distribution are broader, and the main body of demand has quietly changed. Generally, a small-scale enterprise has its own IT department. If the information quantity in the enterprise is relatively large, it will inevitably require database management and enterprise information management. In addition to going to emerging industries, students can also go to these relatively large-scale enterprises to serve an important duty in department of information. The demand for talents in the communications industry is concentrated in related majors in post and telecommunications colleges, and the ability to attract university graduates has dropped significantly. However other service industries such as financial industry, transportation industry have a high demand of IT talents. Even the manufactory industry, such as machinery, chemical, petroleum, automobile, pharmaceutical also have a high demand due to their informationization.

2.2.2.2 Characteristics of talents demand of IT Industry Company

Both IT enterprises and non-IT enterprises need IT to integrate related businesses to promote development. However, IT companies are not blindly hiring IT employees. IT companies generally believe that in the recruitment of college graduates, they require comprehensive skills, including professional skills that meet the job requirements, and other transferable capabilities, such as teamwork and communication skills. The IT industry, as part of the tertiary industry, features diversity, rapid development and internationalized market, significantly different from other traditional service industries. Therefore, the skills and quality requirements have the industry-specific characteristics. For example, in 2013 the top ten professional skills needed by companies are programming and application development, project management, technical support, security, business analysis, cloud/SaaS, virtualization, network design, mobile application and device management, data center control (Pratt, 2012).

First, there is a high requirement for comprehensive knowledge. IT talents must have a knowledge pool of the following three types: proficient in using or master the knowledge for development of IT network; basic knowledge in IT outsourcing, such as basic principles in IT development process and the use of delivery tools; and professional knowledge involved in projects. For example, talents which undertake finance IT outsourcing need to have finance management knowledge, such as international settlement, foreign exchange management, and financial derivatives.

Second, the professional skills have to be practical. The key to measuring the suitability of IT talents to the industry trend is how they flexibly use the knowledge and tools for outsourcing information development, design, testing and project management, and whether they have a broad understanding of operating systems, applications, network management and industry knowledge, and their ability to align professional skills to actual job requirements.

Third, cross-language and cross-culture communication brings high requirements for global vision. The globalization trend of IT industry is prominent, therefore, practitioners in this industry must have a global vision (Li, 2016). In particular, the basis to form a global vision is to have an in-depth understanding of different cultural backgrounds, thinking habits, behavior patterns of businesses and organizations in various countries. Outsourcing technology and management personnel should have literacy and oral communication skills to communicate with foreign customers, understand and respect their differences in culture, traditions, customs, thinking and time difference(Yang, 2017).

2.2.2.3 The increasing employment pressure of IT college students

(1) The increasing number of graduates, and the difficult IT professional employment

According to the latest data released by the National Bureau of Statistics and the Ministry of Education, the number of university students currently in the country is 26.958 million, the number of college graduates is 7.95 million, the number of ordinary college students is 7.486 million, and the total population with university education is 195.93 million. With the increasing enrolment of colleges and universities and the opening of IT major profession, the number of IT graduates has also increased significantly and the employment and entrepreneurship work is facing a complicated and grim situation.

In some interdisciplinary fields, other professional talents also have other professional knowledge required in the field, such as communication engineering, automation. Thus, other students in the relevant fields have undoubtedly squeezed the employment space of computer graduates. Therefore, the employment problem of computer science is not optimistic.

(2) The buyer's market has formed and the job competition is becoming increasingly intense

Many IT companies constantly adjust themselves to adapt to industry development and industrial changes, and continuously increase the quality requirements of employees' employability. Employment is transferring from the seller's market to the buyer's market. Faced with the large number of job-seeking college students, employers generally raise the threshold and lower the starting salary. Some employers have over-emphasized English certificates and IT certificates. Some employers blindly require applicants to have a bachelor degree or above and more than three years of industry experience. Some employers unilaterally extend the employment trial period for graduates.

2.2.2.4 China's IT talent training is out of touch with the job market

In 2018, there are a total of 938 universities offering computer science and technology in China. In the training of IT talents in academic education, all kinds of schools have the characteristics of hierarchy and cross-major, and develop characteristics to cultivate suitable talents for social and economic development. In recent years, the Chinese government has successively put forward the construction goals of "taking a new road to industrialization with Chinese characteristics", "building an innovative country, building a country with strong human resources", "accelerating the transformation of economic development mode, and promoting the optimization and upgrading of industrial structure" (Zhang &Zhou, 2018). These goals require a large number of engineers for its implementation. Therefore, the Ministry of Education proposed the "Excellent Engineer Education and Training Program" in June 2010 (http://www.moe.gov.cn/). The purpose is to require graduates from higher education institutions to achieve the basic skills of engineers and obtain qualifications for engineers, or to cultivate a backup engineer with an engineer potential. Since the introduction of the plan, many engineering colleges and comprehensive universities have joined the plan, and they have jointly explored effective training methods to compensate for the needs of engineering talents to some extent. However, through research, the author found that some schools still have certain problems in the aspects of software engineering talent training, school-enterprise integration and education.

(1) Fuzzy target setting of talent training

Although a considerable number of universities have participated in the "Excellence Plan", when implementing the training program, they often cannot break through the teaching mode and knowledge structure of traditional professional personnel training. The existing teaching content focuses on the subject system, the practice time is relatively low, and the frontier of the subject and the new technology have difficulty to reach the classroom. Those problems have caused the development of graduates to be out of the touch the phenomenon of social needs.

(2) Insufficient engineering education concept

In the process of cultivating software engineering talents, many colleges and universities do not regard the practice and innovation ability as the foundation of talent training. There is overlooking or even neglect in the phenomenon, such as setting of classroom hours, the supporting facilities of practical teaching, the reform of teaching methods and the evaluation of teaching effects.

(3) The teaching team lack practical experience

In recent years, the use of technologies such as the Internet of Things, big data, and artificial intelligence has changed people's method of production and lifestyle, and has also generated a large demand for software talents. The enrolment scale of software engineering majors in various universities has continued to expand, and the faculty has also expanded. Many doctoral students have gone directly to the podium after graduation. Although these people have strong academic ability, they lack professional practice knowledge and engineering practice experience. This is quite different from the requirements of the engineering personnel training for the teaching staff. As a result, the teacher team generally has problems of excessive academic research, lack of engineering experience, and insufficient technical and practical skills.

(4) School-enterprise education is not in place

Although some schools realize that the education of closed-door education is not feasible in the training of engineering talents, they also put "school-enterprise cooperation, work-study combination" into the software engineering talent training program. However, due to inadequate local government policy guidance, insufficient school funding and the inconsistent rhythm of the school personnel training and corporate work timeframe, the joint education between the school and the enterprise cannot be fully implemented.

(5) School-enterprise cooperative education mechanism is poorly sustainable

The school expects the company to be deeply involved in the education process, but the vast majority of school-enterprise cooperation only stays at the superficial level of “friendship” and does not achieve full cooperation from the institutional mechanism, which cause the "industry-study-research" cooperation is still not deep enough to achieve a continuous and stable school-enterprise cooperation model.

2.3 Related capability and competency theories

The research on the employability structure of IT graduates is a new social issue. Although there is no ready-made theory that can be applied, the theories formed by Chinese and foreign scholars in employment can be used as the theoretical basis. This study mainly uses the theories of higher engineering education, human capital (Becker, 1962) and labor market (Sobel, 1982) to analyze and study the employability structure of IT graduates. The human capital theory is an important theory in management science, which can provide static theoretical explanation to the ability characteristics of IT graduates for employment, and provide the theoretical guidance in the setup of the indicator system and the later promotion of employability. The competency theory (Franklin et al., 2010) is a mature and accepted theory in the field of competence review. This theory will provide theoretical reference for the dynamic growth and maturity of the employability of IT graduates. It is also the basis of the general analysis framework of this study, and will offer methodological reference for evaluating the employability of IT graduates.

2.3.1 Capability structure theory

The study on the composition of competency structure are discussed in different disciplines, however are only in view of psychology. The theory of competency structure is recognized in the academic community mainly due to the constituent factors of deconstruction ability which included two factor theory, the multi-factor theory of competence structure (Thurstone, 1938) and the theory of intellectual hierarchy (Vernon, 1961). The theory of competence, as an important theoretical basis, will be made a brief review in this paper.

Two Factor Theory：

The two-factor theory consists of two factors: general factor (G) and specific factor (S) (Morgan, Vorhies, & Mason, 2009). The former means the basic ability showing in each individual and each mental activity and a higher level of intellectual activity basis referring to the inherent ability. The latter, associated with a particular mental activity, is a special ability for individuals to accomplish various special missions and its presentation needs specialized knowledge.

The two interactive factors cooperate to play a role when individuals are in mental activity. The analysis of the two factors concluded that the general factor is roughly equivalent to intelligence from heredity and the special factors are similar to the special ability acquiring through education and training.

Primary Mental Abilities：

The two factor is uncomplicated that behaves little significant to the guiding theory and practice in this paper. American psychologist Thurston (1922) holds that intellectual activity is based on the irrelevantly original factors and primitive abilities. Competency structure are divided into Verbal comprehension (V), Word fluency (W), Number (N), Space (S), Associative memory (M), Perceptual speed (P) and General reasoning (P) and these abilities are more specific to the two factors. Thorndike (Thorndike) also agrees with the ability of the multi-factor theory and that the combined performance effect on the ability.

Hierarchical Structure Theory of Intelligence：

Hierarchical Structure Theory of Intelligence, corresponding to the ability of the two-factor theory and multi-factor theory and proposed by American psychologist Vernon (P.E. Vernon) in 1961 points out the ability is equal to intelligence. The theory subdivided the general factor and the specific factor of two-factor theory. The composition of intelligence identified as four levels of factors. The first level is the ability of speech and education; the second level is the ability of the operation and mechanic; the third level is the language, quantity, mechanical information, spatial information, hand operation and other capabilities; the fourth level is a special ability factor. In addition, there are intellectual three-dimensional structure model theory and intelligence information processing theory. The three-dimensional structure model of intelligence divides intelligence into three dimensions: operational ability dimension including cognition, memory, analytical thinking, comprehensive thinking and evaluation; abstract ability including graphic, symbol, semantic and behavior; results meaning the ability of activity. The information processing theory of intelligence divides intelligence into component intelligence, empirical intelligence and cognitive environment intelligence.

With the exception of psychology, the study of some international organizations on the competency structure is more profound, and those researches are more specific, clear and valuable (Skills and Tasks for Jobs: A SCANS Report for America 2000). Typical studies include Secretary’s Commission on Achieving Necessary Skills SCANS) (Skills and Tasks for Jobs: A SCANS Report for America 2000) completed by the US Department of Labor, Organization for Economic Co-operation and Development (OECD) (Grunfeld & Moxnes, 2003) completed from 1997 to 2002, the Definition and Selection of Competencies (DeSeCo) (Rychen & Salganik , 2003) and EU Tuning completed in 2003. The above research projects all defined the composition of competencies, and put forward the similar elements of competency structure. The SCANS project takes the young laborers as the object to study which ability is needed for young people to succeed in their work. Some conclusions of this project have been mentioned in the employability structure theory and will be further elaborated. The project points out that competency includes basic competency and professional competency as the first level dimensions, both of which have more specific elements. The basic capacity included two layers of factors. The first layer consists of general skills, thinking ability and quality. General skills can be further specifically explored into six basic parts, including reading, writing, listening, speaking, IT and math skills. Innovative thinking, decision making, solves problems, knowing how to learn are essential components of thinking ability. Personal qualities include responsibility, integrity, and self-confidence and so on. There are two levels of factors in the professional ability, one by the resource capacity, communication skills, information management capabilities, system capacity, technical capacity and other elements. The above elements also have specific constituent indicators. The resource capacity includes the ability to dominate the people, finance, material and other resources. The communication skills include communicating, persuasion, leadership, adaptability in different environment etc.; Information capabilities include the ability to acquire, select, maintain, evaluate information and to process information by computer etc.; system capabilities include the ability to understand, correct, improve and design system etc., technical capacity includes the ability to select and employ technology. It is necessary to propose the competency constituent elements for the professional development. The above capabilities can be developed by learning and the best way is setting clear goals corresponding to professional background. If study in an unreal professional environment metaphysically, it will not be possible to obtain the above-mentioned competency elements (SCANS Report, 1992).

In addition to the SCANS study, OECD DeSeCo project research results also have a greater reference value. The project defines the ability to influence the career development based on how the workers face a changing professional environment and what capacity they should have. The project considers the elements of competency include knowledge, skills, as well as the values and motivation, including three specific factors, namely effective tools use, communication skills and independent action. The tools include language, symbols and text, etc. Using tools effectively refers to the knowledge and information. Communication skills include the ability of commutations, teamwork and resolving conflicts; independent action refers to the self-planning and self-management capabilities, including personal interest, self-control and persistence ability (Rychen et al., 2003).

The OECD countries participating in the DeSeCo project also put forward different capacity constituencies. Germany divides competency elements into knowledge, system thinking, learning, communication, tools using and the integration of different cultures. Australia believes that capacity should be composed of four elements: personal ability, complex environmental adaptability, social competence, and social capacity. New Zealand's view is similar to that of Germany, and its research report divides the competency elements into communication skills, IT skills, information skills, problem solving skills, self-management and competitiveness skills, and co-operation skills. Switzerland defines the competency elements as learning capability and information processing capacity, planning management capacity, communication skills, social communication skills, systematic thinking ability (DeSeCo, 2001).

In addition to the above two influential projects, the Tuning Project (Tuning Educational Structures in Europe) in which the study object is different from the above two projects has a certain influence on the competencies composition and is aimed at school students. Tuning project hold the point that students should obtain ability through education, different courses and then timely phased assessment. Competence consisting of knowledge, understanding, skills and competencies included two basic dimensions, namely, general capability and specific ability. General capability including learning capability, analytical ability, comprehensive ability, etc., become more and more important due to its versatility in the changing social, economic, cultural environment. Research in management field shows the different capacity structure in different occupations, different industries, and different cultural environments (Wagenaar & González, 2005). Specific competencies associated with specific disciplines include the comprehensive ability of professional understanding, perception and expertise.

In this paper, more analysis of the competency structure difference will be done based on multi-factor theory and the employment ability framework of IT majors. Multi-factor theory agrees with requirements for IT practitioners in the increasingly complex technical, economical and legal environment. IT industry-related activities need coordination to form a reasonable structure.

2.3.2 Engineering education competency theory

Engineering education is the activity of teaching knowledge and principles related to the professional practice of engineering. It includes the initial education for becoming an engineer, and any advanced education and specializations that follow. Engineering education is typically accompanied by additional post graduate examinations and supervised training as the requirements for a professional engineering license. Engineering education, in a broad sense, refers to the social activities of training engineering talents; and in a narrow sense, it refers to the school education for training of engineering talents. Higher engineering education changes with the progress of science and technology and social development, and is to a large extent the inevitable result of the industrial revolution. At the same time, the original discovery of modern natural science creates the necessary conditions for the rise of higher engineering education. Higher engineering education is the specialized education with science and technology as the main disciplines with the objective of cultivating engineers who can transform science and technology into productive forces. It is the fundamental guarantee to promote scientific and technological progress and technological innovation.

The most popular Engineering education competency theory include Washington Accord (Zhou & Wang, 2014), CDIO Initiative (About CDIO) and ABET EC2000 (Fort, 2013).

Washington Accord.

The Washington Accord is an international accreditation agreement for professional engineering academic degrees, between the bodies responsible for accreditation in its signatory countries. The Washington Accord was initiated and signed by civil engineering professional groups from the United States, Britain, Canada, Ireland, Australia, and New Zealand in 1989 (Fan & Yi, 2014). As of the end of June 2016, the accord had 18-member states (Hua, Ji, & Wu, 2017). The accord focuses on mutual accreditation of international academic engineering qualifications (usually four years), and confirms that the engineering qualifications accredited by a member are basically the same, and suggests that graduates from courses certified by any member state should be deemed by other member states (regions) to have obtained the academic qualifications to undertake primary engineering work. The Washington Accord has very high requirements on the quality of graduates, containing 12 aspects under four dimensions of "knowledge dimension", "ability to solve engineering problems dimension", "general capability dimension", and "attitude dimension", including engineering knowledge, problem analysis, design/development of solutions, research, use of modern tools, engineering and society, environmental and sustainable development, professional norms, individual and team, communication, project management, lifelong learning, many of which are not found in traditional engineering education, with even engineering ethics (Hua et al., 2017).

CDIO Initiative.

The CDIO (Conceive-Design-Implement-operate) Initiative is an educational framework stressing engineering fundamental set in the context of conceiving, designing, implementing and operating real-world systems and products. Throughout the world, CDIO Initiative collaborators have adopted CDIO as the framework of their curricular planning and outcome-based assessment. The CDIO concept was originally conceived at the Massachusetts Institute of Technology in the late 1990s. (Edward, 2002)

In 2000, MIT in collaboration with three Swedish universities - Chalmers University of Technology, Linköping University and the Royal Institute of Technology - formally founded the CDIO Initiative (Yang & Pan, 2017). It became an international collaboration, with universities around the world adopting the same framework. CDIO engineering education model is the latest achievement of international engineering education reform in recent years. Since 2000, cross-border research by four universities including MIT and the KTH Royal Institute of Technology received a large funding of nearly USD20 million from Knut and Alice Wallenberg Foundation. After four years of exploratory research, the CDIO engineering education philosophy was created, and an international cooperation organization so named was set up. CDIO stands for Conceive, Design, Implement and Operate. It takes the life cycle from product development to operation as the carrier, and enables students to learn engineering in an active, practical manner with connections between various courses. CDIO includes three core files: a vision, an outline and 12 criteria (Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014). CDIO's vision is to provide students with an engineering education based on the background where the conceive-design-implement-operate process is built on the project basis and the product and system are established in the real world. Its outline for the first time refines the basic knowledge of engineering, personal ability, interpersonal skills and the entire CDIO process ability necessary for an engineer in a level-by-level manner (3 levels, 70 articles, over 400 clauses), so that engineering education reform is more directional and systematic. Its 12 criteria provide systematic and comprehensive guidelines on the implementation and testing of the entire model, which makes the engineering education reform concrete, operable and measurable, and have important guiding significance for students and teachers. CDIO represents a systematic, scientific and advanced unity, and the development trend of contemporary engineering education. The CDIO training outline divides the ability of engineering graduates into four levels: engineering basic knowledge, personal ability, and interpersonal skills and engineering system capabilities, and requires a comprehensive training approach to make the students achieve the desired goals for the four levels (Zhang, 2010).

The CDIO Syllabus is the cornerstone of CDIO. It offers rational, complete, universal and generalizable goals for undergraduate engineering education. Whether in its complete version or a condensed version, the CDIO Syllabus focuses on personal, interpersonal and system building skills, and leaves a placeholder for the disciplinary fundamentals appropriate for any specific field of engineering. It complements and significantly expands on ABET’s criteria.

ABET EC2000

Furthermore, the United States Accreditation Board for Engineering and Technology (ABET), a famous American discipline certification organization and a well-known international certification organization, carries out various professional identification and is the professional and technical personnel to obtain the authority (Prados, Peterson, & Lattuca, 2005). At present, there are more than 550 universities in the world, 2,500 colleges have participated in its certification, including Carnegie Mellon University, Princeton University, New Mexico State University, University of Houston, Caspian University and other famous universities. ABET certification means a university can cultivate an internationally competitive engineer. For most of its history, ABET's accreditation criteria specifically outlined the major elements that accredited engineering programs must have, including the program curricula, the faculty type, and the facilities. However, in the mid-1990s, the engineering community began to question the appropriateness of such rigid accreditation requirements. After intense discussion, in 1997, ABET adopted Engineering Criteria 2000 (EC2000). The EC2000 criteria shifted the focus away from the inputs (what material is taught) and to the outputs (what students learned). EC2000 stresses continuous improvement, and accounts for specific missions and goals of the individual institutions and programs (Rogers, 2000). The intention of this approach was to enable innovation in engineering programs rather than forcing all programs to conform to a standard, as well as to encourage new assessment processes and program improvements (Lisa, 2012).

Eleven parts summarized by ABET EC2000 with regard to the employability of engineering students.

(1)Apply knowledge of mathematics, science and engineering;

(2)Design and construct experiments, as well as to analyze and interpret data

(3)Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;

(4)Function on multi-disciplinary teams;

(5)Identify, formulate and solve engineering problems;

(6)Understanding of professional and ethical responsibility;

(7)Communicate effectively;

(8)The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;

(9)Recognition of the need for, and an ability to engage in life-long learning;

(10)A knowledge of contemporary issues;

(11)The capability of using the techniques, skills and modern engineering tools which are necessary for engineering practice.

All the Washington Accord, the CDIO engineering education and ABET EC200 set the competencies that graduates need to achieve. It is of great value to design the word table system for employability of IT graduates with reference to the division of abilities.

The ability of the engineering education graduate students was described by the CDIO, the Washington Accord and the ABET EC200, and this result has great reference value and great significance for the IT students in the employability elements selection and structure.

2.3.3 IT education competency theory

ACM/IEEE-CS IT Curricula

As the most famous computer organization in the world, Association for IT Machinery (ACM) and the Institute of Electrical and Electronics Engineers Computer

Society (IEEE-CS) have been tracking the talent in the field of IT for the industry and the demand, status, development and problems in the training for the education (Zhou & Dang , 2004). The most representative and influential work in the field of computational subject education is still IT Curricula organized by IEEE-CS/ACM. ACM / IEEE-CS divide computational disciplines into five major disciplines: Computer Engineering (CE), Computer Science (CS), Information System (IS), Information Technology (IT), Software Engineering (SE) (Yang & Lu, 2010). And it has guiding proposal for the IT Curricula 2001(CC2001) (Roberts, Engel, Chang, Cross, Shackelford, & Sloan, 2001). Following the CC2001, IEEE / ACM modified and expanded the original "CC2001" in the four-professional direction on the basis of the preliminary work after several years' tracking research, feedback and planning comments (Yang et al., 2010). And IS2010, CS2013, SE2014, CE2016 and IT 2017 was issued by IEEE / ACM contrary to each professional area keeping pace with the time. (ACM/IEEE-CS, 2017)

ACM / IEEE-CS believe that a passable computer professional should qualify knowledge, skills and attitude. Skills should include communication, acquiring knowledge and information, professional basic competencies, innovation, project fulfillment, and teamwork. Specifying to professionally basic ability, it includes Computational Thinking, Algorithm Design and Analysis, Program Design and Implementation, System Understanding and Mastery, and System Understanding and Mastery still consists of cognition, design, development and application.

IEET CAC2016

Engineering Education Association of Taiwan (IEET) established in 2003 is an unofficial, non-profit organization and the first professional evaluation agency accredited by the Ministry of Education (Jin, 2016). IEET establish and maintain internationally recognized professional core competencies and ethical norms, thus strengthening the confidence of the industry, the government and the overall community for future projects, IT, technology and construction. Seven core competencies required below for the graduates in the IT Accreditation Criteria 2010 (CAC2010) designed by IEET.

(1) Innovation and application of information technology and mathematical knowledge.

(2) The ability to implement IT skills and modern tools using.

(3) Design and evaluate the capabilities of computerized systems, programs, components or programs.

(4) Project management (cost analysis), effective communication, domain integration and teamwork.

(5) Explore, analyze, apply research results and complex and integrated consulting issues.

(6) Study current events, acknowledge the impact of information technology environment, society and the world, and develop the capacity for continuous learning.

(7) Understand and comply professional theory, recognize social responsibility and respect multiple views.

The authority of ACM / IEEE-CS provides an important reference for IT students to cultivate the employability, especially the professional ability. But we find that a wide range of 82 points in the 13 directions provided by the ACM / IEEE-CS IT Curricula overlap with the four major professional competencies, which will have a greater ambiguity in the survey. The capacity structure of IEET CAC2016 is indistinct, and we will refine the computer expertise based on the reference and integration of IT Curricula and CAC2016.

2.3.4 Occupational competency theory

Occupational competency is the criterion to evaluate the ability of employees to meet the requirements for specific jobs. It is mainly applied to employees of enterprises and civil servants. The construction of occupational competency model is the main method to study it (Xiao, & Liu, 2014). Although its fields of study differ from employability, it can provide a useful reference for the research on the employability of IT graduates. It can be used as reference for theoretical research on the employability of IT graduates, establishment of evaluation indicators, and object-based employability training mode.

The theory of occupational competency capital.: McClelland (1973), an American psychologist, first proposed the competency perspective, arguing that competency is a measurable characteristic of knowledge, skills, values, and driving forces required for employees to achieve high performance in a given situation (Sandberg 2000; Weinert, 2001). Competency refers to a deep-seated characteristic that distinguishes a successful individual from a general individual in a job, and can be motivation, trait, self-image, attitude or values, knowledge of a field, cognition or behavioral skills, or any other individual characteristics that can be reliably measured or counted and can significantly distinguish between excellent and general performance (Hager, 1995). However, some scholars define competency from a broader perspective, thinking that that competency consists of three dimensions: occupation, behavior and strategic integration. Occupation refers to the skills to deal with specific, daily tasks; behavior refers to the skills to deal with non-specific, arbitrary tasks; and strategic integration refers to the management skills to combine with organizational context. According to the principles of systematic, relevant and operable, the so-called competency is deemed to refer to the individual characteristics that can be objectively measured for good performers in the specific job, organizational environment and cultural atmosphere, and the consequential behavioral characteristics that can be predicted and point to performance. From these principles, the characteristic structure of competency includes individual characteristics, behavior characteristics and working conditions. The research of occupational competency mainly explores the key factors that can make enterprises produce high performance from the view of enterprise, so as to promote enterprises to carry out a series of human resource management activities by applying competency model.

The main ideas of occupational competency are summarized as follows: First, competency is related to job performance (Zhao, 2013); second, competency is related to the specific work environment, which is the result of interaction between the job and the individual's characteristics or behavior; third, competency is the prerequisite for individuals to achieve high performance in concrete work.

McClelland believes competency is the syndrome of motivations, personality traits, self-values, knowledge, and skills. Those features can be measured and can be acquired or improved via the educational process, and those who possess these characteristics can perform excellent. Therefore, the measurement can be found based on performance differences and the combined characteristics can apply to a specific occupation for the Competency Model. McClelland put forward an iceberg model (Wagner, Stern, Dell, & Eisenman, 2017). Based on the model, practice ability and employment entrepreneurial ability of IT engineering students belong to the explicit ability characteristic, while the engineering professional accomplishment belongs to the implicit ability characteristic. The American Management Association (AMA) defines competency as "personal knowledge, motivation, traits, self-image, social roles, or skills that are necessarily relevant to excellent job performance" (Hayes, 1979). The study identified five basic competencies of successful managers: professional knowledge, mental maturity, entrepreneurial maturity, interpersonal maturity, and job maturity. The professional competence theory is widely used in the development and management of human resources in the enterprise and shows the applicability of IT professional college students in higher engineering education. Because whether the graduates can do the engineering and technical occupations, it can erasure the IT professional college students' employability and the important standard of university quality training.

2.4 The research on the structure of undergraduate employability

From the previous research on the employability structure of college students, whether it is the employability structure given by the educational research organizations of various countries, or the structure of the graduates' ability from the scholars, they are all based on the components of the employability of college students. Some of these studies have also added external factors that influence the employment outcomes of college students, such as the state of the labor market. From the literature on the study of employability structure, scholars have put forward various views of employability structure and college students' employability structure. These views all attempt to clearly define the components of the employability structure of college students. However, the ideas put forward by some studies are too simple. They simply define the employability of college students as the ability of college students to get jobs, so that they cannot elaborate on the complicated problem of college students' employability. Some studies are too theoretical and lack practical application. Some studies involve a wide range of factors that prevent them from focusing. In addition, most of the research is based on the study of the employment capacity structure of all college students, and lacks specialized research on IT majors. However, the research on the employability of IT undergraduate has only studied the professional ability and neglected the study of other abilities. Based on the above judgments, from the numerous literatures, this paper believes that the following research on the structure of IT undergraduate employability can be used as a reference and theoretical basis for the analysis of the employability structure of college students (see Table 2.3).

The above viewpoints on the structure of college students' employability are cited in the relevant research literature, and they are also more widely recognized by scholars. The above 10 models analyze the structural elements of college students' employability, and point out that the employability of college students is firstly related to professional ability, and they all agree with the multi-element theory of the employability structure of college students. In addition, Bennett et al. (1999) and other model, Yorke and Knignt models, Dacre Pool & Sewell models, Bridgstock models, CDIO Initiative (2010) models and IEET CAC (2017) (Sabin, Peltsverger, Tang, & Lunt, 2016) models are all based on personal perspectives, pointing out that the employability structure should also include general capabilities, personal quality. Therefore, this paper uses professional competence, general capabilities and personal qualities as the first-level indicators of college students' employability structure.

Table 2.3 Structures of IT undergraduate employability

Literature	IT students' employability structure
Hillage and Pollard (1998)	"Employment capital", composed of students' knowledge, skills and attitudes; “performance", refers to the ability of college students show their knowledge, skills and attitudes in the process of job seekers; “planning", refers to the occupation career management capability and strategic capability; "environment" refers to the personal background and labor market conditions.
Bennett, Dunne, & Carré, (1999)	The five-element model of employability structure: one is the knowledge of a specific specialty; two is a specific professional skill; three is vocational consciousness; four is occupation (practice) experience; five is general capability.
Yorke and Knight (2004)	The USEM model of employability structure: professional understanding (knowledge); skills (including key skills); self-efficacy (including self-development awareness); metacognition (including learning how to learn)
Dacre Pool and Sewell (2007)	CareerEDGE model of employability structure: first, professional knowledge, cognition and skills; two is general skills; three is EQ; four is career development knowledge; five is social work experience.
Bridgstock (2009)	The model points out that the employability of college students consists of five components: Students' personality and personal characteristics, specific professional skills, general competence, self-management ability and career development ability.
Washington Accord	Containing 12 aspects under four dimensions of "knowledge dimension", "ability to solve engineering problems dimension", "general capability dimension", and "attitude dimension"
CDIO Initiative	Technical knowledge and reasoning; Personal and professional skills and attributes, interpersonal skills; Teamwork and communication; Conceiving, Designing, Implementing and Operating systems in the enterprise and societal context.

Table 2.3 Structures of IT undergraduate employability (Continued)

Literature	IT students' employability structure
ABET EC2000	Apply knowledge of mathematics, science and engineering; Design and construct experiments, as well as to analyze and interpret data; Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability; Function on multi-disciplinary teams; Identify, formulate and solve engineering problems; Understanding of professional and ethical responsibility; Communicate effectively; The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context; Recognition of the need for, and an ability to engage in life-long learning; A knowledge of contemporary issues; An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.
ACM/IEEE-CS IT Curricula	Specifying to professionally basic ability, it includes Computational Thinking、Algorithm Design and Analysis、Program Design and Implementation、System Understanding and Mastery. And System Understanding and Mastery still consists of cognition, design, development and application.
IEET CAC	Innovation and application of information technology and mathematical knowledge. The ability to implement IT skills and modern tools using. Design and evaluate the capabilities of computerized systems, programs, components or programs. Project management, effective communication, domain integration and teamwork. Explore, analyze, apply research results and complex and integrated consulting issues. Study current events, acknowledge the impact of information technology environment, society and the world, and develop the capacity for continuous learning. Understand and comply professional theory, recognize social responsibility and respect multiple views.

2.5 Defining basic concepts

Before analyzing IT majors' employability structure and its improving path, a basic work is to define the basic concepts in this research, such as IT majors, undergraduates' employability, path of improving undergraduates' employability and so on.

2.5.1 IT students

IT Major is a comprehensive discipline taking information as its research object, mainly focusing on information's law of motion and application methods and applying computer as its research tools with the purpose of enlarging human information's function. IT Students means Students who are majoring in IT, including the students who study in computer science, computer engineering, software engineering, information systems and information technology. (IEEE-CS/ACM, 2001)

Students in higher education are those who are educated in universities but do not work in society. They are talents and kind of special because they are cultivated to master new technology, new ideas, and popular culture. Students register and educated in higher education can be divided into two kinds-full time and part time, containing various students such as college students, vocational school students, undergraduates, postgraduates and doctorial students. In this paper, IT majors mean those undergraduates.

2.5.2 Undergraduates' employability

(1)Undergraduates' employability

Employability emphasizes the result of getting employed. Based on the previous literature, the influential factors of employability are various such as macro-economy, policy of labor market and so on, which cannot be changed directly by higher education.

As personal ability is a very important factor influencing career option and development, so this personal ability named undergraduates' employability is chosen to be studied in this paper.

(2)Employability and competency

There is no uniform definition of competence. Both characteristic competency theory and behavioral competency theory think that competency is a definition for analyzing if one can be qualified for the work chosen or get a good performance during work. Definition of competence is raised after definition of ability brought into human resource management, which also is used for analyzing career activity, identifying work's requirements on one's ability and differences of ability. Competency model, a definition of human resource management, mainly works on people employed (Mansfield, 1996).

Undergraduates' employability, specially means potential employers' ability, is for analyzing undergraduates' ability of getting employed and maintaining career development. Undergraduates' employability, belonging to educational economic management, is gained after being educated in higher education. Competency theory is a very important reference for this research though it belongs to human resource management because undergraduates' employability is also a kind of potential competency of getting a job and maintaining its development (Hu, 2015).

(3) Defining undergraduates' employability in this research

Undergraduates' Employability in this research is a personal ability. Ability should be made sure before defining undergraduates' employability. In Chapter Two, ability is defined in perspective of psychology, pedagogy, economy and management.

These definitions have some common qualities. This research takes the definition of ability in perspective of management. In management, ability is defined as a combination of knowledge, skills and attitudes, which is related to some specific posts' requirements and career role and is shown during work. Yorke (2006) also believes that undergraduates' employability is a series of skills, knowledge and personality. This definition is operable and close to undergraduates' employability. After taking literature at home and abroad as reference and considering the situation of cultivating students in higher education, this research defines undergraduates' employability as knowledge, skills and attitudes of getting jobs and being successful in their chosen jobs when they graduate from universities. Employability is not just an ability matching enterprises' requirement, which should be a positive and active ability. Higher education should be responsible for students to help them meet enterprises' requirements. To some extent, higher education should lead the development of enterprises. That is also why employability should contain abilities of career planning and entrepreneurship.

2.6 Conceptual framework

After sufficient literature review, this research proposes the conceptual framework demonstrated in Figure 2.3. The relationships of each component of the framework are described as follow:

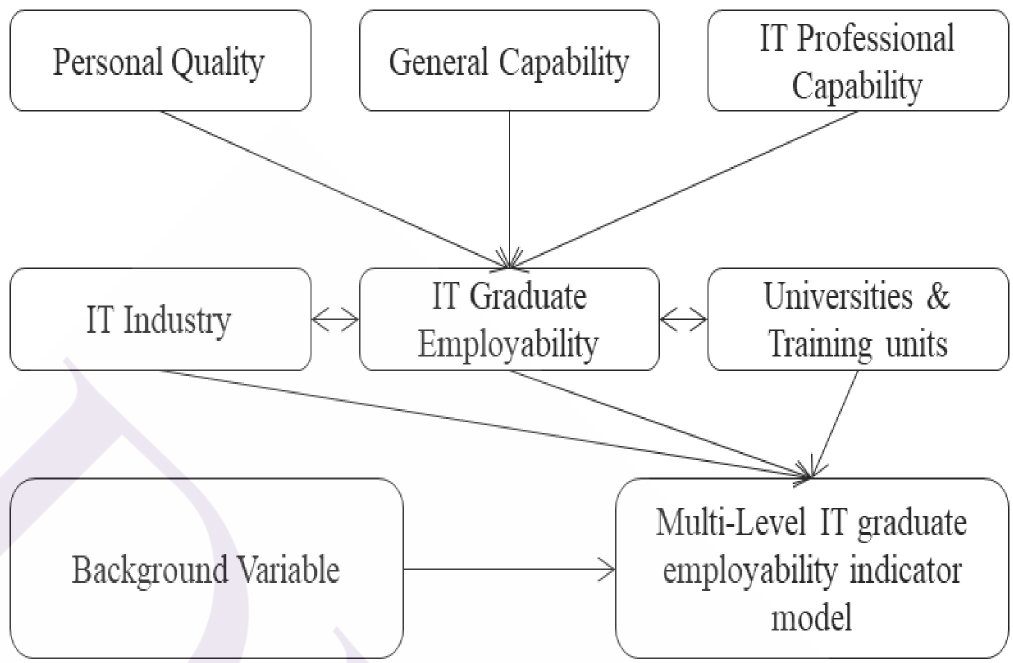


Figure 2.3 The relationships of each component of the framework

1. The top 3 Sections represent all the employability component capabilities that together constituted the IT graduate employability, which is represented with the three arrows between them. Through the literature review, this study proposes that those component capabilities can mainly be classified into General Capability, Personal Quality, and IT Professional Capability. Thus, there are three round shapes.

2. The demands of the IT talent from IT industry shape the IT graduate employability in certain way. The suitable IT graduate employability promotes the IT industry. Therefore, the double-direction arrow is located between them.

3. The education from the university and training units is the basis of the cultivation of the IT graduate employability. The acceptance of the IT graduate employability provides the signal and direction for the education reform. Therefore, the

double-direction arrow is located between them.

4. The characteristics of the IT graduate employability is the most important aspect of forming the multi-level IT graduate employability Indicator model. The universities and training units play an important role in cultivation of employability, so their expertise provides valuable knowledge for the construction of the model. The satisfaction of the IT industry indicates the successfulness of the employability and affects the employment of IT graduate, so it is important to take the opinion of IT industry into consideration. In conclusion, the model is constructed on the basis of all three component, which is represented by three arrows from the three components to model.

5. The context is important for the successful application of the model. When promoting the IT graduate employability, the influence of the background information could cause the output of the model application to be different. Therefore, the influence of background information of the application of model is represented by the arrow from background variable to the model.

2.7 Preliminary construction of IT undergraduate employability structure

The model is constructed to clearly explain a problem or phenomenon, and to guide the problem or phenomenon, so as to achieve the role of theoretical guidance practice. The construction of the undergraduate employability structure should also be based on the above starting point, so the construction of the structure model of undergraduate employability should follow the following principles:

First, the constructed model of undergraduate employability should be able to clearly show the content of undergraduate employability, content of model focus, etc.

Second, the constructed model of undergraduate employability should be identifiable and understandable, that is, the model should be clearly understood by students, parents, teachers, education administrators, and researchers.

Third, the constructed model of undergraduate employability should be able to better guide practice, that is, to guide the various stakeholders who play a role in cultivating undergraduate employability.

Fourth, the structure model of undergraduate employability should have a certain degree of expansion. It can be applied to other research objects by making minor modifications to the model (Rothwell & Arnold, 2007).

Therefore, based on the principle of constructing the structure model of undergraduate employability, the definition and concept of employability and the review of the domestic and foreign employability structure model, this paper defines the IT undergraduate employability structure as the following three components: IT professional capability, general skills, Personal quality.

However, it should be noted that the components of these employability structures are not completely separated. There is a correlation between the components of each capability structure. Undergraduate employability can be improved by the improvement of the components of each capability structure

2.7.1 IT professional capability in IT undergraduate employability structure model

Under the concept of undergraduate employability, in the era of knowledge economy and in the context of the acceleration of the popularization of higher education, college students have been increasingly demanded that they need to have the knowledge and skills commensurate with their academic qualifications, especially the knowledge and skills in line with social needs. As pointed out by Hillage and Pollard (1998), in the era of knowledge economy, undergraduate employability has become one of the most important factors influencing the success of careers, career maintenance and career development. Global integration, knowledge economy, continuous upgrading of the industry, and changing working environment make it necessary for college students to have employability to meet the complex needs of today's profession.

Some scholars use very simple indicators to explain undergraduate employability, which is to consider undergraduate employability as the ability of college graduates to get a job. This interpretation does not fully demonstrate the undergraduate employability. The biggest problem with this interpretation is that it does not explain the skills, knowledge, and understanding gained by college graduates in college professional studies. When college students get jobs, they may not necessarily need the professional knowledge and skills they have acquired at the university. College students can lower their career expectations and get a career that does not correspond to their academic level. Therefore undergraduate employability is not only about its ability to work, it should be the ability of college students to acquire and be able to maintain a career that is consistent with their academic qualifications (Boden & Nedeva, 2010) The definition of undergraduate employability in this paper is based on this understanding. As described in the UK Commission for Employment and Skills (UKCES), 2009, undergraduate employability necessarily includes professional knowledge and professional skills. College students who have only general knowledge and no professional skills cannot achieve significant results in their professional development (Davis, 2002). It is undeniable that an important reason for people to pursue higher education is to study a specific subject knowledge in university, in order to obtain a professional degree or obtain a higher education qualification and diploma, and then get a better job. From the current employment market situation, a good profession, a good diploma in a good university can result in better employment opportunities (Johnes, 2006). According to a survey, although 66% of career opportunities are open to all majors, 34% of career opportunities require students with specific professional backgrounds (Prospects, 2005). From the employer's point of view, the employer evaluates a college graduate based on whether he or she has successfully completed the major. In addition, from the perspective of the reality of college students' entrepreneurship, the entrepreneurial activities of many entrepreneurs are consistent with their majors, at least be related or similar. Therefore, regardless of whether a college graduate enters the professional system and whether his or her occupation is related to the major he or she has studied at university, his or her professional knowledge and skills are an indispensable component of undergraduate employability, and even one of the most important factors.

For the professional ability of IT undergraduate, it is necessary to adopt the professional employability that the IT industry pays attention to. ACM/IEEE-CS IT Curricula (2017) mentioned IT undergraduate's IT system expertise including: IT system cognitive capabilities, IT system design capabilities, IT development capabilities, and IT system application capabilities.

IT system cognitive ability mainly includes: basic system software use, system software composition, basic computer hard system structure, network system composition, hardware system performance, software system performance.

IT system design capabilities include: computational thinking, algorithm design and implementation, programming and implementation, designing digital circuits, designing functional components, designing chips, programming chips, designing embedded systems, designing computer peripherals, designing complex sensors Systems, designing ergonomic devices, designing computers, designing applications, designing database management systems, database modeling and design, designing intelligent systems, developing business solutions, evaluating new search engines, defining information system requirements, designing information systems, Design network structure, experimental design, etc.

IT system development capabilities include: implementing applications, configuring applications, implementing intelligent systems, developing new software environments, creating security systems, configuring and integrating e-commerce software, developing multimedia solutions, configuring and integrating e-learning systems, creating Software user interface, graphics or game software, configuration database products, information retrieval software, enterprise information planning, computer resource planning, network components selection, computer network installation, communication software, mobile computing system, embedded system , to achieve digital circuits, to achieve information systems, experimental implementation, experimental analysis.

IT system application capabilities include: using applications, training users to use information systems, maintaining and updating information systems, managing high-level security requirements projects, managing an organization's website, selecting database products, managing databases, training and support for database users, Resource upgrade scheduling and budgeting, computer installation and upgrade, computer software installation and upgrade, management of computer networks, management of communication resources, management of mobile computing resources, etc.

These four basic professional abilities are the basic abilities of this professional. However, the difference in specific positions determines the professional ability to emphasize different aspects of IT professional capability. Chinese computer education expert Jiang (2011) also praised ACM/IEEE-CS IT Curricula (2017).

IEET CAC defines IT undergraduate's expertise including: The ability to implement IT skills and modern tools using. Design and evaluate the capabilities of computerized systems, programs, components or programs, and acknowledge the impact of information technology environment.

Combining the above professional competence elements and with ACM/IEEE-CS IT Curricula and IEET CAC, this study identifies IT professional capability as: cognitive and operational capability of computer principle, computer system theory design and developing capabilities, computer applications and creativity. The indicators are shown in Table 2.4.

Table 2.4 IT professional capability in IT undergraduate employability structure model

The first level indicators	The second level indicators	The Third level indicators
IT professional capability	Cognitive and operational capability of computer principle	Cognitive capability of basic knowledge of computer
		Cognitive and operational capability of computer components and hardware
		Cognitive and operational capability of software theory
	Computer system theory design and development capability	Computational thinking and modeling capabilities
		Algorithm design and analysis capabilities
		Computer hardware design and development capabilities
		Capability of computer software design and program development
	Computer applications and creativity	Knowledge and understanding of knowledge and processes in the application domain
		General capability to use and maintain computer application systems
		Basic design capability of computer application system
		capability to apply computer for implementing apply system and conducting development and innovation

2.7.2 General capability in IT undergraduate employability structure model

Generic Skills is often referred to in many literatures as Keys kills, Cores kills, employability skills, transferable skills. These different concepts are often used interchangeably without distinction, increasing confusion about the understanding of the dimensions of employability (Melaia & Bick, 2008). This article uses the concept of general skills.

There are a lot of studies about the specific compositional dimensions of general skills. Much of the research is based on surveys and interviews with employers. The Pedagogy for Employability Group of Higher Education Academy in UK published 25 years of research in 2006 (Gulc, Bullen, and Anderson, 2014). The team's research indicates that employers most expect the general skills of undergraduate graduates to include: Imagination and creativity; adaptability and flexibility; willing to learn; independent work ability and autonomy; teamwork skills; ability to manage others; ability to work under pressure; good verbal communication skills; Have written communication skills; mathematical ability; attention to detail; time management skills; ability to take responsibility and make decisions; plan, coordinate and organize skills; ability to apply new technologies.

In the 2009 report, Confederation British Industry in UK listed nine general skills that employers most want college graduates to have. Self-management ability refers to sense of responsibility, flexibility, adaptability, appropriate self-confidence, time management, and ability to improve performance based on feedback and thoughtful learning. A positive attitude refers to active implementation and openness to new ideas. Aggressive and entrepreneurial spirit means innovation, creativity, and risk. Teamwork ability refers to the respect for others, the spirit of cooperation, the ability to persuade others, and the independence of others. Business and customer awareness refers to the basic understanding of the key drivers of career success and the awareness of individual satisfaction and loyalty. Mathematical capability refers to the operation and presentation of numbers and general mathematical cognitive abilities. Communication and literacy skills refer to written expression skills, verbal communication skills, and listening skills. Information technology capabilities refer to the ability to manage basic software and electronic documents. Problem-solving ability refers to the use of creative thinking to propose problem solutions, which is the only cognitive ability. These capabilities are all based on business orientation, from the perspective of the employer. This paper argues that employability is in line with the needs of the industry, and what constitutes employer employability should also be defined from the perspective of the IT industry.

Based on the literature review of undergraduate employability in Chapter 2 of this paper, China's research on undergraduate employability is mainly focused on the research on the dimensions of general skills. Jin (2009) defines general skills as leadership and management skills (including planning, conflict resolution, decision making, etc.) and problem-solving skills. Capability of self-development includes innovation awareness, learning capability, career planning capability, etc. Interpersonal skills include negotiating skills, teamwork, and ability to build and maintain a network of relationships. Basic skills include foreign language ability, ability to use IT, writing ability, calculation/mathematics, reading ability. General skills are those that apply to any major, and are skills that can be transferred in different contexts. For the general skill dimension of undergraduate employability, it refers to the ability of transferring in learning and work. Employers are also very concerned about this general skill of college students. A study by Knight and Yorke (2002) shows that undergraduate graduates that employers most want to hire are undergraduate graduates with good general skills. According to a large-scale graduate employment survey conducted by Taiwan in 2006, most employers pay great attention to their general skills when interviewing undergraduate graduates (Mayer, Salovey, & Caruso, 2004). In addition, graduates must be able to capture the best career opportunities and be able to achieve satisfaction and success in career development, and education in career selection and development management at the university is essential. People who have better ability to identify their career goals and manage their career choices and development tend to have better career development scenarios and higher career performance than those without career management skills (Day & Allen, 2004).

Therefore, based on the understanding of the connotation of general skills and the scholars' research on the dimensions of common skills, this paper will initially define the general skills as the following sub-dimensions, planning capability, executive capability, teamwork and communication skills, etc, as shown in Table 2.5.

Table 2.5 General capability in IT undergraduate employability structure model

The first level indicator	The second level indicators	The third level indicators
General capabilities	Planning	planning capability
		Career planning capability
	Executive capability	Hands-on ability
		Executive capability
	Teamwork and communication skills	Teamwork
		Communication and coordination
		Adaptability
		Using social relations capabilities
	Capability of developing	Learning capability
		Creativity
		Comprehension and expression
		Skills of analyze

2.7.3 Personal quality in IT undergraduate employability structure model

Personal quality, in many literatures, is also called personal characteristics and attitudes, personal attributes and so on. For the dimension of personal quality, some scholars define it as emotional intelligence, and some scholars define it as personal personality. Emotional intelligence can be called personal quality, also known as personality or soft skills. No matter what the definition is, it defines the ability to identify one's emotions, and then to self-motivate, therefore better manage or adjust one's emotions or emotions (Mayer et al., 2004). Personal characteristics and attitudes (Emotional Intelligence) are precursors to the success of students' career choices and career development. Emotional intelligence can be well cultivated during the university's study

(McMahon, Patton, & Tatham, 2003). A study by the OECD, "Rethinking Human Capital," points out that people who are confident, proactive, willing to experience, happy, and sociable are more likely to get a high-paying job. Studies have also shown that graduates with high emotional intelligence have better prospects in obtaining work and career development. Graduates who have strong internal drive and strong self-efficacy could be easier to get jobs and go through the conversion from school to work (Pinquart, Juang, & Silbereisen, 2003). Once in the job role, these students are more likely to have job satisfaction and high performance than those with weak internal drive and low self-efficacy (Judge & Bono, 2010). Goleman (1998) believes that any employability structure should include the dimension of personal emotional intelligence. In the era of knowledge economy, emotional intelligence has become an indispensable basic condition for personal career development.

From the review of career choice and career development theory, we can also see that personal traits or emotional intelligence are important factors influencing individual career choice and development(2003) proves that students' emotional intelligence can be well cultivated and improved in colleges and universities. The emotional intelligence improvement is obviously positively related to their learning performance in school. Therefore, it is also very helpful to strengthen the cultivation of students' emotional intelligence in colleges and universities, which is necessary for students to obtain employment and achieve professional development success. As a university focused on talent development, it is necessary not only to provide students with solid knowledge and skills, but also to help students improve their emotional intelligence.

Therefore, this study divides the personal quality dimension into the following three dimensions: comprehensive ability, values and sense of career achievement, as shown in Table 2.6.

Table 2.6 Personal quality in IT undergraduate employability structure model

The first level indicator	The second level indicators	The third level indicators
Personal quality	Comprehensive ability	Psychological endurance Problem solving ability
	Value	Professional ethics and sense of responsibility
	Sense of career achievement	Sense of career achievement

2.8 Summary of this chapter

This chapter is a literature review of this paper, which is the basis of the theory and research of this paper. This chapter focuses on the research on the employability and structure of college student employability, and systematically introduces IT industry and the talent demand characteristics of IT industry. It also systematically introduced the capability structure theory, engineering education competency theory, IT Education competency theory, and occupational competency theory. Through the relevant theoretical research on the connotation of IT undergraduate employability, employment ability model, IT industry and talent demand characteristics, the research status and shortcomings are understood. Since China's construction and research on IT undergraduate employability structure started late, the research content is not deep enough. From the perspective of enterprise demand, the research on the difference between the degrees of performance the importance of the IT major employability is even rare.

3. METHODOLOGY

Last chapter has reviewed the relevant literature on topic of employability and construct the preliminary employability structure. The main purpose of this chapter is to illustrate the design and implementation of this study. The section 3.1 describes the structure and hypothesis of the study, and identifies the four background variables. The section 3.2 introduces the research methods of this thesis. In section 3.3 the focus group interview is conducted to evaluate and adjust the preliminary employability structure. The section 3.4 and 3.5 illustrate the design and implementation of the small questionnaire survey, the reliability test, and the validity. In section 3.6, the detail information of final questionnaire is presented as well as descriptive statistics and reliability test. The last section presents the data processing and statistical analysis.

3.1 Research architecture and assumptions

3.1.1 Research architecture

The main purpose of this study is to explore the IT undergraduate employability, its structure and its assessment indicators. Based on the research motivation and purpose, the research structure of this research is shown in Figure 3.1.

According to the research motivation and the purpose of the research, this study extracts four research questions. The key point is to explore the structure of IT undergraduate employability. In the literature review, characteristics of IT industry and related competency theory are studied and the characteristics of IT undergraduate employability are selected. Through the analysis of the literature, IT undergraduate employability structure is preliminary constructed under the guidance of several principle.

Then the focus group interview is conducted to assess the employability structure and collect adjustment suggestion. The characteristic elements of the IT undergraduate employability structure are scored, the insignificant feature elements are deleted, and the characteristic elements suggested by the experts are added to form the final version of IT undergraduate employability structure.

On this basis, the small scale questionnaire is compiled and forecasted to conduct the validity and reliability analysis. Then the final questionnaire survey is conducted based on the final IT undergraduate employability system. The importance and performance of employability indicator are studied with statistics analysis. The four-way ANOVA analysis is conducted to study the influence of background variables as well as their interaction effects. Through the IPA and PNI analysis methods, the IT undergraduate employability that urgently requires improvement are identified, which provides a basis for improving the employability of IT undergraduate.

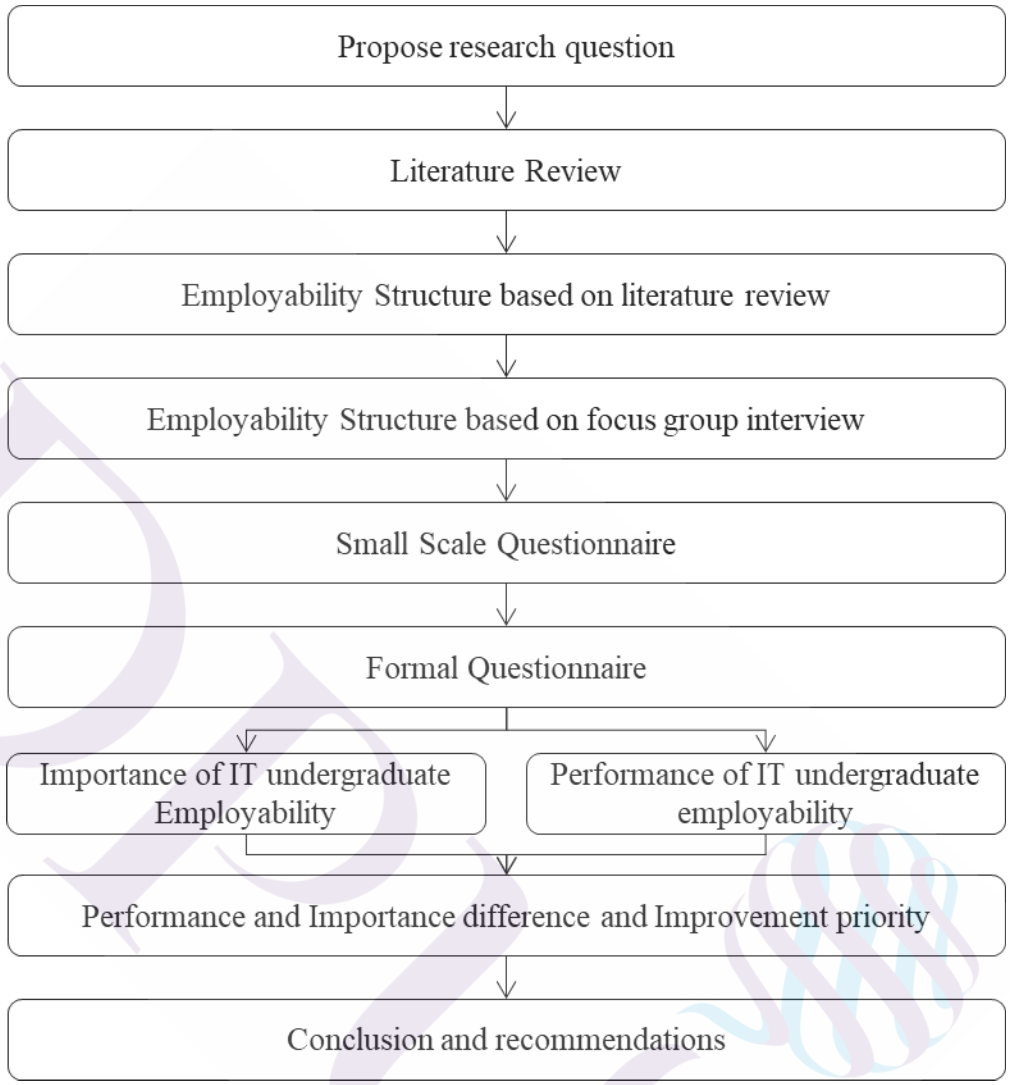


Figure 3.1 Research workflow

3.1.2 Research hypothesis

Based on the research objectives and issues, this study proposes the following hypothesis:

1. IT industry practitioners with different background variables have significantly different views on the importance of IT undergraduate employability.

2. IT industry practitioners with different background variables have significantly different views on the performance of IT undergraduate employability.

This hypothesis explores the relationship between background variables and IT graduate employability.

3.1.3 Identify the background variables

Four background variables are selected for this study. They are location city size, work unit types, work unit size, occupation. The background variables and their attributes are listed in the Table 3.1, as well as the symbol represents each attributes.

The variable location city size represents the hierarchical classification of Chinese cities. The cities with the larger size are generally more developed and have more resource and opportunity available for the IT undergraduates. In this study, the tier level is identified through the administrative level of the city which is a commonly used and generally accurate approximation. The Provincial capitals are classified as tier1 large size city. Prefectural-level cities are classified as tier 2 medium size city. County-level cities are classified as tier 3 small size city.

The work unit type variable represents the different types of the company or institutes for the IT undergraduate. Different types of work unit may have different focus on the general developing direction and day-to-day operation, therefore have different requirement of the IT undergraduate employability. The attribute others in the Table 3.1 represents the work unit type which do not classified into the first four category, such as collective ownership company, sole proprietorship and so on.

Table 3.1 Four background variables of the IT undergraduate employability

Variable name	Attribute	Symbol
City Size	Tier1 large size city	T1
	Tier2 medium size city	T2
	Tier3 small size city	T3
Work unit type	State-owned enterprises	W1
	Schools and research institutes	W2
	Private enterprises	W3
	Foreign-invested enterprises	W4
	Others	W5
Work unit size	Large-sized	S1
	Medium-sized	S2
	Small-sized	S3
Occupation	Managers	O1
	Professional IT technicians	O2
	Professional IT teachers	O3

The work unit size variables represent the different scale of the employee the work units have. The work unit with different employee number is likely to have different management structure and serve the different market, such as local, county, or global level. Therefore it might be useful to explore the influence of the work unit size on the IT undergraduate employability. The enterprise with over 300 employees is classified as large size enterprise. The enterprise with employee between 100 ~ 300 is classified as medium size enterprise. The enterprise with under 100 employee is classified as small size enterprise.

The occupation variable represents the different role the IT undergraduate could perform in the work unit. The different occupation may have high requirement on the different aspects of the employability.

3.2 Research method description

3.2.1 Literature analysis

Literature analysis collects literature on the subject of research for researchers. After analysis, comparison and summary, this study constructs IT undergraduate employability and its assessment indicators. If there are too many indicators and these indicators needed to be divided into several categories, they should be constructed according to the following steps (Guo, 2001):

(1) Literature collection: collect relevant literature at as much as possible.

(2) Overview indicator categories: The two-way breakdown table can be listed first according to the researcher and indicator categories to understand the using frequency of each category by the research institute.

(3) Research and development of indicator categories: According to the above two-way breakdown table, study and formulate the best indicator categories.

(4) Classification of indicators: According to the above categories, a bi-level

breakdown of indicators is prepared for each category, and the indicators in each study are listed in the two-way breakdown of the most appropriate categories to understand that each indicator is in each category. According to the frequency used by the institutes, the indicators with similar names be merged by themselves.

(5) Study and formulate indicators for each category: study and formulate appropriate indicators for each category according to the two-way breakdown of each category of indicators.

This paper seeks the theoretical basis and analytical paradigm by using the network literature retrieval system and the university library retrieval system. Through the collection, reading, collation and review of the literature related to IT undergraduate employability research, the authors summarize the previous conclusions on the definition of IT undergraduate employability, the structure of IT undergraduate employability, and the path of improving undergraduate employability. At the same time, the research on the theory of employment ability is compiled and summarized, such as capability structure theory, engineering education competency theory, IT Education competency theory, Occupational competency theory, from which we can find and learn more fields. It provides a theoretical basis for the research of the employability definition and structural analysis of the paper. Therefore, this paper has a certain degree of innovation on the basis of previous research.

3.2.2 Focus group interviewing

In the field of social sciences, focus group interviewing can be said to be a promising research method. Because researchers can observe and collect a large amount of interactive data of target objects in a short period of time, making up for the disadvantages of traditional questionnaire survey method. Focus group interviewing was adopted by sociology researcher Robert Merton and other social psychologists in the 1940s, and conducted research on attitudes and persuasiveness. Focus group interviewing has been used primarily in business market research for the past 30 years. In the past 10 years, the social sciences academic community has resumed thinking about applying focus group interviewing as a universal research method and possible contribution to social science research. Focus group interviewing can be considered as a way of group interviews, in order to collect qualitative data. It is characterized by a group interaction process to stimulate thinking and ideas, so that participating members can express various experiences and opinions related to research topics under the influence of different opinions and exchanges. (Morgan, 1993)

Focus group interviewing groups are of the members with the same nature and are small groups of about 6 to 12 people. The focus group interviewing is generally led by a trained moderator who guides the discussion and reaction. The main goal is to stimulate opinions, feelings, attitudes and ideas to learn the subjective experience of the participants. Vaughn et al (1996) mentioned that the general steps of the focus group research method are as follows:

1. Prepare for an interview
2. Select participants
3. Conduct an interview
4. Analyse and report interview data

This study uses focus group interviewing and mainly selects 7 Chinese scholars and experts who have long been engaged in IT education. For the purpose of this research and related setting issues, under the auspices of the guiding professor, the study group created an atmosphere of group interaction, and encouraged scholars and experts who participate in focus group interviews to freely express their views or opinions to condense the relevant consensus of the research evaluation index structure and connotation.

3.2.3 Questionnaires

There are many ways to classify questionnaires. From the means of collecting questionnaires, the questionnaire survey method can be divided into mailing questionnaire survey, online questionnaire survey, telephone interview survey, and symposium questionnaire survey. From the way of answering, the questionnaire can be divided into self-administered questionnaires and interviewed questionnaires (Qin et al., 2000). From the perspective of the degree of control on the questionnaire by the investigators, the questionnaire survey can be divided into the structured questionnaire survey and the unstructured questionnaire survey (Wu, 2012).

The following requirements are required to use the questionnaire:

1. Standardization of tools

Yang (1995) proposed that the questionnaire method divides the research topics into several kinds of items (traits), then formulates specific questions based on these items, and prepares a questionnaire for the subjects to choose. The questionnaire method prepares the questionnaire in strict accordance with the design procedure of the standardized test. Whether the test is credible and effective is decided by the reliability and validity test. Zhu

Dequan believes that the questionnaire method distributes the same questionnaire in a unified way, which means the way of asking and answering is the same. The form, content and implementation process of the questionnaire are standard (Zhu Dequan, 2011). The degree of the standardization in questionnaire survey method is generally high. The questionnaire survey method is conducted in strict accordance with the unified design and fixed structure questionnaire. The design of the questionnaire, the implementation of the questionnaire survey method and the processing and analysis of the results are strictly carried out according to certain principles, thus ensuring the science, accuracy and effectiveness of the questionnaire survey method (John, 2010). In summary, standard is the inherent requirement of the theoretical basis of positivism. Due to the nature of Standardization, the quality of the result is less depended on the professional ability of the investigators. If the investigator needs more investigators, these investigators do not need much expertise. The information that the implementer wants can be obtained by following the predetermined implementation steps and requirements.

2. Indirect and anonymity of the process.

Durkheim (the most representative positivist) believes that the task of social science is not to explain what social phenomena should be, or what they must be. The task of science is simply to show what social phenomena are (Durkheim, 1995). Therefore, Durkheim believes that social science does not need to make value judgments on “facts”, but should adopt the principle of “value neutrality”. The understanding of "social facts" is a prominent manifestation of Durkheim’s positivist methodology. In the book Principles and Methods of Social Investigation, Zhou Demin proposed that the questionnaire method can complete the investigation without directly confronting the respondent (Zhou et al., 2012). Respondents can not only complete the questionnaire without interfere from others, but also fill in the opinions and opinions freely, and the questionnaires are not required to be signed. Thus, the questionnaire method has good anonymity (Newman, 2010). The social facts "are behaviours, ways of thinking, and feelings that exist outside of people themselves, and are applied to each individual through a coercive force." If these "social facts" want to describe the original text as much as possible, it depends on whether people reveal their feelings. Therefore, it is necessary that the investigator does not directly meet with the respondent during the implementation process, the questionnaire answered does not require signature, and guarantee the indirectness and anonymity of the process. It can be seen that the implementation of anonymity is the embodiment of the principle of “value neutrality” in the positivist methodology. Those measures are beneficial for the respondent to reveal the real situation, avoid judgement, and the researcher can better understand what the social phenomenon is through investigation.

3. Quantification of conclusions.

The questionnaire survey method uses positivism as a methodology. The positivist methodology emphasizes empirical and holistic research on research hypotheses, mainly using quantitative research methods. One of the basic viewpoints of Durkheim’s positivist methodology is: the research objects of social science and natural science are both objective, and there are inevitable causal laws behind social phenomena. Therefore, social sciences can use the methods of natural science to study society. Chen Xiaoping believes that the questionnaire survey can not only obtain the quantity information of the quantity mark, but also obtain the count data marked for attribute, quality and attitude. These data can be quantitatively analysed through statistical processing methods to make the results more objective, real, systematic and scientific, and improve the quality of research results (Chen, 2005). Wang Hongwei believes that the combination of "sampling-questionnaire-quantitative analysis" in modern social research constitutes the basic characteristics of modern statistical surveys (Wang, 2002). It can be seen that, in the questionnaire survey method, scientific result can be scientifically concluded through quantitative analysis of the specific quantitative data or counting data obtained.

From the above characteristics, we conclude that the questionnaire survey method is developed under the guidance of positivist methodology to develop a relatively complete, specific, and operational research method with programmatic, anonymized and quantitative characteristics.

Steps for the survey:

The questionnaire survey method is a scientific method. Therefore, when investigators use the questionnaire survey method to collect data, they must also meet the systematic requirements of scientific methods.

Meredith D. Gower proposed the steps to conduct a study using a questionnaire: Determine the research objectives; select the respondents; Design a questionnaire format; pre-test the questionnaire; Contact the sample survey in advance; Write a cover letter to the questionnaire and send the questionnaire; Tracking surveys do not answer questionnaires; Analyse the data of the questionnaire (Gall et al., 2006,).

In summary, the questionnaire survey is conducted in accordance with the purpose of determining the research objectives, selecting the survey object and scope, designing the questionnaire, forecasting, formatting measurement, recycling, sorting, analyzing the data, and explaining the route of the results. This study conducts research based on the analysis of the structural elements of the IT students' employability and the basic steps of the academic survey. The survey questionnaires use online interview questionnaires, self-administered questionnaires and structured questionnaires to ensure the convenience and scientificity of collecting questionnaires.

The specific method is as follows: Firstly, the pre-test questionnaire is prepared. The main purpose is to carry out pre-test on the relevant subjects of the research, then use factor analysis to analyse the validity, reliability and questionnaire structure, and re-adjust the element system to get the final result. "IT undergraduate employability structure Indicators" and evaluation scales are made, and finally conducted questionnaire surveys. Through the investigation, this study explores the importance and performance of the employability of IT students in different regions, different enterprises and different job positions. Then, the Import-Performance Analysis (IPA) and PNI methods are used to find out the difference in the importance and performance of IT students' employability based on the enterprise perspective and prioritizing the promotion order.

3.2.4 Analysis of variance (ANOVA)

Analysis of Variance is developed by R. A. Fisher. It is used for the significance test for over two group of variable. The fluctuation of the data can be classified into two groups. The first type is caused by uncontrollable random errors, and the other type is caused by the controllable variables applied in the experiment or data collection process.

Therefore, through analyse the contribution of each types of the fluctuation to the total variance of the data, the significance of the controlled variable in the experiment can be determined.

3.2.5 Importance-performance analysis (IPA)

Importance level - Performance Level Analysis is an analytical tool that prioritizes the importance of attributes to performance levels by analyzing the extent to which consumers value quality attributes and the performance level of consumers (Sampson & Showalter, 1999).In recent years, a considerable number of academic studies have cited the IPA method in an attempt to address the issues facing the education scene and the basis for administrative decision-making.

(1) The development of IPA

The IPA architecture was proposed by Martilla and James (1977). The main idea is to plot the average score of importance and performance level on a two-dimensional matrix with the X-axis as the emphasis and the Y-axis as the performance level. IPA uses a two-dimensional matrix to distinguish the relative positions of different average score attributes, and further proposes practical recommendations and strategic application of specific quality attributes.

(2) Application of IPA

Martilla and James (1977) proposed the IPA two-dimensional matrix architecture, and the matrix axis segmentation criteria are not clearly defined. Hollenhorst et al. (1992) argued that the degree of importance and the degree of performance as the separation points are more effective than the mode of using the midpoint of the grade.

According to the above point of view, the two-dimensional matrix of IPA can be divided into four quadrants, the meanings are:

The first quadrant: the representative level of importance and its actual performance level are high. The factor has the property of keep up the good work, and is the main source of competitive advantage;

The second quadrant: the level of importance is low and its actual performance level is very high. The factor has an attribute of excessive overkill, so that it does not need to over-emphasize the input of resources;

The third quadrant: the representative level of importance and performance level are low. The factor has the lower priority (low priority) attribute, under the limited resources of the current system, can be improved after the fourth quadrant improvement, accounting for the secondary disadvantages;

The fourth quadrant: the representative has a high degree of importance but low level of performance. It belongs to the concentration of the focus, and has the decisive key factors for future development. Therefore, it is necessary to invest more resources to give priority to improvement, which is the main source of disadvantage (Martilla & James, 1977).

3.2.6 Priority need index (PNI)

Witkin's Priority Need Index (PNI) (Witkin and Altschuld, 1995) is used to order the importance of training. The formula is PNI＝I× (I-D). I mean the factor's importance, and D means the employee's proficiency. I and D come from the score of employees themselves and their leaders by using questionnaires, testing and observation.

The bigger the PNI is, the more the training is needed, and such training should be taken into prior consideration. In this way, the priorities can be confirmed into common need and special need, and these needs can be analysed based on task need and personal need. At last the training content and objects can be decomposed into departments, tasks and staff, which helps choose training objects and make training plan. PNI scores were calculated using the subject's "IT undergraduate employability" importance average* (importance mean-performance average), and the scores were ranked from high to low. The higher the score, the more urgent the factor need to improve the employability. The lower the score is, the lower the urgency of the need to improve the employability. So that IT undergraduate employability can be prioritized to provide a basis for improving IT undergraduate employability in the future.

3.3 Focus group interviews

3.3.1. Focus group interview and main finding

As described in the research tools in Chapter 3, the researchers mainly drafted the IT undergraduate employability literature and drafted the preliminary structure of IT undergraduate employability, which was divided into three first level indicators, nine second level indicators and 27 third level indicators. However, in order to consider the appropriateness and objectivity of the content of this draft, the guidance professor agreed to hold a "focus group interview" to listen to some scholars and experts before the questionnaire survey. Focus group interviews will increase the consensus of the draft content as the basis for the preparation of the "IT professional undergraduate employability questionnaire”. Therefore, the researchers held a discussion on the "IT professional undergraduate employability index construction study" at the 411 office of the Beijing University of Science and Technology Graduation School at 9:30 am on October 29, 2017 - Focus Group Interview. Professor Qu Shaowei, director of the Institute of Education and Economics of Beijing University of Science and Technology, served as the moderator. The focus group interview invited Professor of Software and Microelectronics College of Peking University, Professor of Internet of Things Engineering College of Hohai University, Professor of Software College of Dalian University of Technology, Professor of Computer Science of Nanjing University, Professor of Computer Science of Xidian University, and Professor of Software College of Shandong University. Seven scholars and scholars from the School of Information Engineering of Jinan University attended the discussion. The detailed documentation of the focus group interview are added to the appendix III

After discussion by focus group interviews, the participating scholars and experts provided many valuable suggestions for the revision of the indicators. The suggestion allows researchers to further think about the review and achieve a considerable degree of consensus. The main consensus opinions are as follows:

1. Too many third level indicators. On the one hand, the more the subjects are, the less willingness of the subject to fill out. On the other hand, some indicators are not meaningful. It is recommended to further adjust the third level indicator, and the indicator with the same attributes can be classified and integrated. If there are too many indicators, in the future analysis of indicators, there will be some degree of problem (difficulties in interpretation) and even the classification attribute of the meaning of the pointer.

2. The second level indicator has a large coverage layer, and it is recommended to split the second level indicator so that the subject can understand the indicator more clearly.

3. The connotation of the relevant draft indicators is based on relevant educational theories and research institutes. But based on the needs of research and innovation, it is hoped to design some innovative or ideal indicators to create higher quality effects.

4. It is found that some indicators have the concepts. It is advisable to adjust and summarize the indicators for the appropriateness.

3.3.2 The final version of IT undergraduate employability structure

Through the discussion with the seven experts from focus group interview, valuable advices for the adjustment of employability structure are collected. Then some adjustments are made for the employability structure according to those suggestions. The details of the change are listed as follow.

Some of the third level indicators are consider as embedded in other indicators. For example, the comprehension and expression indicator is included in the communication and coordination indicator. The indicator skill of analyse and problem-solving can be represented by several other indicators like planning, creativity, design capability, computer thinking and so on. What's more, the hands-on ability and adaptability indicators are not valued by the expert invited to the focus group interview. The reason for this might be that the current aims of education are not focus on those capabilities and the Chinese company usually provide in-workplace training programme which partially cultivates those capability. The indicator knowledge and understanding of knowledge and processes in the application domain is also deleted for many of its aspects are reflect in the cognitive capability of IT professional knowledge.

Some indicators are split and renamed as two different third level indicators. The indicator professional ethics and sense of responsibility is split into two indicators as indicator professional ethics and indicator sense of responsibility because those two capability are consider very important for the undergraduate to perform well in the career and both measure different aspects of the personal quality. The indicator computer hardware design and development capabilities are redesigned as two indicators: indicator computer system development capabilities and indicator design capability of computer hardware. According to the experts, this classification could better present the capability required for the hardware related work.

The second-level indicators have some significant changes. Some third level indicators are regrouped to form new second level indicators. Some second level indicators are renamed for more accurate interpretation and easier understanding. This is a focus aspect of the focus group interview debate. Although it is the consensus that the second level indicator should be split, there is no consensus on a detail classification of the second level indicator because many third level indicators are related in many aspect. For example, in general capability, the indicator using social relations capability is advice to be extracted as second level indicator for it is quite distinct from other indicators. However some experts argue that the social support can only be obtained from good communication skill, therefore it should not be listed as second level indicators. What's more, in the IT professional capability category, the final version of employability is classified through software or hardware of develop and application capability. Some experts argue that the classification should be classified according to whether it is develop capability or application capability. The structure of employability indicator system is tested in the validity test.

According to the above consensus, the researchers re-examine the connotation of the draft and try to streamline the generalization of the relevant attributes. Finally, 3 first level indicators, 9 second level indicators and 27 third level indicators were corrected to 3 first level indicators, 11 second level indicators and 23 third level indicators. The revised indicator field, layer orientation and indicators connotation are listed in Table 3.2.

Table 3.2 IT undergraduate employability indicators based on focus group interviewing

First level indicator		Second level indicator		Third level indicator	
Personal quality	A	Values and endurance	A1	Psychological endurance	A1-1
				Professional ethics	A1-2
				Sense of responsibility	A1-3
		Sense of career achievement	A2	Sense of career achievement	A2-1
General capability	B	Capability of developing	B1	Executive capability	B1-1
				Learning capability	B1-2
				Creativity	B1-3
		Planning and career planning capability	B2	Planning capability	B2-1
				Career planning capability	B2-2
		Team leadership	B3	Teamwork	B3-1
				Communication and coordination	B3-2
		Using social relations capabilities	B4	Using social relations capabilities	B4-1
IT professional capability	C	Design and develop capability of computer software system	C1	Capability of computer software design and program development	C1-1
				Basic design capability of computer application system	C1-2
				Capability to apply computer for implementing apply system and conducting development and innovation	C1-3
		Cognitive and operational capability of computer principle	C2	Cognitive capability of basic knowledge of computer	C2-1
				Cognitive and operational capability of computer components and hardware	C2-2
				Cognitive and operational capability of software theory	C2-3
		Computer hardware systems design and development capabilities	C3	Computer system development capabilities	C3-1
				Design capability of computer hardware	C3-2
		Computational thinking, modeling and algorithm capabilities	C4	Computational thinking and modeling capabilities	C4-1
				Algorithm design and analysis capabilities	C4-2
		General capabilities to use and maintain computer applications	C5	General capability to use and maintain computer application systems	C5-1

3.3.3 Interpretation of the third level indicators for the revised employability structure

The IT undergraduate employability structure system is constructed through literature analysis and focus group interview. The third level indicators are defined and interpreted in the following section for the accuracy and effectiveness of further analysis and application

3.3.3.1 Interpretation of third level indicators from personal quality category

Psychological endurance is the ability of the individual to bear and adjust the psychological pressure and negative emotion caused by adversity, and mainly about the resilience of adversity, tolerance, endurance and strength of defeat (Xun, 2013).

Professional ethics includes the professional code of conduct and norms that should be followed in certain occupational activities, which reflect certain occupational characteristics and adjust certain occupational relations (Chadwick, 1998).

A sense of responsibility is the spirit of a person's active and beneficial effect on himself, nature and human society. Sense of responsibility is a state of mind that drives a person to perform well spontaneously. A sense of achievement is a psychological feeling produced by the balance between the desire and reality of the employees in their work and career.

3.3.3.2 Interpretation of third level indicators from general capabilities category

Executive capability refers to the ability of every individual to turn his orders and thoughts into actions, turn them into results, so that they can fulfil their tasks with quality.

Learning capability generally refers to people's ability to seek knowledge, work and self-develop in formal learning or informal learning environment.

Creativity is the ability to provide new ideas, new theories, new methods and new inventions with economic value, social value and ecological value in the fields of technology and various practical activities (Yue, 2004).

Planning capability is the ability of people to plan according to specific projects or events, as well as comprehensive evaluation of the project's planning, meticulous, reasonable and overall consideration (Owen et al., 1997).

Career planning capability is the ability to analyze and measure the subjective and objective factors of an individual's career choices, determine individual goals and strive to achieve this goal.

Teamwork ability is the collaborative effort of a team to achieve a common goal or to complete a task in the most effective and efficient way (Larson et al., 1989).

Communication and coordination ability refers to the capability for communicating with other people related to the main task to better coordination the action in the workplace and deliver important information's

The ability to use social relations refers to the establishment, development of certain social relations and the use of communication and cooperation to protect and rationally use this social relationship in order to achieve the ability of exchanging resources, cooperating in depth and achieving goals.

3.3.3.3 Interpretation of third level indicators from IT professional capability category

Capability of computer software design and program development means that students need to master the latest software development and design technology and software project management methods in addition to the basic theoretical knowledge in the field of computer software. The knowledge that needs to be mastered includes: C programming, VB programming, Java object-oriented programming, data structure, computer network and communication, network operating system, software engineering, multimedia technology and application, large database processing technology (Kenneth, 2013).

Basic design capability of computer application system is the ability to develop an object-oriented application with a computer language. The main contents of the knowledge skills include object-oriented concept, object-oriented development method, Java programming foundation, unified modeling language, UML based system analysis and design, business logic layer development, interface layer development, data layer development, Web application development(Ma & Fang,2015).

Capability to apply computer for implementing apply system and conducting development and innovation refers to the design and development of the internal structure of the new computer system based on the technical requirements of the computer users to the application system, and the professional ability to realize and innovate.

The cognitive ability of computer basic knowledge refers to a computer professional ability to understand and master the basic knowledge of IT projects. The knowledge needs to be understood including computer basic knowledge, Windows operating system, network knowledge and operation, MS office, and more Media and common tool software and other knowledge content.

Cognitive and operational capability of computer components and hardware refers to a computer professional ability to understand the basic principles of the computer, the internal working mechanism, the knowledge of the hardware composition, the learning and the operation of the computer. It is necessary to recognize and master the subsystems of the computer (including the calculator and storage), the basic composition principle, design method, interrelation and each subsystem and hardware of each subsystem and hardware are connected to each other to form the technology and related knowledge of the whole machine system, and have good operation ability, and can complete the basic operation and application of the computer domain.

Cognitive and operational capability of software theory refers to a computer professional ability to understand, recognize, and operate computer software related theory and software technology. It needs to master software theory, method and technology involved in the process of software design, development, maintenance and use, and the function of computer hardware and software allocation, software and hardware interface division, computer software structure, composition and implementation methods and techniques.

Computer system development capabilities refer to the computer professional ability of developing information system development and application software system in the form of writing code. It is necessary to master the knowledge and skills of the development of computer systems, improvement of the man-machine interface, the rational organization of the computer workflow and the good operating environment for the users.

Design capability of computer hardware refers to the ability to learn and master the basic knowledge of computer hardware and PC machine assembly technology, to be familiar with the performance of computer accessories, to understand the connotation of various hardware terms, to be familiar with the hardware design ability of the hardware structure of the microcomputer and the electrical knowledge of the digital products, and to skilfully use all kinds of testing and maintenance tools, have the ability of problem analysis and locate and eliminate hardware faults

Computational thinking and modeling ability is the thought processes involved in formulating and expressing the solution(s) for a problem in such a way that a computer—human or machine—can effectively carry out. Modeling ability is a kind of computer professional ability to realize computer modeling by thinking modeling tools. Modeling is an important means and prerequisite for research system. The process of describing the causality or relationship of the system with model is modeling. It includes the analysis of the motion law of the system itself, based on the mechanism of objects to construct model, processing of the experimental or statistical data of the system, and based on the knowledge and experience of the system to formulate a model (Wing, 2014).

The algorithm design and analysis capability refer to the computer professional ability of College Students' problem modeling and algorithm design skills, including the analysis and design methods of non-numerical algorithms, the basic concepts and methods of algorithm analysis, induction, classification, dynamic programming, greedy, traversal of graphs, backtracking, and branch limits. The knowledge content, such as the method and the random algorithm, has the ability to choose the appropriate strategy for the specific practical problems to design the algorithm and the evaluation algorithm, and gradually develop the good quality of the effort to design as high as possible efficient algorithms.

The general capability to use and maintain the computer application system is to know the basic knowledge of computer software and hardware applications, master the structure and composition of the computer system, and have the computer professional ability to test, maintain and maintain the computer system.

3.4 Questionnaire design and pre-test

3.4.1 Questionnaire preparation

The questionnaire surveyed the IT enterprise, Projects engaged in computer business enterprises, senior industrial managers, the industrial management of government and social organization, and computer teachers in computer companies or enterprises. The design of the questionnaire mainly includes two aspects.

The first is the basic identification information of the respondents, including gender, age, location city size, type of work unit and size of the work unit, and occupation, etc., all in the form of multiple-choice questions.

The following is the IT undergraduate employability evaluation survey. Respondents were asked to evaluate the importance of employability and to respond to the current IT undergraduate employability performance. This study uses 67 topics based on the 23 third level indicators of the "IT undergraduate employability evaluation factor system". Take the Likert 5 point scale as the test method, and clarify each third level indicator design related question in the questionnaire, a total of 23 questions. In the questionnaire survey, respondents were asked to evaluate the importance and performance of these options in IT undergraduate employability, and hit the "√" on the corresponding scores. For the level of importance, they are "very important", "important", "general", "not important" and "not at all important". Each level indicates that the interviewed group believes that the importance of the competency program is about 100%-80%, 80%-60%, 60%-40%, 40%-20%, 20%-0%, and is respectively given 5, 4, 3, 2, 1 points, the higher the score, the more important the employability project. The degree of performance of IT undergraduate's employability is "very good", "good", "general" and "poor". "Every level indicates that the respondents believe that the performance of the project is about 100%-80 %, 80%-60%, 60%-40%, 40%-20%, 20%-0%, and assigned 5, 4, 3, 2, 1 points respectively. The higher the score is, the better the performance of the employability is.

3.4.2 Determination of the survey object, population and sample

The questionnaire surveyed the IT enterprise, Projects engaged in computer business enterprises, senior industrial managers, the industrial management of government and social organization, and computer teachers in computer companies or enterprises.

Population:

The IT practitioner group is very complex and large, and it is relatively extensive. All computer practitioners form the theoretical parent group of this paper. As Fan and Lan (2008) pointed out, the overall theory is often imaginary, not a real, operational whole. The available overall is a real, concrete, and operational overall. The sampling framework must be determined in the research design. Judging from the existing computer practitioners in China, the main focus is on corporate work.

Sample sampling:

Fan and Lan (2008) believe that the study sampling is to take some representative individuals from a population as a sample. Sampling in research design is a highly technical task and an issue that researchers must seriously consider in order to obtain accurate and reliable information. Therefore, this paper uses a random sampling method to investigate computer industry practitioners such as computer business enterprises, senior industrial managers, the industrial management of government and social organization, and computer teachers in computer companies or enterprises.

3.4.3 Pre-test process

The survey conducted pre-tests in four cities: Beijing, Dalian, Chengdu and Guangzhou in the form of an on-site centralized anonymous questionnaire. The data obtained will provide a direct basis for the adjustment of the questionnaire and the establishment of the final evaluation indicator system. The reasons for selecting computer companies and universities in Beijing, Dalian, Chengdu, and Guangzhou for research are as follows. First of all, the four regions are all developed regions of China's economy. Beijing and Dalian are the city representatives of the northern Panyuhai Bay Economic Zone. Beijing is China's largest research base for information industry in leading position. Dalian is a national-level demonstration information industry base. The computer industries in the above two cities are developed. Chengdu is the leading city in the development of electronic information industry in the west China area. Shenzhen is a typical representative of the economically developed cities in the coastal areas of the east China area. The choice of the four places not only reflects the commonality of the developed regions, but also reflects the regional differences between the North and the South. Second, the four regions are all areas with relatively high level of education in China. Beijing is the region with the highest concentration of higher education resources in China. Therefore, the area where the sampling object is located has a high degree of typicality and representativeness.

3.4.3.1 Calculation basis of sample size for sampling

The purpose of the pre-test is to provide evaluation indicators and testable questionnaires that are tested by factor analysis for formal empirical evaluation. Therefore, the sample size of this sampling depends mainly on the needs of factor analysis. In factor analysis, how many pre-samples should be used to make the results most reliable do not have consistent conclusion among scholars. But most scholars now agree that the number of samples should be more than the scale of employability indicators. A representative view is that Comrey (1988) suggested that the number of specimens should be consistent with the number of scales. Tinsley and Tinsley (1987) believe that the ratio of the number of specimens to the number of questions per subscale should be between 1:1 and 1:10. Wu Minglong, a well-known scholar of Chinese statistics, put forward a comprehensive view that the ratio of subscales to subjects is at least 1:3, and the total number should not be less than 100. Therefore, the sampling rule of this forecast will calculate the number of samples according to the Wu Minglong sampling method. There are 4 items in this pre-test subscale1 of “personal quality", 11 items in subscale2 of "general capabilities', and 23 items in subscale3 of professional ability". The corresponding number of people should not be less than 12, 33 and 69 respectively. In order to ensure that the number of samples must fully support the pre-test needs, and also in line with the consideration of economic cost of research, it is determined that the number of to be sampled should be the maximum, that is, should not be less than 100 copies. The total number of valid samples obtained in this pre-test was 231, which met the requirements of the pre-test and could meet the basic needs of factor analysis.

3.4.3.2 Sample description

The questionnaire surveyed the IT enterprise, Projects engaged in computer business enterprises, senior industrial managers, the industrial management of government and social organization, and computer teachers in computer companies or enterprises. They are specific participants in the computer industry's activities and have a deep understanding of the capabilities required by the computer industry. The ability to recognize the employability comes from practical experience, so it can be used as the main target of this survey. The study randomly distributed questionnaires in 57 IT industry work unit within four areas (Beijing, Dalian, Chengdu, and Shenzhen). A total of 260 questionnaires were distributed, and 231 valid questionnaires were returned, with a recovery rate of 88.85%.

In general, the average gender distribution of the survey subjects is estimated to be evenly distributed. The age distribution of sample is mainly under 40 years old. The main education level is concentrated in undergraduate and specialist courses. The job is computer engineering technicians, and most of them have received employment guidance and forecast investigation. The unit where the object is located is more evenly distributed in large, medium and small companies. Such sample distribution is in line with the needs of this research.

3.5 Reliability and validity test of pre-questionnaire

3.5.1 Reliability test

Reliability refers to the degree of consistency or stability of the scale. Consistency (intrinsic reliability) mainly tests whether the same concept or trait is measured in the same scale. Stability (External Reliability) The main test uses the same questionnaire to repeatedly measure the same group of tested subjects at different times, and the measurement results are consistent (Zhang & Tian, 2007). Since the thoughts, environment, or opinions of the respondents change at different times, it is common to conduct internal reliability analysis when performing reliability analysis (Zhao, 2013). The standard coefficient commonly used for reliability measurement is the cronbach Alpha coefficient (Bland & Altman, 1997). The larger the coefficient, the higher the internal consistency of the variable is, indicating that the measurement items between the variables have a good correlation. The reliability statistics are expressed as the internal consistency of the variables. The higher the alpha coefficient is, the higher the internal consistency of the scale and the better the reliability of the scale. According to DeVellis (1991), the following conclusions are given for cronbach's α coefficient: if the reliability coefficient of any test or scale is above 0.8, the reliability of the test or scale is very good. If the reliability coefficient of any test or scale is between 0.7-0.8, the reliability of the test or scale is good. If the reliability coefficient of any test or scale is between 0.65-0.7, the reliability of the test or scale is usable. Unnormalized cronbach's α coefficients are usually used, but standardized cronbach's α coefficients are used when the difference between each item's average and standard deviation are large.

The reliability analysis of the "IT undergraduate employability questionnaire" in this study was measured by cronbach's α coefficient, and the consistency and reliability of the formal questionnaire questions in this study were explored. The following are the reliability values of the three scales of "personal quality", "general capabilities", and "IT professional capability":

Table 3.3 Reliability test results of first level and second level indicators

Dimensions	Cronbach's Alpha	Number of items
Personal quality	0.915	12
Values and endurance	0.906	9
Sense of career achievement	0.772	3
General capability	0.926	24
Capability of developing	0.918	9
Planning and career planning capability	0.879	6
Teamwork	0.801	6
Using social relations capabilities	0.815	3
IT professional capability	0.951	33
Design and develop capability of computer software system	0.912	9
Cognitive and operational capability of computer principle	0.877	9
Computer hardware systems design and development capabilities	0.909	6
Computational thinking, modeling and algorithm capabilities	0.865	6
General capabilities to use and maintain computer applications	0.780	3

Table 3.3 shows that the cronbach's alpha coefficient of the "general capabilities scale" and "IT professional capability" scales and the cronbach's alpha

based on the standardized terms are all greater than 0.9, indicating that the reliability of the scale is very good, the "personal quality" scale cronbach's alpha reached 0.915, which is about 0.9, and the cronbach's alpha based on the standardized term is also greater than 0.9, indicating that the reliability of the scale is very good. The sub-dimensions of the employability structure generally have a cronbach's alpha value that larger than 0.8, which means that the questionnaire is reliable at sub-dimension level. Considering the number of items for this dimensions is quite limited and the alpha value is not far from the threshold, those questions are still retained.

In order to test whether each of the items from the questionnaire can be deleted, the cronbach's alpha values are calculated under the condition that the specific item is deleted. In conclusion, the deletion of each of the items in the questionnaire will decrease the cronbach's alpha value of the relevant indicator, therefore all the questions should be retained.

3.5.2 Validity test

Each measurement of employability in this study is directly measured. It is difficult to find other standard data for assistance during the same period, therefore difficult to analyze the validity of the criteria. Therefore, only content validity and construction validity are discussed. Content validity is designed to detect the relevance of content. Based on the relevant theories of existing employability structure theory and undergraduate employability, this study is based on the relevant empirical research questionnaires, and the questionnaire is continuously revised on the basis of experts. Therefore, it is believed that there should be considerable content validity. The purpose of validity analysis is to verify that the design and investigation of the questionnaire meets the extent to which the researcher wants to understand the characteristics. The validity test carries out factor analysis by using the questionnaire as a target, constructs factor variables, and names and explains the factor variables.

The purpose of validity analysis is to verify that the design and investigation of the questionnaire meets the extent to which the researcher wants to understand the characteristics. Validity can be divided into three main types: content validity, construct validity, and empirical validity (Qiu, 2009). Content validity, also known as surface validity or logical validity, refers to the suitability and conformance between measurement objectives and measurement content (Qiu, 2009). The empirical validity is used to measure whether the data obtained by the questionnaire is consistent with the existing theory, and can also be called the criterion validity or the predictive validity. When using the empirical validity to assess, first of all, we need to select an indicator as the criterion based on the existing theory, and use the data obtained from the survey to analyze the proximity of the employability and the criterion of the questionnaire. If the closer to the criterion, that is, there is a significant correlation with the criterion, then it can be judged that the employability is effective. It is also possible to judge the effectiveness of employability from the significant differences between the values and characteristics of the criterion, such as large differences and high effectiveness. However, in the process of practical application of validity analysis, the most difficult thing is to choose a reasonable and appropriate criterion, so the application of this method has certain limitations. Construct validity is used to determine the degree of correspondence between the measured results and the observed values. This method is relatively easy to use, and the methods used are generally factor analysis (Qiu, 2009).

The measurement employment ability in this study is directly measured. It is difficult to find other standard data for assistance in the same period, and it is impossible to analyze the validity of the criterion. Therefore, only content validity and construction validity are discussed.

3.5.2.1 Content validity test

Content validity refers to the degree of agreement between what is actually measured by a scale and what is to be measured. The most widely used indicator in the quantitative evaluation of the content validity of the scale is the content validity index. Content validity index is divided into two categories. Item level validity index (item.1evel CVI, I-CVI) evaluates the content validity of each item. The scale-level CVI (S-CVI) of the scale level evaluates the content validity of the entire scale. According to different calculation methods, S-CVl is divided into all-consistent S-CVI (S-CVI/UA) and average S-CVI (S-CVI/Ave). The scale I-CVI is not less than 0.78, and the S-CVI/UA and S-CVl/Ave are not lower than 0.8 and 0.9 respectively, indicating that the content is more effective.

In the expert consultation questionnaire for content validity evaluation, experts are asked to make a choice about the relevance (or representativeness) between each item and the corresponding content dimension. The options are 4 level rating: 1 = irrelevant, 2 = weak correlation, 3 = strong correlation, 4 = very relevant. Thus, the number of experts with a score of 3 or 4 for each entry divided by the total number of experts participating in the survey is the corresponding I-CVI. Lynn gave the I-CVI criteria: When the number of experts is less than or equal to 5, the I-CVI should be 1.00, that is, all experts believe that the item has a good correlation with the concept content to be measured, which means that the content of this item is better. When the number of experts is 6 or more, the standard can be lowered, but the I-CVI is required to be no less than 0.78.

According to different calculation methods, S-CVI can be divided into two categories.

1) All-consistent S-CVl (S-CVl/UA.universal agreement).

The number of entries rated 3 or 4 by all experts as a percentage of all entries reflects the consensus of all experts. Davis suggested that S-CVI/UA should be no less than 0.8. According to the definition of S-CVI/UA, when the number of experts increases, the possibility of opinions being different also increases. Therefore, even if each entry has a good I-CVI, a lower S-CVI/UA situation may occur.

2) Average S-CVI (S-CVI/Ave).

There are three calculation methods. The first one is mean of the scale of all entries I-CVI. The second one is mean of the constituted ratio where each expert scores of 3 or 4. The number of occurrences of the 3 or 4 score divided by the number of ratings. The results calculated by the above three methods are the same. Since the first calculation method is very good for I-CVI and easy to understand, it is recommended. Also S-CVI/Ave should reach 0.90.

In this study, the questionnaire was compiled with 67 items of IT undergraduate employability importance scale. A total of 7 experts (A, B, C, D, E, F, and G) were evaluated for content validity.

From the above results, it can be seen that the 65 items in the scale have I-CVI greater than 0.78, suggesting that these items have excellent content validity. The entries QB2-1 and QB2-2 were only approved by 4 of the 7 experts, with an I-CVI of 0.57. The content of the prompt is generally valid and will be considered for modification or deletion. There were 65 entries in the scale that were rated 3 or 4 by all experts, so the S-CVI/UA was 0.97. After calculating, the mean for each I-CVI yields an S-CVI/Ave of 0.97, greater than 0.90. Considering that the content validity index of the scale is still good, the S-CVI can be further improved after the items QB2-1 and QB2-2 are revised or deleted. The results are shown in Table 3.4, the items with I-CVI value of 1 are not shown in Table 3.4.

Table 3.4 List of questionnaire item that do not reach good assessment of “good” for validity test

Item	Expert rating							The number of experts with a rating of 3~4	I-CVI	Assessment
	A	B	C	D	E	F	G			
QA2-1	3	3	4	3	4	2	4	6	0.86	Relatively good
QA3-3	4	4	2	3	3	4	3	6	0.86	Relatively good
QA8-3	3	3	4	4	3	3	2	6	0.86	Relatively good
QA9-3	3	3	4	3	2	4	4	6	0.86	Relatively good
QB2-1	2	4	4	2	4	2	4	4	0.57	Normal quality
QB2-2	3	2	4	2	2	3	3	4	0.57	Normal quality
QB6-3	2	3	3	4	4	3	4	6	0.86	Relatively good
QC1-2	4	3	2	4	4	3	3	6	0.86	Relatively good

Note: The questionnaire items with the assessment level of “good” is note presented in this table.

3.5.2.2 Construct validity

Construct validity refers to the degree to which the concepts and characteristics of the theory are measured. Therefore, factor analysis is sometimes used to test construct validity, and construct validity is used to measure multiple indicators.

The purpose of structural analysis is to verify that the design and investigation of the questionnaire can reach the extent that the researcher wants to understand the characteristics. The IT undergraduate employability structure is developed though literature analysis and then adjusted through focus group interview. Therefore the IT undergraduate employability structure is considered as suitable for further research. The questionnaire for this study is also developed through the process of the focus group interview. The question items are first developed according to the first draft of the employability structure and then adjusted according to the comment of the experts from the interview. However, it is necessary to assess whether the questionnaire measure the exact construct as this study has developed from previous process.

This study adopts confirmatory factor analysis to test the construct validity of the questionnaire. The confirmatory factor analysis is one kind of common factor analysis method to test the latent variable. The CFA is used to test the latent variable, when the study have firm theoretical basis. The CFA test whether the measurement of the study is consistent with the designed construct model. The IT undergraduate employability structure is developed through qualitative method, therefore it is suitable to use CFA. This study uses AMOS of SPSS software to conduct the confirmatory factor analysis. The questionnaire is divided into three parts: the questionnaire items from personal quality, the questionnaire items from general capability, and the questionnaire items from IT professional capability. Then factor loadings from the CFA output are used to calculate the AVE and CR value. Lastly the model fitness criteria values are collected from the SPSS output files. A. Validity test for “personal quality”

(1) The criteria of the CFA results

For the analysis of the result from confirmatory factor analysis, firstly the factor loading of each measurement variables are studied in order to justify the validity test and provide the interpretation of construct validity of the questionnaire. In general, the factor loading requirement of CFA is more than 0.5, and the higher the value is, the more valid the questionnaire could be. Ideally, the factor loading of the measurement variables should be larger than 0.7.

The reliability of the questionnaire has already been tested in the section 3.5.1. The results show that the data from the questionnaire are suitable for analysis. In order to further ensure the reliability of the factor analysis result, the average variance extracted (AVE) and composite reliability (CR) is calculated for each of the indicators from the questionnaire items. The AVE represents the variance of the data from the model used in the analysis with respect to the random influence in the measurement. The recommended value of AVE should be larger than 0.5 (Fornell & Larcker, 1981). The composite reliability is a measurement about the internal consistency and the scale reliability. The recommended value for composite reliability should be larger than 0.7.

In order to accurately assess the construct validity, several commonly used criteria of model fitness are selected for this study. They are CMIN/DF, GFI, CFI, NFI, and RMSEA. CMIN/DF is the minimum discrepancy divided by its degrees of freedom (Browne, 1984). The value of CMIN/DF is recommended to be smaller than 2 or 3 (Byrne, 1989; Carmines, 1981; Marsh & Hocevar, 1985). The GFI is the goodness of fit index. The higher GFI represents a better fit of the model and a value of represent a perfect fit of the model. The GFI value higher than 0.9 represent a suitable model fit

(Jo¨reskog & So¨rbom, 1986). The CFI is the comparative fit index. This index compares the hypothesized model and the model from the questionnaire data. An index value, which is higher than 0.9, is needed to ensure the fitness of the model (Hu & Bentler, 1999). The NFI compare the difference of the evaluated model from questionnaire and difference of the baseline model. The rule of thumb suggests that the cutoff value should be around 0.9 (Bentler & Bonett, 1980). The RMSEA value indicates the how well the parameters fit the model with the consideration of the number of the parameters. The cutoff of the RMSEA value for the reasonable fit is 0.8, and the lower value means better fit (Browne & Cudeck, 1993).

(2) Result of the confirmatory factor analysis

The factor loading of all questionnaire item to 23 indicators are presented in table 3.5 to 3.7. All factor loadings are statistically significant. The majority of the factor loading are larger than 0.7, which suggest that questionnaire items adequately reflect the latent construct of the IT undergraduate employability. Some factor loading are below 0.7, however they are all larger than 0.5 and relatively close to 0.7, therefore this study consider they to be valid for further analysis. The covariance between all latent variable are not equal to 1, which suggest that the questionnaire items for each latent variable are not the same.

The AVE and CR value for each third level indicator measurement model are also listed in the table 3.5 to 3.7. All AVE value are larger than the criteria 0.5 and all CR value are larger than the criteria value 0.7, which indicates that the reliability of the confirmatory factor analysis are reasonable.

Table 3.5 Factor loading, AVE, and CR value for indicators in general capability group

Indicator name	Questionnaire items	Factor loading	AVE	CR
Executive capability	B1-1-1	0.814	0.584	0.807
	B1-1-2	0.786		
	B1-1-3	0.687		
Learning capability	B1-2-1	0.786	0.666	0.857
	B1-2-2	0.835		
	B1-2-3	0.827		
Creativity	B1-3-1	0.714	0.628	0.835
	B1-3-2	0.841		
	B1-3-3	0.817		
Planning capability	B2-1-1	0.834	0.615	0.826
	B2-1-2	0.829		
	B2-1-3	0.679		
Career planning capability	B2-2-1	0.757	0.679	0.863
	B2-2-2	0.888		
	B2-2-3	0.822		
Teamwork	B3-1-1	0.698	0.531	0.771
	B3-1-2	0.66		
	B3-1-3	0.819		
Communication and coordination	B3-2-1	0.738	0.608	0.822
	B3-2-2	0.836		
	B3-2-3	0.761		
Using social relations capabilities	B4-1-1	0.831	0.600	0.818
	B4-1-2	0.762		
	B4-1-3	0.727		

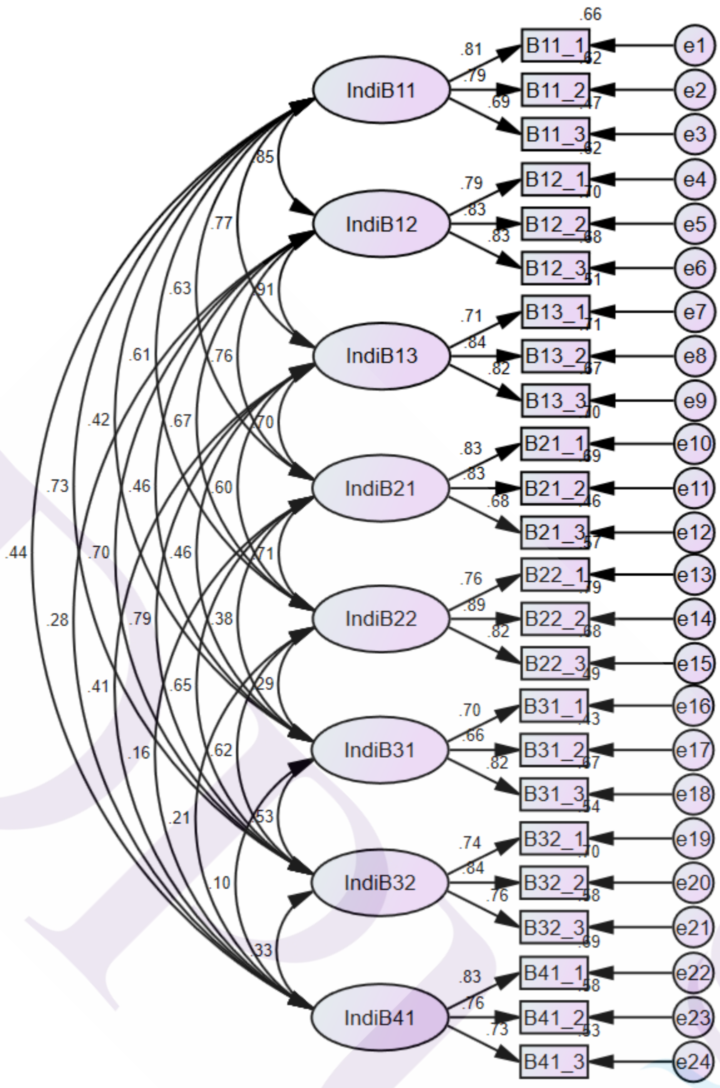


Figure 3.2 CFA graph for general capability indicator group

Table 3.6 Factor loading, AVE, and CR value for indicators in IT professional capability group

Indicator name	Questionnaire items	Factor loading	AVE	CR
Capability of computer software design and program development	C1-1-1	0.769	0.579	0.804
	C1-1-2	0.78		
	C1-1-3	0.732		
Basic design capability of computer application system	C1-2-1	0.766	0.574	0.801
	C1-2-2	0.698		
	C1-2-3	0.805		
Capability to apply computer for implementing apply system and conducting development and innovation	C1-3-1	0.844	0.605	0.821
	C1-3-2	0.745		
	C1-3-3	0.741		
Cognitive capability of basic knowledge of computer	C2-1-1	0.722	0.542	0.780
	C2-1-2	0.767		
	C2-1-3	0.718		
Cognitive and operational capability of computer components and hardware	C2-2-1	0.708	0.574	0.801
	C2-2-2	0.803		
	C2-2-3	0.758		
Cognitive and operational capability of software theory	C2-3-1	0.705	0.609	0.822
	C2-3-2	0.875		
	C2-3-3	0.751		
Computer system development capabilities	C3-1-1	0.834	0.743	0.897
	C3-1-2	0.867		
	C3-1-3	0.884		
Design capability of computer hardware	C3-2-1	0.821	0.728	0.889
	C3-2-2	0.877		
	C3-2-3	0.861		
Computational thinking and modelling capabilities	C4-1-1	0.753	0.626	0.833
	C4-1-2	0.791		
	C4-1-3	0.827		
Algorithm design and analysis capabilities	C4-2-1	0.691	0.538	0.777
	C4-2-2	0.782		
	C4-2-3	0.725		
General capability to use and maintain computer application systems	C5-1-1	0.753	0.544	0.781
	C5-1-2	0.716		
	C5-1-3	0.743		

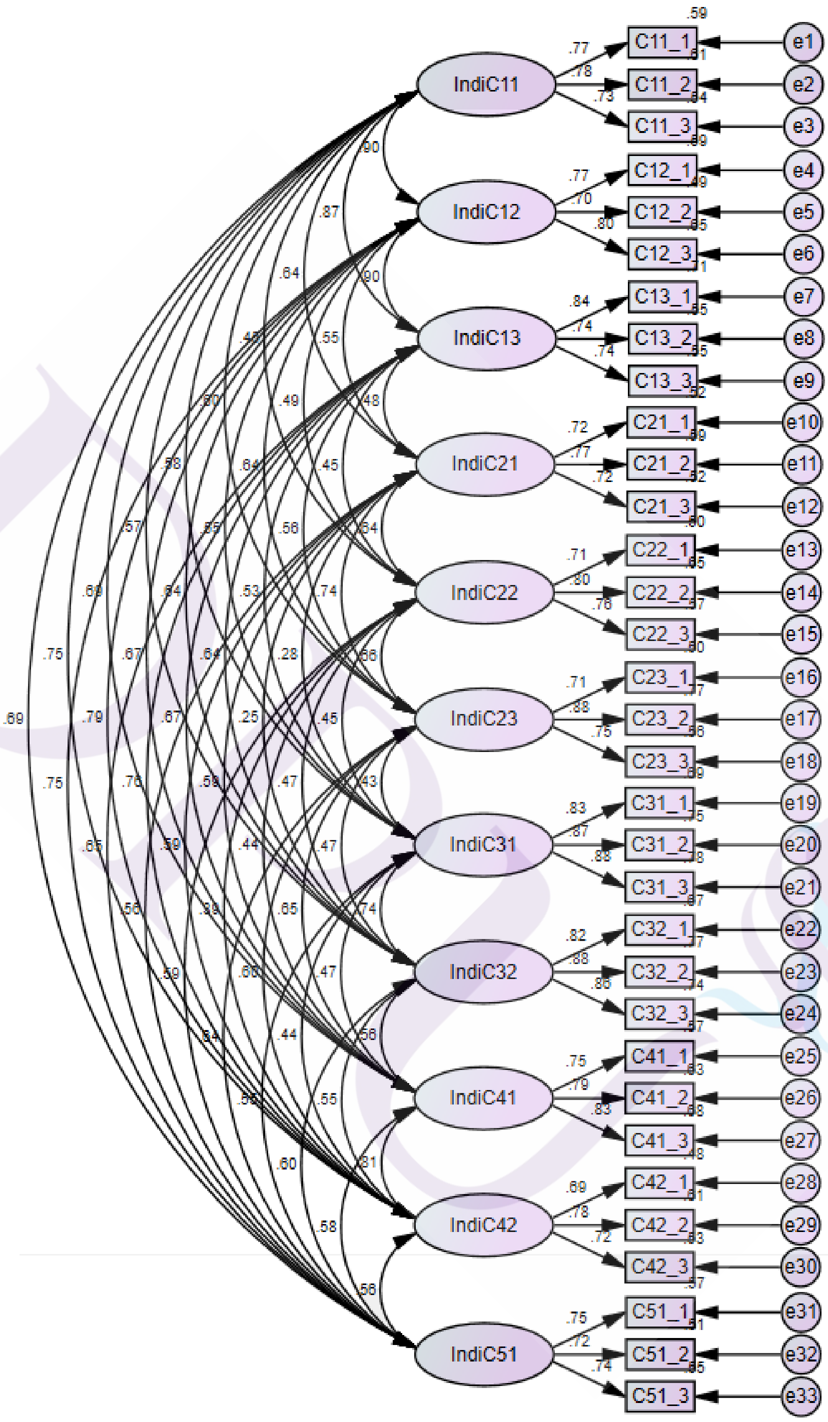


Figure 3.3 CFA graph for IT professional capability indicator group

Table 3.7 Factor loading, AVE, and CR value for indicators in personal quality group

Indicator name	Questionnaire items	Factor loading	AVE	CR
Psychological endurance	A1-1-1	0.802	0.656	0.851
	A1-1-2	0.819		
	A1-1-3	0.808		
Professional ethics	A1-2-1	0.749	0.536	0.776
	A1-2-2	0.71		
	A1-2-3	0.736		
Sense of responsibility	A1-3-1	0.799	0.689	0.869
	A1-3-2	0.854		
	A1-3-3	0.837		
Sense of career achievement	A2-1-1	0.764	0.524	0.767
	A2-1-2	0.738		
	A2-1-3	0.665		

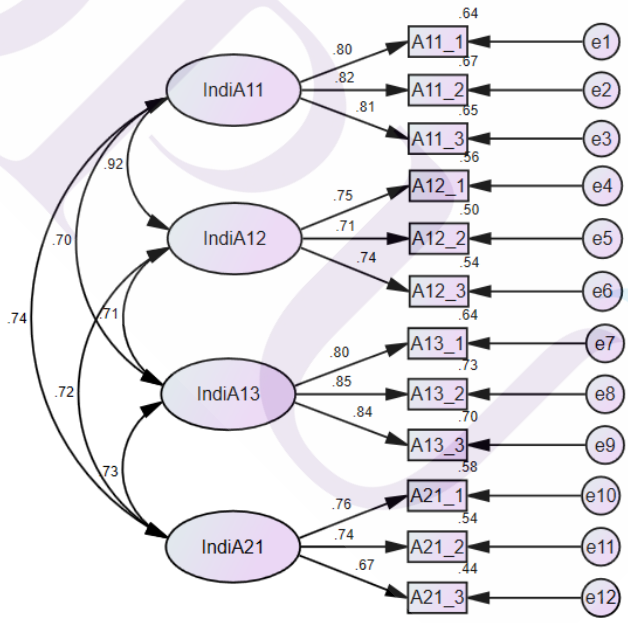


Figure 3.4 CFA graph for personal quality indicator group

The model fitness criteria are shown in table 3.8. The majority of index fit the common criteria (CMIN/DF <2, GFI>0.9, CFI>0.9, NFI>0.9, and RMSEA <0.08).

Although some criteria are slightly not matching the value, they are still close to the lower standard provide by Bentler (1990). The cut off value suggested by Bentler are CMIN/DF <3, CFI>0.85, NFI >0.85. Since the majority of the value fit the criteria and the rest one are quite close to the cut off, this study consider the model fitness to be acceptable for the further analysis.

Table 3.8 The criteria for the model fitness

	CMIN/DF	GFI	CFI	NFI	RMSEA
Personal quality	2.237	0.93	0.96	0.931	0.073
General capability	1.63	0.886	0.954	0.891	0.052
IT professional capability	1.758	0.842	0.926	0.847	0.057

In conclusion, the validity of the questionnaire items is suitable for the study of the IT undergraduate employability. The IT undergraduate employability structure is suitable for further analysis.

3.6 Final confirmation and implementation of the questionnaire

According to the prediction and the results of factor analysis, the employment ability index of IT undergraduate employability constructed. On this basis, the sentences that are easy to cause difficulties and deviations in the prediction process are adjusted. The questionnaire style has also been redesigned. The final draft of the questionnaire has been formed and a formal questionnaire survey has been carried out.

3.6.1 Basic content of the questionnaire

The design of the questionnaire mainly consists of five parts in three aspects. The first part is about the basic identification information of the respondents, including the area of the work unit, the location of the work unit, and the work unit types. All of the questions are in the form of multiple-choice questions.

Followed by the investigation of the IT undergraduate employability factor, respondents are asked to evaluate the importance of employability. At the same time, evaluate the current performance of IT undergraduate employability. Based on the 46 questions of the 23 third level indicators of the "IT undergraduate employability indicator", the study used the Likert 5-point scale as the test method. The questionnaire asked respondents to evaluate the importance of these IT undergraduate employability in the actual job search process, and hit the "√" on the corresponding score. For the level of importance, they are "very important", "important", "general", "not important" and "not at all important". Each level indicates that the interviewed group believes that the importance of the competency program is about 100%-80%, 80%-60%, 60%-40%, 40%-20%, 20%-0%. Each level is given 5, 4, 3, 2, and 1 point respectively. The higher the score is, the more important the employability project is. For the level of performance, they are "very important", "important", "general", "not important" and "not at all important". Each level indicates that the interviewed group believes that the importance of the competency program is about 100%-80%, 80%-60%, 60%-40%, 40%-20%, 20%-0%. Each level is given 5, 4, 3, 2, and 1 point respectively. The higher the score is, the more important the employability project is.

3.6.2 Questionnaire population

This study selects enterprises that participate in the IT industry for questionnaires. Specifically, the questionnaire population are the enterprises which engaged with electronic industry vocational skills identification and guidance center.

The ministry of Industry and Information Technology Communications Industry Vocational Skills Identification Guidance Center is directly under the Ministry of Industry and Information Technology of China. The institution has provincial-level electronic industry vocational skill appraisal centers in 31 provinces (autonomous regions and municipalities directly under the central government), which are mainly responsible for the identification and organization of unique occupational skills in the electronics industry, and the formulation and training of specific occupational skills standards for the electronics industry. According to the agency, over 1 million employee from IT industry have participated in the qualification activity of center. Many enterprises regularly use evaluation service from the center and have active and strong connection with the center. In order to have competitive advantages in employment, IT industry participants would also seek qualification from the center.

There are several advantages for this selection. Firstly, since the identification and guidance center operate in 31 provinces, selecting sample from this population could ensure that the questionnaire covers all provinces of china. Secondly, this population contains employee from varieties of IT industry enterprise. In China, the qualification certificate is an important condition for engaging in a certain job. Therefore, employee from all kinds of IT industry enterprise would participates in the test of the identification and guidance center. This population would ensure the questionnaire cover employee from all size scale of enterprise and all work unit types of enterprise. Thirdly, since skill certification is a significant part in employment, the population selection would ensure that the recipients of the questionnaires are current employee of the IT industry. In conclusion, the population of the questionnaire would effectively represents the Chinese IT industry.

3.6.3 Distribution and collection of questionnaires

The distribution method is the indirect issuance by the Ministry of Industry and Information Technology's Electronic Industry Vocational Skills Identification and Guidance Center and the National Computer Basic Education Research Association. The Ministry of Industry and Information Technology's electronic industry vocational skills appraisal and guidance center has considerable influence in the computer industry, and has a strong guarantee for the timeliness and effectiveness of the questionnaire during the testing process. The questionnaire is distributed by the center in the national scales across 31 provinces.

This study began a questionnaire survey from the beginning of March 2018. After determining the principle of sample selection and the selection principle of the respondents, the questionnaires were distributed through the online electronic questionnaire through the Electronic Industry Vocational Skills Identification and Guidance Center of the Ministry of Industry and Information Technology. The study randomly distributed questionnaires in IT industry enterprises that engage in the activities of the center.

As of March 31, 2018, a total of 2031 questionnaires were received. A preliminary examination of the questionnaire revealed a total of 189 unqualified questionnaires, all of which were removed. 45 questionnaires in the disqualification questionnaire were incomplete. In addition, there are almost no differences in the choice of answers for the different items in the 86 questionnaires of the unqualified questionnaire. There were also 58 questionnaires filled in by the subcontract questionnaire. The time for filling out the questionnaire was short, less than 5 minutes. After removing the unqualified questionnaires, 1842 effective samples were obtained, and the effective questionnaire recovery rate was 85.44%.

3.6.4 Descriptive statistics for recovered samples

For the variable of city type, the recipients are evenly distributed across different city types. While for the occupation variable, the professional IT technicians is the dominating occupation for the IT undergraduate. The descriptive statistics of the sample are shown in Table 3.9:

Table 3.9 Statistics table for sample description

Variable	Category	Symbol	Number of samples	Percentage
City size	Tier1 large size city	T1	602	32.70%
	Tier2 medium size city	T2	600	32.60%
	Tier3 small size city	T3	640	34.70%
Work unit type	State-owned enterprises	W1	344	18.67%
	Schools and research institutes	W2	136	7.38%
	Private enterprises	W3	626	33.98%
	Foreign-invested enterprises	W4	496	26.92%
	Others	W5	240	13.02%
Work unit size	Large-sized	S1	728	39.50%
	Medium-sized	S2	440	23.90%
	Small-sized	S3	674	36.60%
Occupation	Managers	O1	160	8.70%
	Professional IT technicians	O2	1514	82.20%
	Professional IT teachers	O3	168	9.00%

Note: 1. the others attribute represents the work unit type which does not classified into the first four category, such as collective ownership company, sole proprietorship and so on.
2. The detailed definitions of background variable are presented in section 3.1.3

3.6.5 Reliability test of formal questionnaire

The reliability analysis of the “IT undergraduate employability” questionnaire in this study was measured by Cronbach's α coefficient, and the consistency and reliability of the questionnaire were predicted. Since some second level indicator only have one third level indicator and one question, only the alpha value of first level indicators are tested. For 1842 questionnaires, the reliability test results are shown in Table 3.10 and Table 3.11:

Table 3.10 Reliability test results for importance of three scales

	Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of items
Personal quality	.899	.903	12
General capabilities	.911	.916	24
IT professional capability	.903	.905	33

Note: Since some second level indicator only have one third level indicator and one question, only the alpha value of first level indicators are tested.

Table 3.11 Reliability test results for performance of three scales

	Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of items
Personal quality	.896	.899	12
General capabilities	.901	.907	24
IT professional capability	.918	.920	33

Note: Since some second level indicator only have one third level indicator and one question, only the alpha value of first level indicators are tested.

The above data shows that the Cronbach's Alpha coefficient and Cronbach's Alpha based on standardized items for importance of the "general capabilities scale" and "IT professional capability" scales are both greater than 0.9, indicating that the reliability of the scale is very good. The Cronbach's Alpha of the "personal quality" scale reaches 0.899, which is approximately equal to 0.9, and Cronbach's Alpha based on standardized items is also greater than 0.9. The Cronbach's Alpha coefficient and

Cronbach's Alpha based on standardized items for performance of the "general capabilities scale" and "IT professional capability" scales were all greater than 0.9, indicating that the reliability of the scale is very good. The Cronbach's Alpha of the "personal quality" scale reached 0.896, and the Cronbach's Alpha based on standardized items also equalled 0.9, indicating that the reliability of the scale is very good. The above data indicates that the reliability of the scale can fully support the scientificity and credibility of the questionnaire.

3.7 Data processing and statistical analysis

After the questionnaire is collected, the valid questionnaire will be encoded and the questionnaire will be entered into the computer. Then use SPSS for Windows 22.0 Chinese version of the statistical package software for statistical analysis. The statistical methods used are as follows:

3.7.1 Descriptive statistics for general importance and performance

Descriptive statistics are used to screen out the questionnaires, to understand the discrete distribution of the overall data, to analyze the distribution of basic data, and the average, standard deviation, and percentage of the scores under the IT undergraduate employability project, which have been used by IT practitioners to evaluate the importance of IT undergraduate employability and the degree of performance of college students.

3.7.2 ANOVA analysis of background variable influence

ANOVA analysis is selected as the analysis method for background variable analysis of this study. This analysis method could identify which background variable and their interactions have significant influence on the opinion of importance and performance from the questionnaire recipients. Firstly multivariate analysis is conducted in SPSS with four background variable as fixed factors and importance/performance of 23 indicators as dependent variable. The statistical significance of each item is examed. The items with significance lower than 0.05 are selected for further analysis.

Then the partial eta squared value is used to assess the effect size of each selected items on the importance or performance. According to Cohen's (1988) recommendation about the intensity of η^2, value of $0.01 \leqq \eta^2 \leqq 0.06$ will be considered as a low-level practice; value of $0.06 \leqq \eta^2 \leqq 0.14$ is significant for moderate practice, value of $\eta^2 \geqq 0.14$ is highly practical (Qiu, 2010). If the interaction effect of one background variable is significant, then the second order interactions are studied in detail and the main effect of this background variable will not be analyzed in details. The interaction effects are analyse from the prospective of background variable and indicators respectively.

Lastly the top 10 second order interactions with the highest partial eta squared value are selected for the further analysis of the simple effect. Firstly, the general interaction effects of top 10 items are analyse from the prospective of background variable and indicators respectively. Secondly, the simple effects are analyse to identify some pattern in the background variable interaction effect across multiple indicators.

3.7.3 Importance-performance analysis (IPA)

This study identifies the employability that needs to be strengthened based on the "importance-performance" cross-matrix map constructed by IPA analysis based on the “importance level” and “performance level” results. This study uses the subject’s "importance of IT undergraduate employability" as the X-axis, the subject’s "degree of performance of IT undergraduate employability" as the Y-axis. This study uses the average of the importance and performance of the subjects’ IT undergraduate employability as separation points to draw four quadrants. The plot of IPA is shown in the figure 3.1.

The code numbers and representations of the various quadrants in this study are:

Keeping quadrant (A quadrant): It indicates that the employability importance is high and the degree of performance is high. The employability that falls within this quadrant is highly valued by the researcher, which is the IT enterprise demand side, and is very satisfied with the performance of the university students.

Over-supplying quadrant (B quadrant): It indicates that the employability importance is low, but the degree of performance is high. The employability that falls within this quadrant is more satisfactory for the research subject, which is the demand side of the IT enterprise, but the ability that the enterprise does not pay attention to.

Low priority quadrant (C quadrant): It indicates that the degree of importance is low and the degree of performance is low. The employability falling within this quadrant is considered to be less important to the researcher, which is the demand side of the IT enterprise, but the degree of performance of the university student is not satisfactory in the quadrant. After D’s project is improved first, it will be improved to be the "secondary important" ability.

High priority quadrant (D quadrant): indicates a high degree of importance but a low degree of performance. The core competence project that falls within this quadrant is the ability of the research subject, which is the demand side of the IT enterprise, and the ability of the university student to perform poorly. It is expected that priority must be given to improving the ability to “immediately need improvement”.

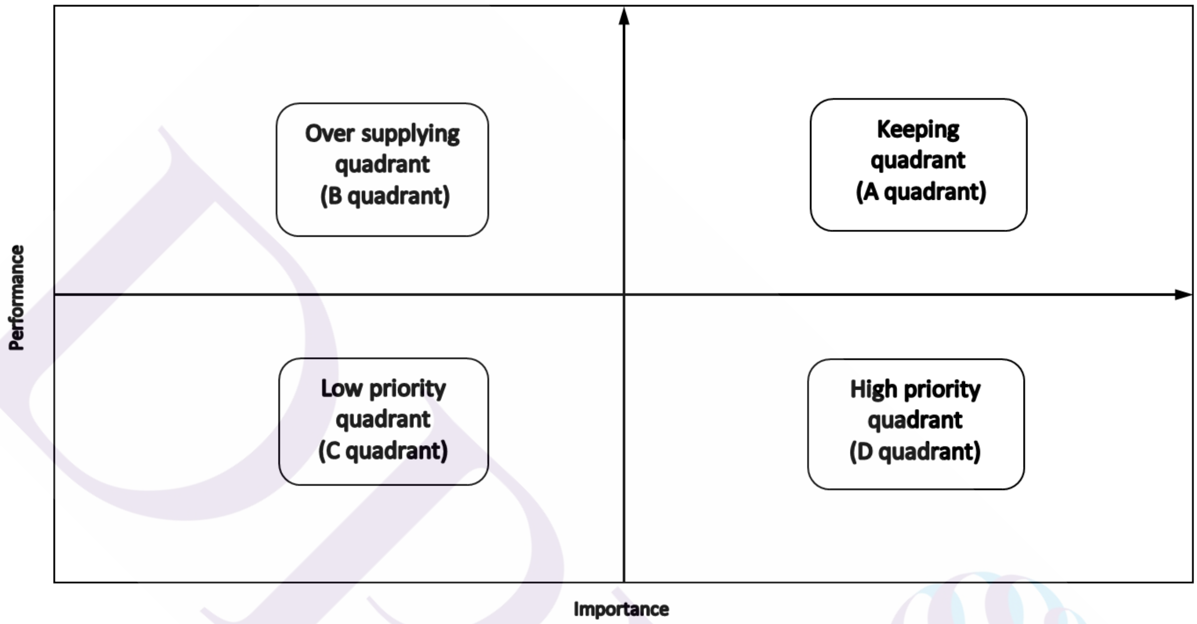


Figure 3.5 IPA two-dimensional matrix

3.7.4 Priority need index (PNI)

PNI scores were calculated using the subject’s “IT undergraduate employability” importance average * (importance means - performance average), and the scores were ranked from high to low. The higher the score is, the more urgent it is needed to improve the employability. The lower the score is, the lower the urgency of the need to improve the employability. Therefore, IT undergraduate employability can be prioritized to provide a basis for improving IT undergraduate employability in the future.

4. RESEARCH RESULTS

After rigorous and detailed discussion in the first three chapters, this chapter will analyze and discuss the data from questionnaires according to the research questions and research hypotheses. The first section analyzes the general statistics of importance and performance of IT undergraduate employability based on the perspective of business needs. The second section presents the four-way analysis of background variables on the importance opinion score of IT undergraduate employability indicators. The third section presents the four-way analysis of background variables on the performance opinion score of IT undergraduate employability indicators. The fourth section presents the Importance-Performance analysis and the PNI analysis for the IT undergraduate employability analysis to identify the employability indicators that urgently require improvements.

4.1 Analysis of the importance and performance of IT undergraduate employability

This study adopts questionnaire method to explore the importance and performance of IT undergraduate employability based on the perspective of enterprise needs. Data compilation and statistical analysis were conducted on the results of the 1842 questionnaires to understand the importance and performance of IT undergraduate employability. The first step of data analysis in this study is general statistics analysis for the questionnaire data.

4.1.1 The importance analysis for IT undergraduate employability

The questionnaire has a total of 23 employability items for important levels of employability. The study used descriptive statistics to analyze each employability test. This study used the average score of the scores of the 23 third level indicators as the comparison criteria. The average score of each employability items is 100%-80%, 80%-60%, 60%-40%, 40%-20%, 20%-0%, given 5, 4, 3, 2, 1 point respectively, and the following sections are calculated according to this. These data is analyzed to explore the importance of IT undergraduate employment ability as shown in appendix V.

The average of 23 employability scores ranged from 4.331 to 3.149. The interviewed group considered that the top 10 important items were psychological endurance (M=4.198), professional ethics (M=4.097), sense of responsibility (M=4.193), sense of career achievement (M=4.069), executive capability (M=4.186), learning capability (M=4.266), creativity (M=4.210), planning capability (M=4.207), career planning capability (M=4.162) and teamwork (M=4.219).

From Table 4.1, it can be seen that the total number of items considered by the respondents to be less than 4 points is 7 items. These seven items are general capability to use and maintain computer application systems (M=3.944), basic design capability of computer application system (M=3.857), capability to apply computer for implementing apply system and conducting development and innovation (M=3.840), cognitive and operational capability of computer components and hardware (M=3.826), computer system development capabilities (M=3.600), design capability of computer hardware (M=3.357), and using social relations capabilities (M=3.149). However, according to statistics, it is found that among the items in which the respondents think that the employability is less important, the sub-item average is at least 3.1 points. It shows that most of these abilities are still considered important, but their importance is relatively low in compared to the previous ability.

Table 4.1 Ranking of IT undergraduate employability according to importance score

Employability indicator name	Mean	Standard deviation
Cognitive and operational capability of software theory	4.331	0.795
Learning capability	4.266	0.823
Teamwork	4.219	0.788
Creativity	4.210	0.733
Planning capability	4.207	0.896
Psychological endurance	4.198	0.821
Sense of responsibility	4.193	0.840
Executive capability	4.186	0.723
Communication and coordination	4.164	0.860
Career planning capability	4.162	0.935
Algorithm design and analysis capabilities	4.129	0.878
Capability of computer software design and program development	4.119	0.844
Professional ethics	4.097	0.896
Cognitive capability of basic knowledge of computer	4.093	0.806
Computational thinking and modelling capabilities	4.090	0.716
Sense of career achievement	4.069	0.831
General capability to use and maintain computer application systems	3.944	0.969
Basic design capability of computer application system	3.857	0.918
Capability to apply computer for implementing apply system and conducting development and innovation	3.840	1.015
Cognitive and operational capability of computer components and hardware	3.826	0.911
Computer system development capabilities	3.600	0.977
Design capability of computer hardware	3.357	1.097
Using social relations capabilities	3.149	1.211

Based on the above discussion, this study conducted an investigation of the importance of the IT undergraduate employability. The overall average score for the degree of importance was found to be 4.013, which was higher than the "important" score of 4, indicating that the respondent's perception of IT undergraduate employability was considered to be generally important. Even the average of the five employability items with the lowest scores is higher than 3 points, indicating that respondents still have a certain degree of attention to the above-mentioned IT undergraduate employability project. The detail information of final questionnaire data is attached in appendix V.

4.1.2 The performance analysis for IT undergraduate employability

The questionnaire has a total of 23 employability items for performance levels of employability. The study used descriptive statistics to analyze each employability test. This study used the average score of the scores of the 23 third level indicators as the comparison criteria. The average score of each employability items is 100%-80%, 80%-60%, 60%-40%, 40%-20%, 20%-0%, given 5, 4, 3, 2, 1 point respectively, and the following sections are calculated according to this. The detailed data is presented in appendix V.

According to Table 4.2, the average of 23 employability scores ranged from 3.725 to 2.7106. The interviewed group considered that the top 10 best performed items were cognitive and operational capability of software theory (M=3.725), teamwork (M=3.662), sense of career achievement (M=3.547), learning capability (M=3.526), professional ethics (M=3.489), cognitive and operational capability of computer components and hardware (M=3.276), computational thinking and modeling capabilities (M=3.257), general capability to use and maintain computer application systems (M=3.245), executive capability (M=3.214), cognitive capability of basic knowledge of computer(M=3.200).

The order of performance level is shown in Table 4.2, it can be seen that the respondents believe that 5 items have the performance level less than 3 points. They are psychological endurance (M=2.998), design capability of computer hardware (M=2.885), using social relations capabilities (M=2.832), capability of computer software design and program development (M=2.821), and algorithm design and analysis capabilities (M=2.706). However, according to statistics, it was found that the respondents considered that the items with the highest level of employability performance had the average score of less than 4 points. It shows that the overall respondents believe that the performance of IT undergraduate employability is generally low.

Based on the above discussion, the respondents believe that the degree of performance of college students' computer professional employment is generally low. The main reason is that the majority of the respondents' opinions tend to be "very poor", "poor" and "general". It is believed that the ability of university education to cultivate is not enough to expose them to the challenges of the workplace, and that there is a considerable gap between the knowledge and workplace needs of students in school.

Table 4.2 Ranking of IT undergraduate employability according to performance score

Employability	Mean	Standard deviation
Cognitive and operational capability of software theory	3.725	1.028
Teamwork	3.662	0.942
Sense of career achievement	3.547	0.857
Learning capability	3.526	1.034
Professional ethics	3.489	0.950
Cognitive and operational capability of computer components and hardware	3.276	1.058
Computational thinking and modelling capabilities	3.257	1.018
General capability to use and maintain computer application systems	3.245	0.966
Executive capability	3.214	1.077
Cognitive capability of basic knowledge of computer	3.200	0.747
Capability to apply computer for implementing apply system and conducting development and innovation	3.170	1.041
Basic design capability of computer application system	3.169	0.970
Career planning capability	3.145	0.861
Sense of responsibility	3.114	0.716
Planning capability	3.114	0.767
Communication and coordination	3.111	0.973
Creativity	3.025	0.900
Computer system development capabilities	3.009	1.081
Psychological endurance	2.998	0.822
Design capability of computer hardware	2.885	1.127
Using social relations capabilities	2.832	1.008
Capability of computer software design and program development	2.821	1.020
Algorithm design and analysis capabilities	2.706	1.063

4.1.3 Summary

The results of this section show that the importance of IT undergraduate employability has been generally considered as important. The average of 23 employability scores ranged from 4.331 to 3.149. The total number of items considered by the respondents to be less than 4 points is 7. However, according to statistics, among the employability which is consider as relatively not important, the lowest average value of the item was more than 3.1 points. This shows that most of that employability indicators are still considered as important, but it is relatively low in importance compared to the previous ability.

Based on the analysis of the degree of performance, the average of 23 employment ability scores ranged from 3.725 to 2.706. A total of five projects are considered to have a performance level below 3 points. However, according to statistics, it was found that among the employability with the best performance, the average score of the respondents was also less than 4 points. It shows that the overall respondents' evaluation of the performance of IT undergraduate employability is generally low. This shows that from the perspective of enterprises, the performance of colleges and universities in cultivating students' graduation ability needs to be improved. This result deserves the attention of the relevant units of the university.

4.2 Importance difference analysis of IT undergraduate employability

This section intends to explore the influence effect of backgrounds variable on the importance of the IT undergraduate employability. Through the questionnaire, four background variables are collected with the data for employability structure. Those four background variables are city size, work unit type, work unit size, and occupation, as explained in chapter 3.1.3. The different background variable may have different level of influence on the importance of the employability, and some of them may have significant interaction effect on the employability importance. Having an in-depth understanding of the background effect could provide a detailed guidance for the further study and possible application of the IT undergraduate employability structure. The detail of the analysis method is discussed in the chapter 3.7.4, and the analysis results are shown in the following sections.

4.2.1 Analysis of main effect of background variable on employability importance

Through ANOVA analysis, this study finds that there are significant background variable effects on the IT under graduate employability. While the many of the employability indicators importance are influenced by the background variable, the effect size is generally small. Since all of those main effect have more significant interaction items, only the interactions are studied in details.

Variable city size have statistically significant (sig <0.05) influence on five IT undergraduate employability indicators, such as A1-1 (psychological endurance), A1-3 (sense of responsibility), B1-3 (creativity), B2-1 (planning capability), C1-1 (capability of computer software design and program development). Variable work unit type have statistically significant (sig <0.05) influence on three IT undergraduate employability indicators, such as A1-1 (psychological endurance), A1-2 (professional ethics), B2-1 (planning capability). Variable work unit size have statistically significant (sig <0.05) influence on six IT undergraduate employability indicators, such as A1-3 (sense of responsibility), B1-1 (executive capability), B1-3 (creativity), B2-2 (career planning capability), C4-1 (computational thinking and modeling capabilities), C4-2 (algorithm design and analysis capabilities). Variable occupation does not have statistical significant influence on the employability indicators. However the partial eta squared values are all lower than 0.03, which indicates that the influences of background variable on the opinion of importance are generally small.

For all of the item selected with main effect from single variable, there are at least one related interaction items with a larger partial eta squared value. For example, the influence of work unit type on importance indicator A1-2 (professional ethics) has a partial eta squared value of 0.013, while the interaction item of work unit type * work unit size have a larger value of 0.019. The influence of city size on importance indicator B1-3 (creativity) has a partial eta squared value of 0.011, while the interaction item city size * work unit type have a larger value of 0.031. Therefore the main effects of the background variables are not studied in details, only the interaction effect are studied.

Form the prospective of employability indicators, 9 out of 23 indicators are influenced by the background variable, which indicates that the influence of the background variable on the opinion of importance of the IT undergraduate employability have a large scale and cannot be ignored. Four indicators are influence by more than one variables as shown in Table 4.3.

Table 4.3 Significant main effect of the background variable on importance score

Background variable	Indicator name	F	η^2	Post hoc
City size	Psychological endurance	7.726^{***}	0.017^{Δ}	T1>T2 T3>T2
	Sense of responsibility	6.414^{***}	0.014^{Δ}	T1>T2 T3>T2
	Learning capability	3.284^{*}	0.007	T3>T2
	Creativity	3.476^{*}	0.008	T3>T1
	Teamwork	3.086^{*}	0.007	T1>T2
	Cognitive capability of basic knowledge of computer	4.745^{***}	0.010^{Δ}	T1>T2 T1>T3
Work unit type	Psychological endurance	4.814^{***}	0.021^{Δ}	W3>W4
	Professional ethics	14.457^{***}	0.059^{Δ}	W1>W4 W3>W4 W5>W4
	Sense of responsibility	4.149^{***}	0.018^{Δ}	W5>W4
	Sense of career achievement	6.395^{***}	0.027^{Δ}	W1>W4 W3>W4
	Learning capability	3.877^{***}	0.017^{Δ}	W5>W1 W5>W4
	Career planning capability	3.446^{***}	0.015^{Δ}	W3>W1
	Computational thinking and modelling capabilities	2.979^{*}	0.013^{Δ}	W1>W4
	General capability to use and maintain computer application systems	2.638^{*}	0.011^{Δ}	W1>W4
Work unit size	Professional ethics	5.660^{***}	0.012^{Δ}	S3>S2
	Sense of responsibility	3.364^{*}	0.007	S3>S1
	Creativity	8.045^{***}	0.017^{Δ}	S1>S2 S1>S3
	Career planning capability	6.311^{***}	0.014^{Δ}	S3>S1
Occupation	Cognitive capability of basic knowledge of computer	4.746^{***}	0.010^{Δ}	O2>O1
	Computer system development capabilities	3.546^{*}	0.008	O2>O1

Note: 1. Statistical significance: *: P<0.05, ***: P<0.001
2. Effect size: Δ: Small effect, ΔΔ: Medium effect, ΔΔΔ: Large effect

For the post hoc test, this study adopts Scheffé method and taking the result of Tukey method into consideration. The result shows that

For psychological endurance, recipients in the large size city and small size city gave higher score than the recipients in the medium size city. Recipients in private enterprise gave higher score than the recipients in the foreign-invested enterprise.

For professional ethics, recipients in state-owned, private, and other types of enterprise gave higher score than the recipients in the foreign-invested enterprise. Recipients in large scale enterprise gave higher score than the recipients in the medium scale enterprise.

For sense of responsibility, recipients in the large size city and small size city gave higher score than the recipients in the medium size city. Recipients in private enterprise gave higher score than the recipients in the foreign-invested enterprise. Recipients in large scale enterprise gave higher score than the recipients in the small scale enterprise. Recipients in large scale enterprise gave higher score than the recipients in the small scale enterprise.

For sense of career achievement, recipients in state-owned and private enterprise gave higher score than the recipients in the foreign-invested enterprise.

For learning capability, recipients in the small size city gave higher score than the recipients in the medium size city. Recipients in, other types of enterprise gave higher score than the recipients in the state-owned and foreign-invested enterprise.

For career planning capability, recipients in the private enterprise gave higher score than the recipients in the state-owned enterprise. Recipients in large scale enterprise gave higher score than the recipients in the small scale enterprise.

For creativity, recipients in the small size city gave higher score than the recipients in the large size city. Recipients in large scale enterprise gave higher score than the recipients in the medium and small scale enterprise.

For teamwork, recipients in the large size city gave higher score than the recipients in the medium size city.

For cognitive capability of basic knowledge of computer, recipients in the large size city gave higher score than the recipients in the medium and small size city. Recipients of professional IT technicians gave higher score than the recipients of manager.

For computer system development capability, recipients of professional IT technicians gave higher score than the recipients of manager.

For computational thinking and modelling capabilities, recipients in the stated-owned enterprise gave higher score than the recipients in the foreign-invested enterprise.

For general capability to use and maintain computer application systems, recipients in the stated-owned enterprise gave higher score than the recipients in the foreign-invested enterprise.

4.2.2 Analysis of second order interaction effect of background variable on employability importance

4.2.2.1 General analysis of second order interaction on importance

All six sets of interaction have statistically significant influence on the importance opinion of IT undergraduate employability. There are 34 second order interaction item of the background variable which have a statistically significant lower than 0.05. The effect sizes of all interactions are all below 0.06 and have an average of 0.023, which indicates that the effects of interactions are small. Since the partial eta values are generally larger than the main effect, the interactions of the background variable are still important.

However different set of interaction have different level of influence on the importance opinion. The interaction city size * work unit size, city size * occupation, work unit size *occupation seems to be the weaker interaction items because they have the less influenced indicators (around 3~4) and the partial eta squared value are all below 0.02. While city size * work unit size, work unit type * occupation, work unit type * work unit size are the stronger influencing back ground variables. They have more than 6 influenced indicators and have some interaction with the partial eta squared value larger than 0.03.

Table 4.4 Significant interaction effect of background variable on importance score

Interactions	Number of influenced indicators	Average η^2	Influenced indicators
City size * Occupation	5	0.011	B1-3, C1-3, C2-2, C3-1, C4-2
City size * Work unit size	3	0.015	B1-3, B2-2, C4-2
Work unit size * Occupation	4	0.016	,B1-1, B1-3, B2-2, C4-2
City size * Work unit type	9	0.027	A1-1, B1-2, B1-3, B2-1, B2-2, C1-2, C2-1, C3-1, C4-2
Work unit type * Occupation	6	0.028	B1-2, B1-3, B2-1, C1-2, C2-2, C4-2
Work unit type * Work unit size	7	0.028	A1-1, A1-2, B2-2, B3-2, C3-1, C3-2, C4-2

Note: The employability indicators are A1-1: Psychological endurance, A1-2: Professional ethics, A1-3: Sense of responsibility, A2-1: Sense of career achievement, B1-1: Executive capability, B1-2: Learning capability, B1-3: Creativity, B2-1: Planning capability, B2-2: Career planning capability, B3-1: Teamwork, B3-2: Communication and coordination, B4-1: Using social relations capabilities, C1-1: Capability of computer software design and program development, C1-2: Basic design capability of computer application system, C1-3: Capability to apply computer for implementing apply system and conducting development and innovation, C2-1: Cognitive capability of basic knowledge of computer, C2-2: Cognitive and operational capability of computer components and hardware, C2-3: Cognitive and operational capability of software theory, C3-1: Computer system development capabilities, C3-2: Design capability of computer hardware, C4-1: Computational thinking and modeling capabilities, C4-2: Algorithm design and analysis capabilities, C5-1: General capability to use and maintain computer application systems. See section 3.3

From the prospective of the indicators, as shown in Table 4.4, 15 out of 23 indicators are influenced by the interaction effect of the background variable which show interaction effect is common in the employability. At the level of First level indicators, the scale of the interaction effect are not balanced. Personal quality indicators are less likely to be influenced by background variable. For personal quality, 2 out of 4 third level indicators have interaction effect. For general capability, 6 out of 8 third level indicators have interaction effect. For IT professional capability, 7 out of 11 third level indicators have interaction effect. The number of interaction effect for the individual indicators are quite different. Indicator A1-2 (professional ethics), B1-1 (executive capability), C1-3 (capability to apply computer for implementing apply system and conducting development and innovation), C2-1 (cognitive capability of basic knowledge of computer), C3-2 only have one interaction item, while indicator B1-3 (creativity), B2-2 (career planning capability), C4-2 (algorithm design and analysis capabilities)have more than 5 interaction items. This shows that the indicators have different characteristics and require further stud in the application of the IT undergraduate employability structure.

The interaction graphs of second order interaction effect of back ground variables are presented in the Figure 4.1~4.6. The interaction graphs present the general tendency of the interactions. In the next section, this study will analysis the interaction items with relatively greater effect size to identify the important background variables combinations. From the interaction graphs, this study finds that the first three interactions (City size * Occupation, City size * Work unit size, Work unit size * Occupation) are relatively weaker than the later three interactions (City size * Work unit type, Work unit type * Occupation, Work unit type * Work unit size). The interaction graphs show that there is no dominating interaction pattern on the employability, however some demographic character seems to influence the employability more significantly. The detailed analysis will be presented in next section.

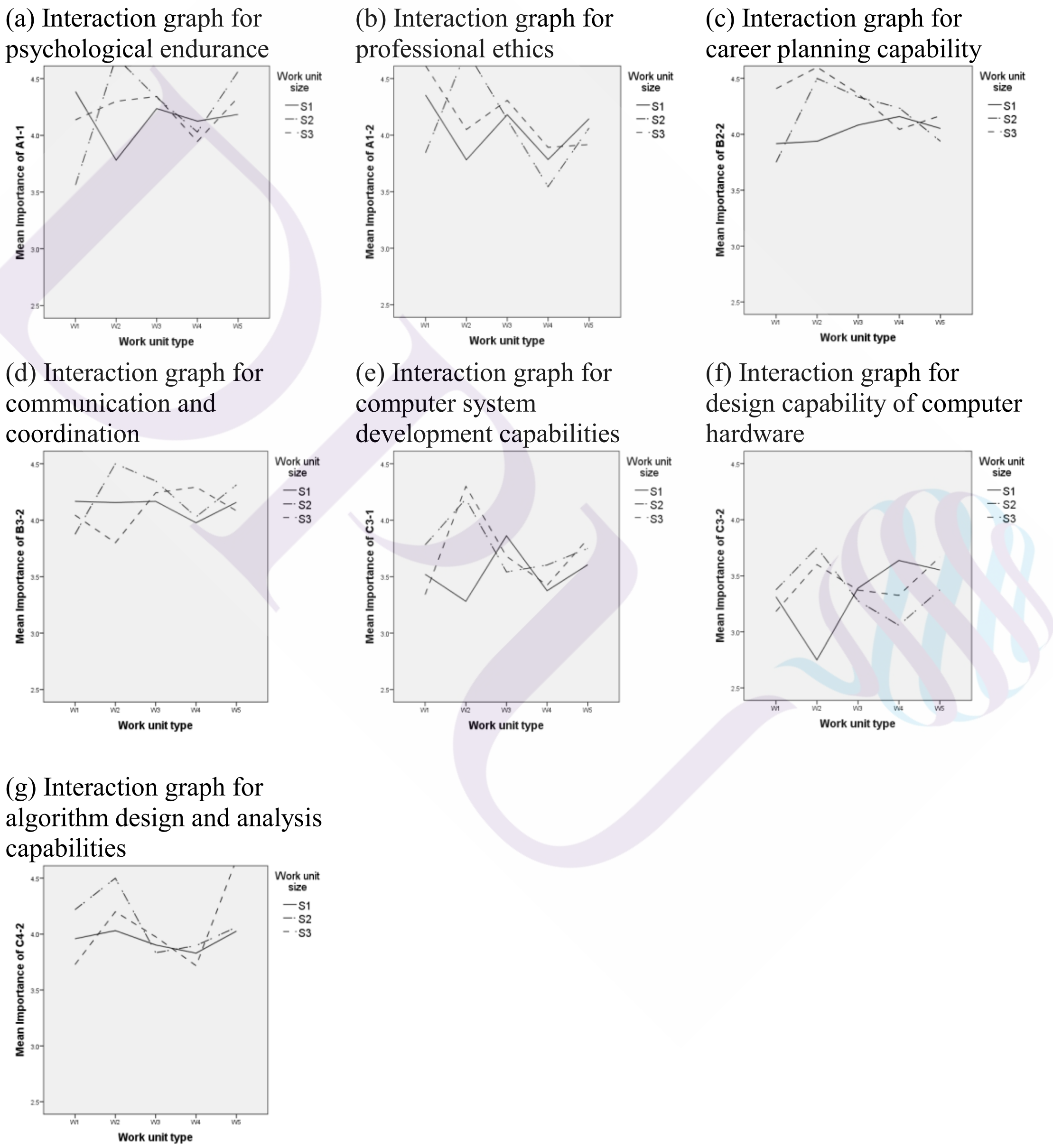
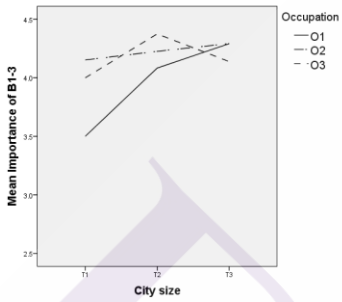
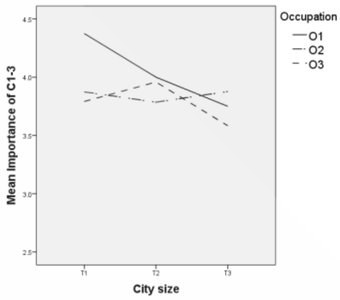


Figure 4.1 Interaction graph for background variable work unit type and work unit size

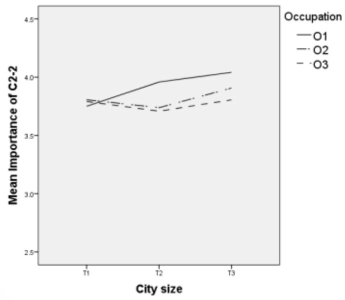
(a) Interaction graph for creativity



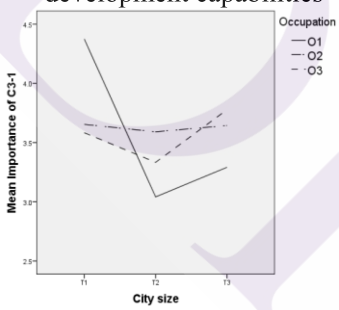
(b) Interaction graph for capability to apply computer for implementing apply system and conducting development and innovation



(c) Interaction graph for cognitive and operational capability of computer components and hardware



(d) Interaction graph for computer system development capabilities



(e) Interaction graph for algorithm design and analysis capabilities

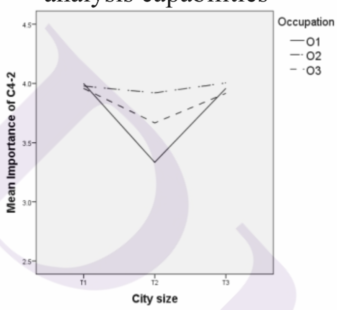
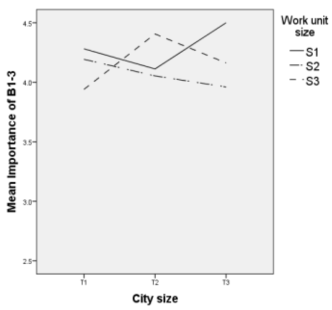
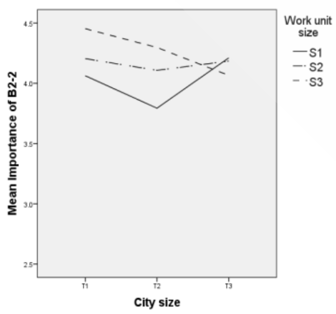


Figure 4.2 Interaction graph for background variable city size and occupation

(a) Interaction graph for planning capability



(b) Interaction graph for career planning capability



(c) Interaction graph for algorithm design and analysis capabilities

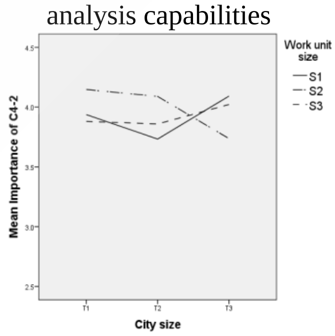
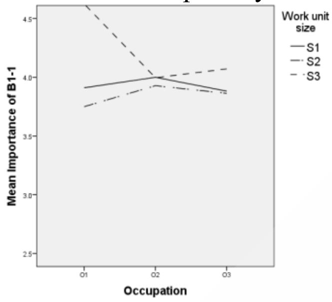
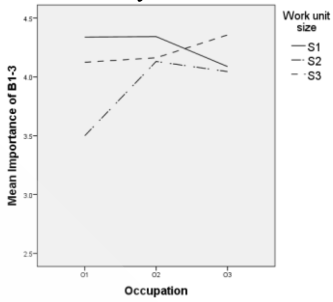


Figure 4.3 Interaction graph for background variable city size and work unit size

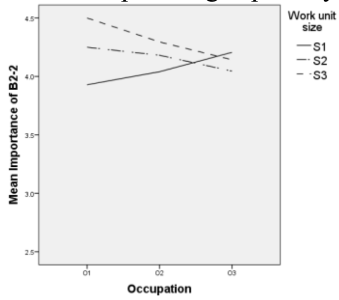
(a) Interaction graph for executive capability



(b) Interaction graph for creativity



(c) Interaction graph for career planning capability



(d) Interaction graph for algorithm design and analysis capabilities

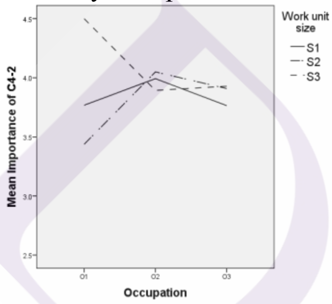
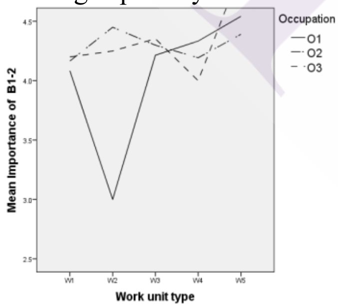
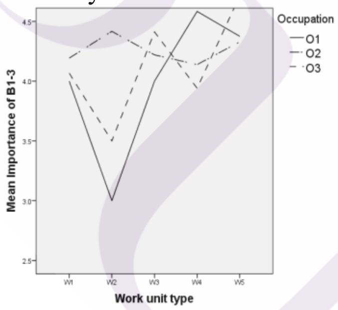


Figure 4.4 Interaction graph for background variable occupation and work unit size

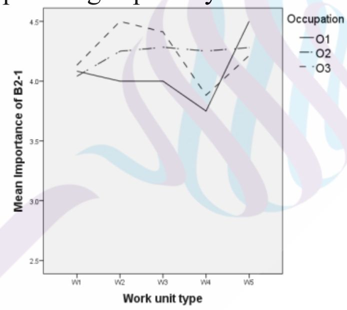
(a) Interaction graph for learning capability



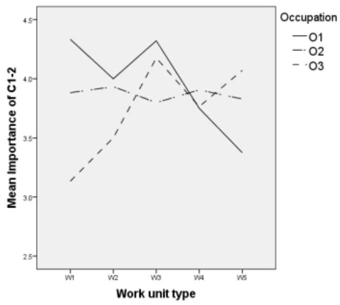
(b) Interaction graph for creativity



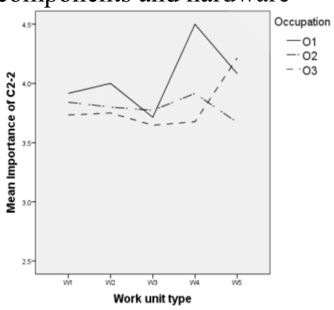
(c) Interaction graph for planning capability



(d) Interaction graph for basic design capability of computer application system



(e) Interaction graph for cognitive and operational capability of computer components and hardware



(f) Interaction graph for algorithm design and analysis capabilities

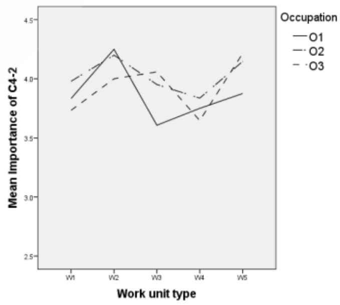
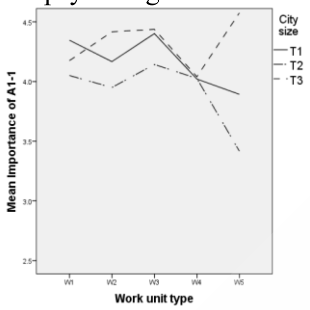
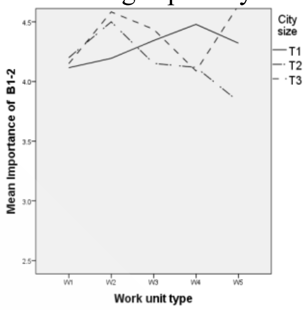


Figure 4.5 Interaction graph for background variable work unit type and occupation

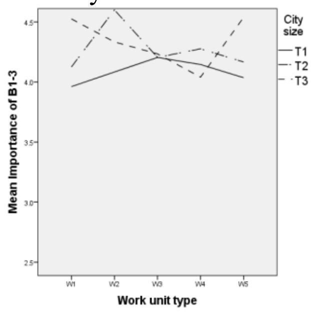
(a) Interaction graph for psychological endurance



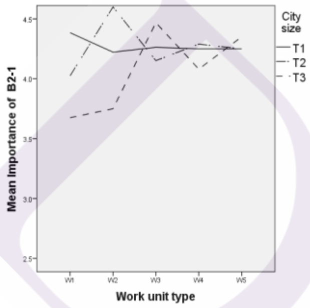
(b) Interaction graph for learning capability



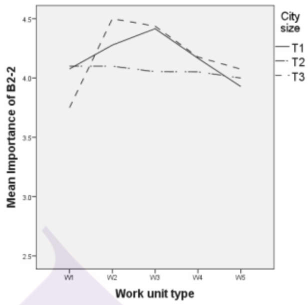
(c) Interaction graph for creativity



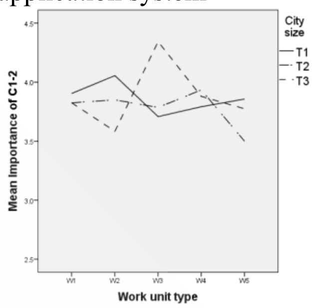
(d) Interaction graph for planning capability



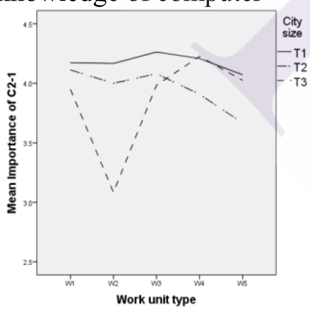
(e) Interaction graph for career planning capability



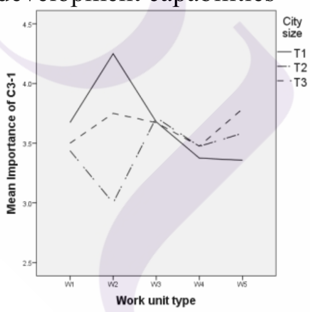
(f) Interaction graph for basic design capability of computer application system



(g) Interaction graph for cognitive capability of basic knowledge of computer



(h) Interaction graph for computer system development capabilities



(i) Interaction graph for algorithm design and analysis capabilities

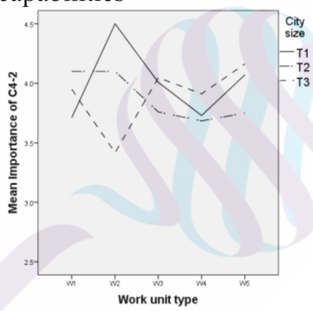


Figure 4.6 Interaction graph for background variable work unit type and city size

4.2.2.2 Analysis of top 10 second order interaction on importance

In order to further explore the characteristics of the second order interaction effect, 10 interaction items are selected for simple effect analysis based on the effect size (partial eta squared value). There are 13 indicators have the partial eta squared value above the average value, therefore the selected 10 interaction items are a reliable approximation of the major influence effect. Three interaction items in this category are city size * work unit type, work unit type * occupation, and work unit type * work unit size, which again prove the point from last chapter that those interactions are the stronger group. The details of the top 10 second order interaction items can be found in Table 4.5.

From the prospective of the indicators, the most likely influenced indicators are A1-1 (psychological endurance), B1-2 (learning capability), B1-3 (creativity), B2-1 (planning capability), C2-1 (cognitive capability of basic knowledge of computer), C3-1 (computer system development capabilities), and C4-2 (algorithm design and analysis capabilities). The numbers of interaction for each of the indicators are around 1~2 and the average partial eta squared value are similar. This means that those indicators are affected by the background variable at the similar effect level.

Table 4.5 Top 10 second-order interaction items

Background variables	Indicators	F	η^2
W * S	Psychological endurance	4.421^{***}	0.041
W * S	Algorithm design and analysis capabilities	3.743^{***}	0.035
W * S	Computer system development capabilities	2.905^{***}	0.027
W * O	Creativity	5.241^{***}	0.048
W * O	Learning capability	3.437^{***}	0.032
T* W	Computer system development capabilities	4.317^{***}	0.040
T* W	Algorithm design and analysis capabilities	3.530^{***}	0.033
T* W	Cognitive capability of basic knowledge of computer	3.434^{***}	0.032
T* W	Career planning capability	3.386^{***}	0.031
T* W	Learning capability	2.938^{***}	0.027

Note: 1. Background variable: T: city size, W: work unit type, S: work unit size, O: occupation.
2. Statistical significance: *: $P<0.05$, ***: $P<0.001$

Through analysis of the simple effect of the top 10 interaction items, some combinations of the background variable are found to have certain tendency in the influence level.

For interaction work unit type * occupation, Firstly, under the condition of manager occupation, recipient in schools and research institutes tend to give a lower importance ranking to learning capability and creativity comparing to the recipients in foreign-invested enterprise and others type of enterprise. This could be that the employees in those two categories face more challenging environment and competition which require more frequent knowledge updates and project innovation. Secondly, under the condition of schools and research institutes, the professional IT technicians have a higher importance ranking for the learning capability and creativity comparing to manager. The data for this simple effect analysis is shown in Table 4.6.

Table 4.6 Simple effect analysis for interaction occupation * work unit type

Indicator	Variable combination1		Variable combination2		Mean difference (1-2)	Std. Error
Creativity	O1	W4	**O1**	**W2**	1.583^{*}	.416
Creativity	O1	W5	**O1**	**W2**	1.375^{*}	.389
Learning capability	O1	W4	**O1**	**W2**	1.333^{*}	.470
Learning capability	O1	W5	**O1**	**W2**	1.542^{*}	.440
Creativity	**W2**	**O2**	W2	O1	1.417^{***}	.372
Learning capability	**W2**	**O2**	W2	O1	1.450^{*}	.420

Note: 1. Variable combination 1 have larger mean score that the variable combination2, thus the positive mean difference.

2. Background variable: O1: Managers, O2: professional IT technicians, W2: schools and research institutes, W4: Foreign-invested enterprise, W5: other types of enterprise.

3. The attribute others in the table represents the work unit type which do not classified into the first four category, such as collective ownership company, sole proprietorship and so on.

4. Statistical significance: *: P<0.05, ***: P<0.001

For interaction city size * work unit type, Firstly under the condition of large size city, the recipients in schools and research institutions generally consider computer system development capability, and algorithm design and analysis capability to be more importance comparing to all other work unit type. Secondly, under the condition of small size city, the recipients from schools and research institutions generally consider cognitive capability of basic knowledge of computer to be less important comparing to recipients from all other types of work units. Thirdly, under the condition of schools and research institutions, the recipients from small size city tend to consider B2-1 (planning capability), C2-1 (cognitive capability of basic knowledge of computer), and C4-2 (algorithm design and analysis capabilities) as less important. The data for this simple effect analysis is shown in Table 4.7.

Table 4.7 Simple effect analysis for interaction city size * work unit type

Indicator	Variable combination1		Variable combination2		Mean difference (1-2)	Std. Error
Cognitive capability of basic knowledge of computer	T3	W1	**T3**	**W2**	.867*	.261
Cognitive capability of basic knowledge of computer	T3	W3	**T3**	**W2**	.901*	.250
Cognitive capability of basic knowledge of computer	T3	W4	**T3**	**W2**	1.142***	.240
Cognitive capability of basic knowledge of computer	T3	W5	**T3**	**W2**	.942***	.246
Computer system development capabilities	**T1**	**W2**	T1	W3	.571*	.180
Computer system development capabilities	**T1**	**W2**	T1	W4	.875***	.212
Computer system development capabilities	**T1**	**W2**	T1	W5	.893*	.243
Algorithm design and analysis capabilities	**T1**	**W2**	T1	W1	.788*	.211
Algorithm design and analysis capabilities	**T1**	**W2**	T1	W4	.771*	.215
Algorithm design and analysis capabilities	W2	T1	**W2**	**T3**	1.083*	.325
Cognitive capability of basic knowledge of computer	W2	T1	**W2**	**T3**	1.083***	.265
Cognitive capability of basic knowledge of computer	W2	T2	**W2**	**T3**	.917*	.290
Planning capability	W2	T2	**W2**	**T3**	.850*	.323

Note: 1. Variable combination 1 have larger mean score that the variable combination2, thus the positive mean difference.

2. Background variables: T1: Large size city, T3: Small size city, W1: State-owned enterprises, W2: Schools and research institutes, W3: Private enterprises, W4: Foreign-invested enterprises, W5: Others.

3. The attribute others in the table represents the work unit type which do not classified into the first four category, such as collective ownership company, sole proprietorship and so on.

4. Statistical significance: *: $P<0.05$, ***: $P<0.001$

For interaction work unit size * work unit type, there is no obvious dominating or dominated combination. The patterns for this background variable interaction are quite scattered.

4.2.3 Analysis of third order interaction effect of background variable on employability importance

The third order interaction effects also exist in the background variable influence. The only significant interaction is city size * work unit type * work unit size. It has influenced 19 out of 23 indicators with a statistical significance lower than 0.05. The effect size of third order interaction on the indicator A1-1 (psychological endurance) and B2-2 (career planning capability) are significantly larger than other interaction items. The partial eta squared values of those two item are 0.134 and 0.104 which are almost reach the level of large level of effect (0.14). What's more, those effect size are also much larger than the third interaction effect on professional ethics which is 0.068.

4.2.4 Summary

This chapter conducts the four-way ANOVA analysis with 23 dependent variable. This study finds that the background variables have statistically significant influence on many of the employability indicators. However most of the main effect and interaction effect are relatively weak from the aspect of the effect size.

From the interaction analysis, firstly the variable occupation does not play a significant role. Most of the interaction combination does not contain variable occupation. Besides, the numbers of indicators that are influenced by variable occupation are also limited. Secondly, the three combination have relatively more significant influence on the importance opinion of employability, such as (city size and work unit type), (work unit type and occupation), and (work unit type, work unit size). Thirdly the result from the third order interaction analysis shows that the recipients' opinion on importance of A1-1 (psychological endurance) and B2-2 (career planning capability) have the most significant interaction effect

From the simple effect analysis, recipients of management of schools and research institutes consider learning capability and creativity as less important, while IT technicians from schools and research institutes consider learning capability and creativity to be more important. Recipients from schools and research institutes in small size city consider B2-1 (planning capability), C2-1 (cognitive capability of basic knowledge of computer) and C4-2 (algorithm design and analysis capabilities) to be less important, while recipients from schools and research institutes in large size city consider C3-1 (computer system development capabilities) and C4-2 (algorithm design and analysis capabilities) to be more important.

It can be conclude from the above analysis that most of the significant interaction combinations contain background variable schools and research institutions from work unit type. This means that the requirement of IT undergraduate employability by schools and research institutions is quite different. This finding could be explained by the fact that the rest of the work unit type are all enterprises which naturally have different function and operation purpose, therefore they have quite distinct requirement of the IT undergraduate employability.

4.3 Performance difference analysis of IT undergraduate employability

This section continues the four-way analysis of the background variable influence on the recipients' opinion on the performance of the IT undergraduate employability. Through the questionnaire, four background variables are collected with the data for employability structure. Those four background variables are city size, work unit type, work unit size, and occupation, as explained in chapter 3.1.3. The different background variable may have different level of influence on the importance of the employability, and some of them may have significant interaction effect on the employability importance. The detail of the analysis method is discussed in the chapter 3.7.4, and the analysis results are shown in the following sections.

4.3.1 Analysis of main effect of background variable on employability performance

Through four-way ANOVA analysis, this study finds that there are statistically significant background variable effects on the performance opinion of IT under graduate employability. As the finding in performance four –way ANOVA analysis, while the many of the employability indicators performance are influenced by the background variable, the effect size are generally small. For all of the item selected with main effect from single variable, there are at least one related interaction items with a larger partial eta squared value. Since all of those main effect have more significant interaction items, only the interactions are studied in details.

Variable city size have statistically significant (sig <0.05) influence on four IT undergraduate employability indicators, such as A1-1 (psychological endurance), A2-1 (sense of career achievement), B2-1 (planning capability), and B2-2 (career planning capability). Variable work unit size have statistically significant (sig <0.05) influence on five IT undergraduate employability indicators, such as A1-2 (professional ethics), A1-3 (sense of responsibility), A2-1 (sense of career achievement), C3-1 (computer system development capabilities), and C4-2 (algorithm design and analysis capabilities). Variable work unit type have statistically significant (sig <0.05) influence on four IT undergraduate employability indicators, such as A1-1 (psychological endurance), A1-2 (professional ethics), A2-1 (sense of career achievement), and B1-1 (executive capability). Variable occupation have statistically significant (sig<0.05) influence on only one IT undergraduate employability indicator which is B2-1 (planning capability). However the partial eta squared values are all lower than 0.03, which indicates that the influences are generally small.

Form the prospective of employability indicators, 9 out of 23 indicators are influenced by the background variable, which indicates that the influence of the background variable on the opinion of importance of the IT undergraduate employability have a large scale and cannot be ignored. Four indicators are influence by more than one variables as shown in Table 4.8.

For the post hoc test, this study adopts Scheffé method and taking the results of Tukey method into consideration. The results show that:

For psychological endurance, recipients in the small size city gave higher score than the recipients in the medium size city. Recipients in the private and other types of enterprise gave higher score than the recipients in the schools and research institutes and foreign-invested enterprise.

For professional ethic, recipients in the state-owned, private and other types of enterprise gave higher score than the recipients in the schools and research institutes and foreign-invested enterprise. Recipients of professional IT technicians gave higher score than the recipients of manager.

Table 4.8 Significant main effect of the background variable on performance score

Background variable	Indicator name	F	η^2	Post hoc
City size	Psychological endurance	5.733^{*}	$.012^{\Delta}$	T3>T2
	Sense of responsibility	10.116^{***}	$.022^{\Delta}$	T3>T1 T3>T2
	Learning capability	6.691^{***}	$.014^{\Delta}$	T3>T1 T3>T2
	Creativity	9.732^{***}	$.021^{\Delta}$	T3>T1 T3>T2
	Planning capability	35.514^{***}	$.072^{\Delta\Delta}$	T1>T2 T3>T1 T3>T2
	Career planning capability	13.551^{***}	$.029^{\Delta}$	T3>T1 T3>T2
	Teamwork	7.055^{***}	$.015^{\Delta}$	T3>T2
	Cognitive and operational capability of computer components and hardware	6.972^{***}	$.015^{\Delta}$	T3>T1 T3>T2
	Cognitive and operational capability of software theory	6.056^{***}	$.013^{\Delta}$	T3>T1
	Computer system development capabilities	7.122^{***}	$.015^{\Delta}$	T3>T2
	Design capability of computer hardware	6.620^{***}	$.014^{\Delta}$	T3>T1 T3>T2
	Algorithm design and analysis capabilities	5.290^{*}	$.011^{\Delta}$	T3>T2
Work unit type	Psychological endurance	13.495^{***}	$.056^{\Delta}$	W5>W1 W3>W2 W5>W2 W3>W4 W5>W4
	Professional ethics	8.123^{***}	$.034^{\Delta}$	W1>W2 W1>W4 W3>W2 W5>W2 W3>W4 W5>W4
	Sense of responsibility	4.616^{***}	$.020^{\Delta}$	W5>W2
	Planning capability	5.471^{***}	$.023^{\Delta}$	W5>W3
	Career planning capability	5.473^{***}	$.023^{\Delta}$	W2>W1 W4>W1 W5>W1
	Algorithm design and analysis capabilities	3.689^{*}	$.016^{\Delta}$	W2>W1
Work unit size	Sense of responsibility	5.741^{*}	$.012^{\Delta}$	S1>S3
	Creativity	8.713^{***}	$.019^{\Delta}$	S1>S2, S3>S2
	Career planning capability	4.001^{*}	.009	S2>S1
Occupation	Professional ethics	3.337^{*}	.007	O2>O1

Note: 1. Background variable: T1: large size city, T2: medium size city, T3 small size city. W1: State-owned enterprises, W2: schools and research institutes, W3: Private enterprises, W4: Foreign-invested enterprise, W5: other types of enterprise. S1: large size enterprise, S2: medium size enterprise, S3: small size enterprise. O1: Managers, O2: professional IT technicians, O3: Professional IT teachers.

2. Statistical significance: *: $P<0.05$, ***: $P<0.001$

3. Effect size: Δ: Small effect, ΔΔ: Medium effect, ΔΔΔ: Large effect

For sense of responsibility, recipients in the small size city gave higher score than the recipients in the large and medium size city. Recipients in the other types of enterprise gave higher score than the recipients in the schools and research institutes. Recipients in the large scale enterprise gave higher score than the recipients in the small scale enterprise.

For learning capability, recipients in the small size city gave higher score than the recipients in the large and medium size city.

For creativity, recipients in the small size city gave higher score than the recipients in the large and medium size city. Recipients in the large and small scale of enterprise gave higher score than the recipients in the medium scale enterprise.

For planning capability, recipients in the small size city gave higher score than the recipients in the large and medium size city. Recipients in other types of enterprise gave higher score than the recipients in the private enterprise.

For career planning capability, recipients in the small size city gave higher score than the recipients in the large and medium size city. Recipients in the schools and research institutes, foreign-invested enterprise and other types of enterprise gave higher score than the recipients in the state-owned enterprise. Recipients in the medium scale enterprise gave higher score than the recipients in the large scale enterprise.

For cognitive and operational capability of computer components and hardware, recipients in the small size city gave higher score than the recipients in the large and medium size city.

For cognitive and operational capability of software theory, recipients in the small size city gave higher score than the recipients in the large size city.

For computer system development capabilities, recipients in the small size city gave higher score than the recipients in the medium size city.

For design capability of computer hardware, recipients in the small size city gave higher score than the recipients in the large and medium size city.

4.3.2 Analysis of second order interaction effect of background variable on employability performance

4.3.2.1 General analysis of second order interaction on performance

Unlike previous analysis on the influence on importance, all six sets of interaction have statistically significant influence. For the performance opinion, the combination of city size and occupation do not have statistically significant interaction effect on the performance of employability. What's more, for the combination of city size and work unit size, there are only two interaction items and their significance values are 0.037 and 0.043 which are close to the threshold 0.05. Their partial eta squared values are both 0.012 which are also relatively small. Therefore the interaction items of city size and work unit type are exclude from further analysis.

For the rest four interaction combinations, there are 39 second order interaction item of the background variable which have a statistically significant lower than 0.05. The effect sizes of all interactions are all below 0.06 and have an average of 0.023, which indicates that the effects of interactions are small. Since the partial eta values are generally larger than the main effect, the interactions of the background variable are still important. Except the city size and work unit size, the other four combinations all have a significant percentage of indicators influenced. It also worth mentioning that the group of interaction combination which have stronger interaction effect from section 4.2.2.1 also have relatively higher average partial eta squared.

Table 4.9 Significant interaction effect of background effect on performance score

Interactions	Number of influenced indicators	Average η^2	Influenced indicators
City size * Work unit size	2	0.012	A2-1, C1-1
Work unit size * Occupation	8	0.016	A1-2, A1-3, A2-1 B3-2, C1-1, C2-1, C4-2, C5-1
Work unit type * Occupation	9	0.022	A1-1, A1-2, A1-3, B1-3, B2-2, C1-1, C1-3, C2-1, C2-2
Work unit type * Work unit size	8	0.025	A1-2, B1-3, B2-1, B2-2, C2-2, C3-1, C3-2, C4-2
City size * Work unit type	12	0.026	A1-1, A1-3, A2-1, B1-1, B1-3, B2-2, B3-1, C1-1, C1-2, C3-1, C4-1, C4-2

Note: The employability indicators are A1-1: Psychological endurance, A1-2: Professional ethics, A1-3: Sense of responsibility, A2-1: Sense of career achievement, B1-1: Executive capability, B1-2: Learning capability, B1-3: Creativity, B2-1: Planning capability, B2-2: Career planning capability, B3-1: Teamwork, B3-2: Communication and coordination, B4-1: Using social relations capabilities, C1-1: Capability of computer software design and program development, C1-2: Basic design capability of computer application system, C1-3: Capability to apply computer for implementing apply system and conducting development and innovation, C2-1: Cognitive capability of basic knowledge of computer, C2-2: Cognitive and operational capability of computer components and hardware, C2-3: Cognitive and operational capability of software theory, C3-1: Computer system development capabilities, C3-2: Design capability of computer hardware, C4-1: Computational thinking and modeling capabilities, C4-2: Algorithm design and analysis capabilities, C5-1: General capability to use and maintain computer application systems. See section 3.3

From the prospective of the indicators, as shown in Table 4.9, 20 out of 23 indicators are influenced by the interaction effect of the background variable which show interaction effect is common in the employability. The employability indicator that do not affected by the interactions are B1-2 (learning capability), B4-1 (using social relations capabilities), and C2-3 (cognitive and operational capability of software theory). The numbers of interaction effects for the individual indicators are relatively balanced and the numbers are about 1 ~ 3. No indicators have particularly large or small amount of interactions. This shows that the interaction effects are quit common in performance opinion on the employability indicators, and the interactions are evenly spread across the employability structure.

The interaction graphs of second order interaction effect of back ground variables are presented in the Figure 7~11. The interaction graphs present the general tendency of the interactions. In the next section, this study will analysis the interaction items with relatively greater effect size to identify the important background variables combinations. From the interaction graphs, this study finds that the first two interactions (City size * Work unit size, Work unit size * Occupation) are relatively weaker than the later three interactions (City size * Work unit type, Work unit type * Occupation, Work unit type * Work unit size). This indicates that the background variables have more significant influence on the employability. The interaction graphs show that there is no dominating interaction pattern on the employability, however some demographic character seems to influence the employability more significantly. The detailed analysis will be presented in next section.

(a) Interaction graph for capability of computer software design and program development

(b) Interaction graph for sense of career achievement

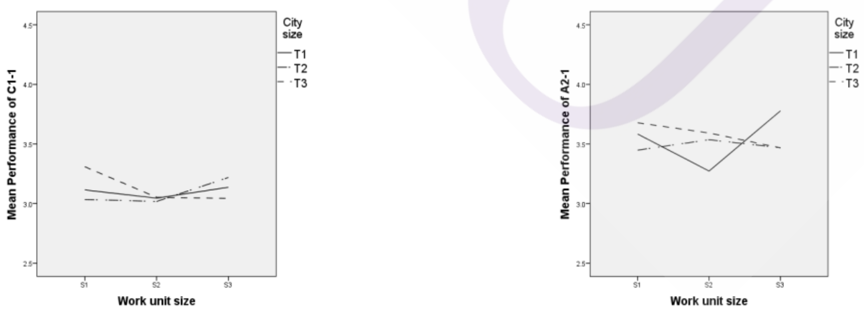
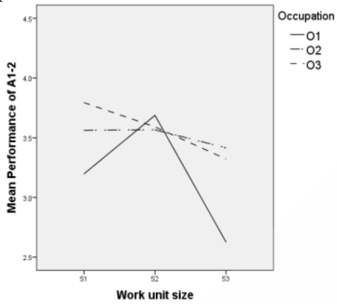
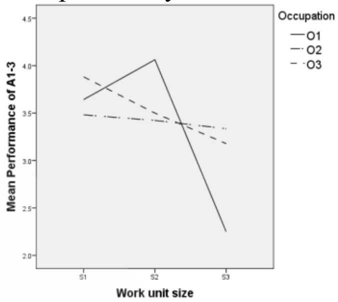


Figure 4.7 Interaction graph for background variable work unit size and city size

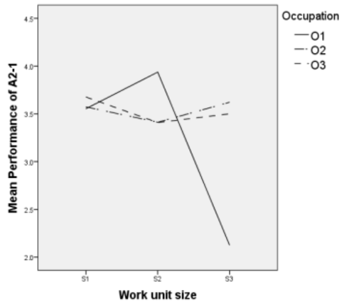
(a) Interaction graph for professional ethics



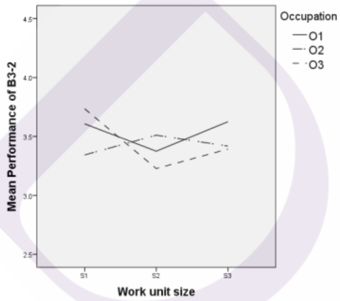
(b) Interaction graph for sense of responsibility



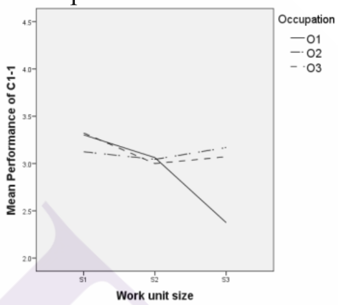
(c) Interaction graph for sense of career achievement



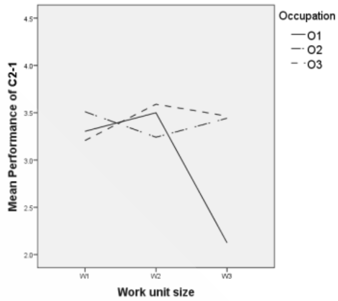
(d) Interaction graph for communication and coordination



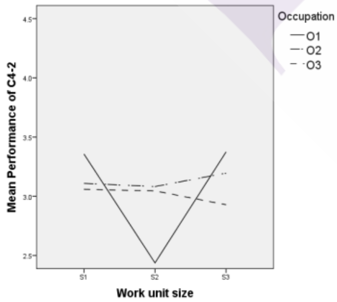
(e) Interaction graph for capability of computer software design and program development



(f) Interaction graph for cognitive capability of basic knowledge of computer



(g) Interaction graph for algorithm design and analysis capabilities



(h) Interaction graph for general capability to use and maintain computer application systems

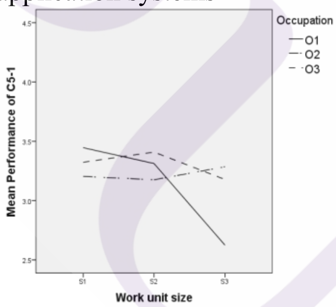
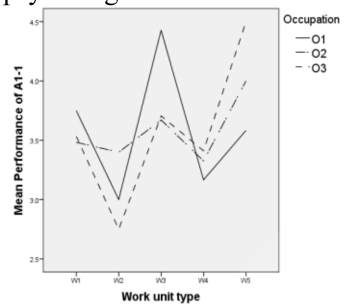
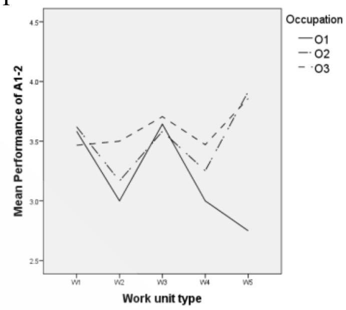


Figure 4.8 Interaction graph for background variable work unit size and occupation

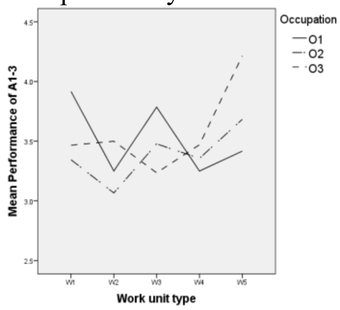
(a) Interaction graph for psychological endurance



(b) Interaction graph for professional ethics

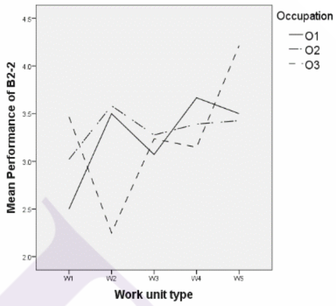


(c) Interaction graph for sense of responsibility

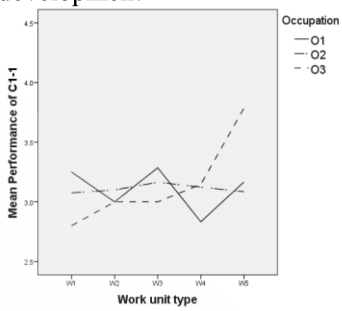


(d) Interaction graph for creativity

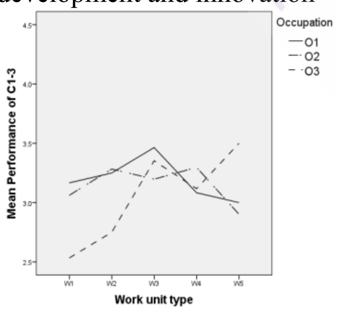
(e) Interaction graph for career planning capability



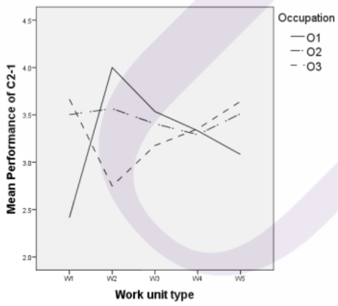
(f) Interaction graph for capability of computer software design and program development



(g) Interaction graph for capability to apply computer for implementing apply system and conducting development and innovation



(h) Interaction graph for cognitive capability of basic knowledge of computer



(i) Interaction graph for cognitive and operational capability of computer components and hardware

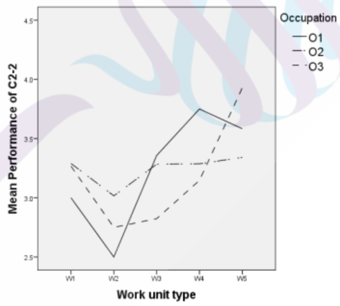
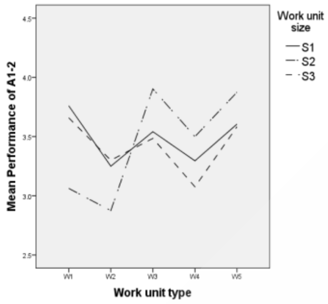
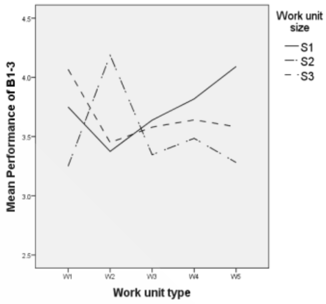


Figure 4.9 Interaction graph for background variable work unit type and occupation

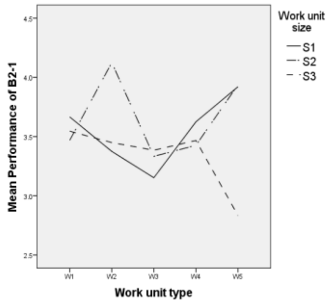
(a) Interaction graph for professional ethics



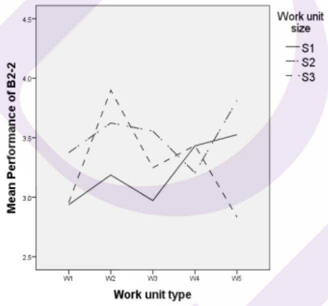
(b) Interaction graph for creativity



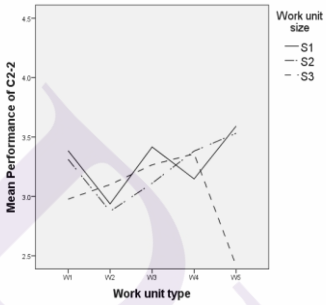
(c) Interaction graph for planning capability



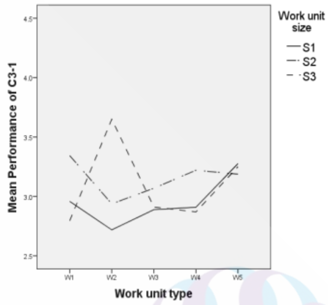
(d) Interaction graph for career planning capability



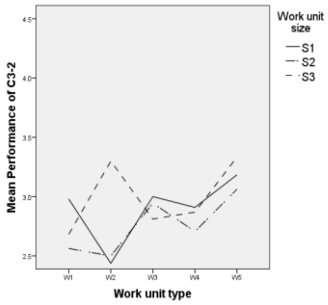
(e) Interaction graph for cognitive and operational capability of computer components and hardware



(f) Interaction graph for computer system development capabilities



(g) Interaction graph for design capability of computer hardware



(h) Interaction graph for algorithm design and analysis capabilities

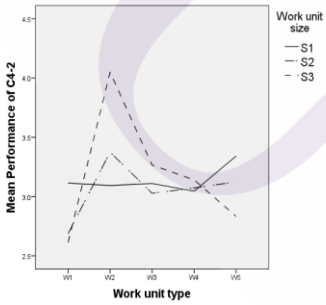
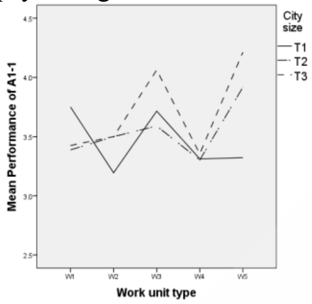
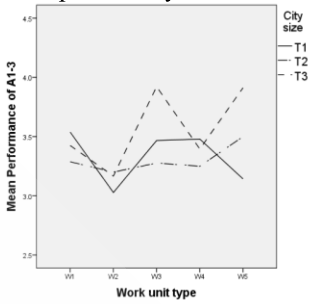


Figure 4.10 Interaction graph for background variable work unit type and work unit size

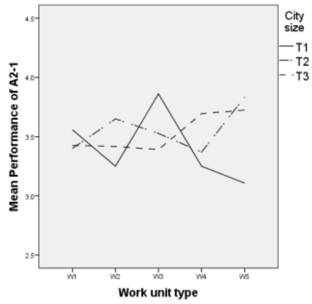
(a) Interaction graph for psychological endurance



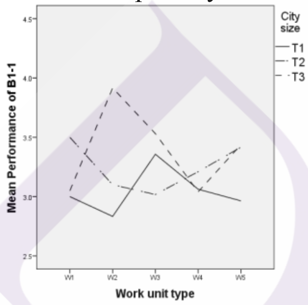
(b) Interaction graph for sense of responsibility



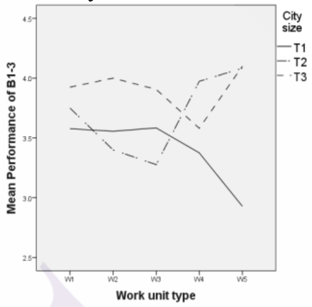
(c) Interaction graph for sense of career achievement



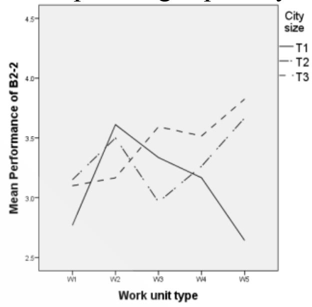
(d) Interaction graph for executive capability



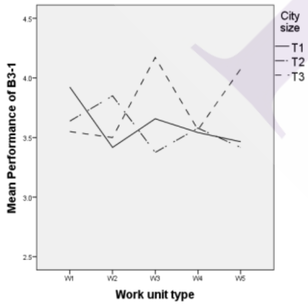
(e) Interaction graph for creativity



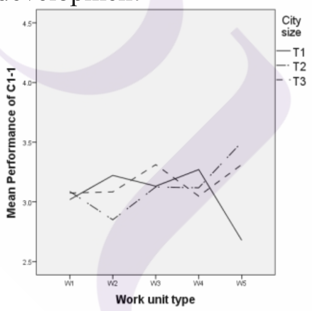
(f) Interaction graph for career planning capability



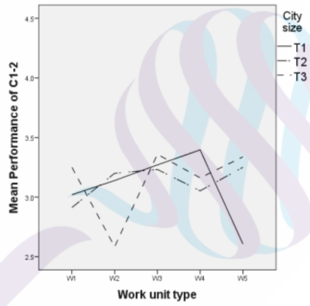
(g) Interaction graph for teamwork



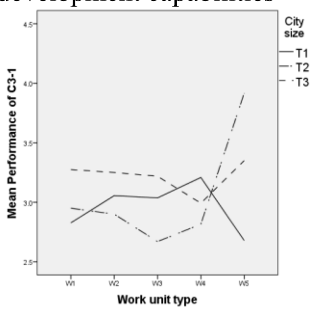
(h) Interaction graph for capability of computer software design and program development



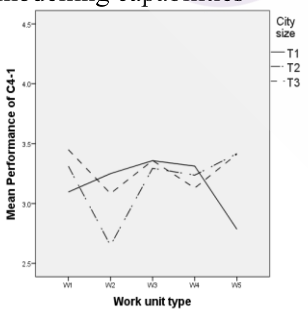
(i) Interaction graph for basic design capability of computer application system



(j) Interaction graph for computer system development capabilities



(k) Interaction graph for computational thinking and modelling capabilities



(l) Interaction graph for algorithm design and analysis capabilities

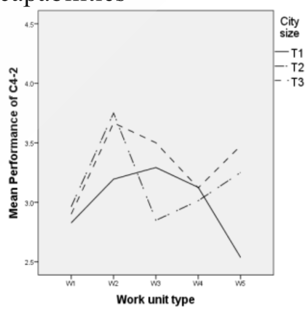


Figure 4.11 Interaction graph for background variable work unit type and city size

4.3.2.2 Analysis of top 10 second order interaction on performance

As discussed in section 4.2.2.1, the top 10 interaction items are selected for simple effect analysis based on the ranking of effect size (partial eta squared value). Those items come from two interaction combinations: city size and work unit type, work unit type and work unit size. Each of the combination has five interaction items. All of them have the background variable work unit type, which suggests that this variable is significantly influence the interaction effect on the performance of employability. The average of city size related interaction is 0.032 and the average of work unit size related interaction is 0.027.The details of the top 10 second order interaction items can be found in Table 4.10.

Table 4.10 Top 10 interaction effect items on performance score

Background variables	Indicators	F	η^2
T * W	Creativity	5.147^{***}	0.047^{Δ}
T * W	Sense of career achievement	3.342^{***}	0.031^{Δ}
S * W	Planning capability	3.295^{***}	0.031^{Δ}
T * W	Teamwork	3.112^{*}	0.029^{Δ}
S * W	Career planning capability	3.057^{*}	0.028^{Δ}
T * W	Psychological endurance	2.927^{*}	0.027^{Δ}
T * W	Capability of computer software design and program development	2.809^{*}	0.026^{Δ}
S * W	Professional ethics	2.796^{*}	0.026^{Δ}
S * W	Cognitive and operational capability of computer components and hardware	2.760^{*}	0.026^{Δ}
S * W	Creativity	2.741^{*}	0.026^{Δ}

Note: 1.Background variable: T: city size, W: work unit type, S: work unit size.
2. Statistical significance: *: P<0.05, ***: P<0.001
3. Effect size: Δ: Small effect, ΔΔ: Medium effect, ΔΔΔ: Large effect

From the prospective of the indicators, only indicator B1-3 (creativity) is influenced by two interaction, the rest of indicators have just one interaction influence in the top 10 category. Most of the effect sizes are similarly located in the small range from 0.026 to 0.031, except the influence of work unit type * city size interaction on indicator B1-3 (creativity) is at a larger level of 0.047.

Through analysis of the simple effect of the top 10 interaction items, some combinations of the background variable are found to have certain tendency in the influence level.

For interaction city size * work unit type, firstly under the condition of large size city, the recipients in private enterprise consider A1-1 (psychological endurance),A2-1 (sense of career achievement), B1-3 (creativity) to be better performed comparing to the recipients from schools and research institutes, Foreign-invested enterprises, and other types of the work unit types. Secondly, under the condition of other types of work unit, the recipients from the large city generally consider A1-1 (psychological endurance), A2-1 (sense of career achievement), B1-3 (creativity), C1-1 (capability of computer software design and program development) to be less well performed comparing to the recipients from medium and small size city. Thirdly, under the condition of small size city, the recipients from private enterprise and other types of the enterprise consider A1-1 (psychological endurance) and B3-1 (teamwork) to be better performed comparing to the recipients from state-owned enterprise and foreign-invested enterprise. Lastly, under the condition of private enterprise, the recipients from small size city consider the indicators A1-1 (psychological endurance), B1-3 (creativity), B3-1 (teamwork) to be better performed comparing to the recipients from the recipients from large size city and medium size city. The data for this simple effect analysis is shown in Table 4.11.

Table 4.11 Simple effect analysis for interaction city size * work unit type

Indicator	Variable combination1		Variable combination2		Mean Difference (1-2)	Std. Error
Sense of career achievement	**T1**	**W3**	T1	W2	.611***	.157
Sense of career achievement	**T1**	**W3**	T1	W4	.611***	.141
Sense of career achievement	**T1**	**W3**	T1	W5	.754***	.174
Psychological endurance	**T1**	**W3**	T1	W2	.521*	.172
Creativity	**T1**	**W3**	T1	W5	.655*	.202
Psychological endurance	W5	T3	**W5**	**T1**	.891***	.202
Sense of career achievement	W5	T2	**W5**	**T1**	.726*	.289
Sense of career achievement	W5	T3	**W5**	**T1**	.618*	.184
Creativity	W5	T2	**W5**	**T1**	1.155*	.336
Creativity	W5	T3	**W5**	**T1**	1.171***	.214
Capability of computer software design and program development	W5	T3	**W5**	**T1**	.634*	.224
Psychological endurance	**T3**	**W3**	T3	W1	.637*	.186
Psychological endurance	**T3**	**W3**	T3	W4	.708***	.142
Teamwork	**T3**	**W3**	T3	W1	.622*	.185
Teamwork	**T3**	**W3**	T3	W4	.607***	.141
Psychological endurance	**T3**	**W5**	T3	W1	.787***	.178
Psychological endurance	**T3**	**W5**	T3	W4	.858***	.132
Teamwork	**T3**	**W5**	T3	W1	.525*	.178
Teamwork	**T3**	**W5**	T3	W4	.510***	.132
Psychological endurance	**W3**	**T3**	W3	T1	.347*	.139
Psychological endurance	**W3**	**T3**	W3	T2	.473*	.144
Creativity	**W3**	**T3**	W3	T2	.629***	.153
Teamwork	**W3**	**T3**	W3	T1	.515***	.139
Teamwork	**W3**	**T3**	W3	T2	.797***	.144

Note: 1. Variable combination 1 have larger mean score that the variable combination2, thus the positive mean difference.

2. Background variables: T1: Large size city, T2: Medium size city, T3: Small size city, W1: State-owned enterprises, W3: Private enterprises, W4: Foreign-invested enterprises, W5: Others.

3. The attribute others in the table represents the work unit type which do not classified into the first four category, such as collective ownership company, sole proprietorship and so on.

4. Statistical significance: *: P<0.05, ***: P<0.001

For interaction city size * work unit type, like the result from section 4.2.2.1, the pattern for this background variable interaction are quite scattered. Less domination interaction effects are observed. Firstly under the condition of large-size city, the recipients from other types of work unit consider B1-3 (creativity), B2-1 (planning capability), B2-2 (career planning capability), C2-2 (cognitive and operational capability of computer components and hardware) to be better performed. Secondly, under the condition of other work unit type, the recipients from small size city consider B2-1 (planning capability), C2-2 (cognitive and operational capability of computer components and hardware) to be less well performed. The data for this simple effect analysis is shown in Table 4.12.

Table 4.12 Simple effect analysis for interaction work unit size * work unit type

Indicator	Variable combination1		Variable combination2		Mean Difference (1-2)	Std. Error
Planning capability	**S1**	**W5**	S1	W3	.768***	.172
Career planning capability	**S1**	**W5**	S1	W1	.589*	.160
Career planning capability	**S1**	**W5**	S1	W3	.554*	.171
Cognitive and operational capability of computer components and hardware	**S1**	**W5**	S1	W2	.655*	.221
Creativity	**S1**	**W5**	S1	W2	.717*	.208
Planning capability	W5	S1	**W5**	**S3**	1.088*	.325
Planning capability	W5	S2	**W5**	**S3**	1.104*	.354
Career planning capability	W5	S2	**W5**	**S3**	.979*	.352
Cognitive and operational capability of computer components and hardware	W5	S1	**W5**	**S3**	1.175***	.325
Cognitive and operational capability of computer components and hardware	W5	S2	**W5**	**S3**	1.115*	.354

Note: 1. Variable combination 1 have larger mean score that the variable combination2, thus the positive mean difference.

2. Background variables: S1: Large size enterprise, S3: Small size enterprise, W1: State-owned enterprises, W2: Schools and research institutes, W3: Private enterprises, W5: Others.

3. The attribute others in the table represents the work unit type which do not classified into the first four category, such as collective ownership company, sole proprietorship and so on.

4. Statistical significance: *: P<0.05, ***: P<0.001

4.3.3 Analysis of third order interaction effect of background variable on employability performance

Three third order interactions have influence on the performance opinion of the IT under graduate employability. Like the result from section 4.2.3, interaction city size * work unit type * work unit size have relatively strong influence effect, accounting 12 out of 18 total third order interaction. The average partial eta squared value for this interaction is 0.046 which is twice the average value of the relevant second order interaction. The other two third order interactions are relatively weak. Interaction work unite type * work unit size *occupation only have statistically significant influence on indicator C1-3 (capability to apply computer for implementing apply system and conducting development and innovation). Interaction city size * work unit type * occupation have influenced 5 indicators, however, the average partial eta squared value is only 0.021 which is quite small. While the statistical significance of interaction city size * work unit type * work unit size are all below 0.01, some of its interaction statistical significance are 0.025, 0.031, 0.033, 0.047, which is much closer to the threshold 0.05.

4.3.4 Summary

This chapter conducts the four-way ANOVA analysis with 23 dependent variable of performance opinion on IT undergraduate employability indicators. This study finds that the background variables have statistically significant influence on many opinion of employability indicator performance. However most of the main effect and interaction effect are relatively weak from the aspect of the effect size. From the main effect analysis, background variable occupation has much weaker influence on the performance opinion compare to other three background variable.

For the second order interaction analysis, the combinations of city size * occupation and city size * work unit size do not have significant influence on the performance opinion of employability. Two interaction combinations of city size * work unit type and work unit type * work unit size have relatively strong level of effects on the performance opinion. On the other hand, 20 out of 23 indicators have background variable effect, which means the interactions are quite common. No particular indicators are more significantly influenced by background variable. For the third order interaction analysis, interaction city size * work unit type * work unit size have relatively strong influence effect.

From the simple effect analysis, recipients from private enterprise in large size city consider A1-1 (psychological endurance), A2-1 (sense of career achievement), and B1-3 (creativity) as better performed. Recipients from private enterprise and other type of enterprise in small size city consider A1-1 (psychological endurance), B3-1 (teamwork) as better performed. Recipients from other types of enterprise from large size city consider A1-1 (psychological endurance), A2-1 (sense of career achievement), B1-3 (creativity), and C1-1 (capability of computer software design and program development) as less well performed. Recipients from large size other types of enterprise consider B1-3 (creativity), B2-1 (planning capability), B2-2 (career planning capability), C2-2 (cognitive and operational capability of computer components and hardware) as better performed. Recipients from small sized other types of work unit consider B2-1 (planning capability), B2-2 (career planning capability), C2-2 (cognitive and operational capability of computer components and hardware) as less well performed.

It can be conclude from the above analysis that most of the significant interaction combinations contain background variable private and other types of enterprise from work unit type. This means that those types of enterprise are more sensitive about the performance of IT undergraduate employability. This might be caused by the fact that those types of enterprise face more competition pressure, comparing to state-owned enterprise and school which receive government support and foreign-invested enterprise which is more likely to recruit high quality talents.

4.4 IPA analysis and PNI analysis of IT undergraduate employability

What is the difference in the importance and performance of IT undergraduate employability based on the perspective of business needs? What is the employability of IT undergraduate that is in urgent need of improvement? These contents have a very realistic effect on the adjustment of teaching mode and content in colleges and universities, and the clear understanding of college students' ability and reinforcing their own direction. IT undergraduate's personal quality, general capabilities, IT professional capability constitute the IT undergraduate employability factor from different aspects. Therefore, after literature analysis and importance difference analysis and performance difference analysis in the situation of various background variable, this study uses Importance-Performance Analysis to further analyse the difference between the importance degree from the enterprise demand side and the actual performance level. Paired-samples *t*-test was performed on the importance and performance of 23 factors to determine whether there was a statistical significance difference between the two ($Sig<0.05$ means significant difference). At the same time, calculate the difference (P-I) between the importance level and the performance difference, and then understand the gap between the two, and determine the employability indicators that IT undergraduate needs to improve. In addition, besides the IPA approach, PNI can sort the training needs, that is, the ability to improve. In the next section, we will use PNI to sort the employability of IT majors to identify the top 8 indicators. We compare and integrate those eight indicators with indicators obtained by IPA analysis to find the collection. Those are the IT professional undergraduate employability with the most urgent need for improvement. This section is divided into five parts. The first part is the cross-analysis of IPA importance and performance level. The second part is IPA importance-performance Partition positioning. The third part is the quadrant characteristics and analysis. The fourth part is PNI analysis of IT undergraduate employability, and lastly final analysis and comprehensive discussion.

4.4.1 Cross-analysis of IPA

According to the analysis of the importance of IT undergraduate employability, the average score of 23 employability items is between 4.331 and 3.149. The interviewed group considered that the top 10 most important items were psychological endurance (M=4.198), professional ethics (M=4.097), sense of responsibility (M=4.193), sense of career achievement (M=4.069).), executive capability (M=4.186), learning capability (M=4.266), creativity (M=4.210), planning capability (M=4.207), career planning capability (M=4.162) and teamwork (M=4.219).

Secondly, according to the performance analysis of IT undergraduate employability, the average score of 23 employability items is between 3.725 and 2.706.

The respondents considered that the top 10 performance levels include: cognitive and operational capability of software theory (M=3.725), teamwork (M=3.662), sense of career achievement (M=3.547), learning capability (M=3.526).), professional ethics (M=3.489), cognitive and operational capability of computer components and hardware (M=3.276), computing thinking and modeling capabilities (M=3.257), general capability to use and maintain computer application systems (M=3.245), executive capability (M = 3.214), cognitive capability of basic knowledge of computer (M = 3.200). The order of importance and performance of IT undergraduate employability is shown in Table 4.13.

Table 4.13 Importance ranking and performance ranking of IT under graduate employability

	Importance			Performance	
Ranking	Employability	Mean value	Ranking	Employability	Mean value
1	C2-3	4.331	1	C2-3	3.725
2	B1-2	4.266	2	B3-1	3.662
3	B3-1	4.219	3	A1-4	3.547
4	B1-3	4.21	4	B1-2	3.526
5	B2-1	4.207	5	A1-2	3.489
6	A1-1	4.198	6	C2-2	3.276
7	A1-3	4.193	7	C4-1	3.257
8	B1-1	4.186	8	C5-1	3.245
9	B3-2	4.164	9	B1-1	3.214
10	B2-2	4.162	10	C2-1	3.2
11	C4-2	4.129	11	C1-3	3.17
12	C1-1	4.119	12	C1-2	3.169
13	A1-2	4.097	13	B2-2	3.145
14	C2-1	4.093	14	A1-3	3.114
15	C4-1	4.09	15	B2-1	3.114
16	A1-4	4.069	16	B3-2	3.111
17	C5-1	3.944	17	B1-3	3.025
18	C1-2	3.857	18	C3-1	3.009
19	C1-3	3.84	19	A1-1	2.998
20	C2-2	3.826	20	C3-2	2.885
21	C3-1	3.6	21	B4-1	2.832
22	C3-2	3.357	22	C1-1	2.821
23	B4-1	3.149	23	C4-2	2.706

Note: The employability indicators are A1-1: Psychological endurance, A1-2: Professional ethics, A1-3: Sense of responsibility, A2-1: Sense of career achievement, B1-1: Executive capability, B1-2: Learning capability, B1-3: Creativity, B2-1: Planning capability, B2-2: Career planning capability, B3-1: Teamwork, B3-2: Communication and coordination, B4-1: Using social relations capabilities, C1-1: Capability of computer software design and program development, C1-2: Basic design capability of computer application system, C1-3: Capability to apply computer for implementing apply system and conducting development and innovation, C2-1: Cognitive capability of basic knowledge of computer, C2-2: Cognitive and operational capability of computer components and hardware, C2-3: Cognitive and operational capability of software theory, C3-1: Computer system development capabilities, C3-2: Design capability of computer hardware, C4-1: Computational thinking and modelling capabilities, C4-2: Algorithm design and analysis capabilities, C5-1: General capability to use and maintain computer application systems. See section 3.3

According to the above discussion and Table 4.13, in the IT undergraduate employability indicators, cognitive and operational capability of software theory, teamwork, learning capability, executive capability are the top 10 items of importance and also the top 10 items of performance levels.

However, sense of responsibility, planning capability, communication and coordination, creativity are indicators with top 10 importance, but the degree of performance are in the last 10 indicators. Cognitive and operational capability of computer components and hardware, general capability to use and maintain computer application systems, sense of career achievement, computational thinking and modeling capabilities, cognitive capability of basic knowledge of computer are the indicators with top 10 performance level, however deemed as not so important. Finally, using social relations capabilities, design capability of computer hardware, computer system development capabilities are the indicators in last 10 importance ranking, that is, less important items. Their performance level is also in the last 10 performance ranking.

Table 4.14 Significance difference in satisfaction factors

Employability indicator	Importance value	Performance value	I-P value	*t*-value	Ranking of difference
Psychological endurance	4.198	2.998	1.2	18.175***	3
Professional ethics	4.097	3.489	0.608	15.91***	16
Sense of responsibility	4.193	3.114	1.079	20.86***	6
Sense of career achievement	4.069	3.547	0.522	16.319***	21
Executive capability	4.186	3.214	0.972	19.726***	9
Learning capability	4.266	3.526	0.74	19.818***	12
Creativity	4.21	3.025	1.185	16.172***	4
Planning capability	4.207	3.114	1.093	17.628***	5
Career planning capability	4.162	3.145	1.017	21.217***	8
Teamwork	4.219	3.662	0.557	15.997***	19
Communication and coordination	4.164	3.111	1.053	21.539***	7
Using social relations capabilities	3.149	2.832	0.317	12.764***	23
Cognitive capability of basic knowledge of computer	4.093	3.2	0.893	19.942***	10
Cognitive and operational capability of computer components and hardware	3.826	3.276	0.55	15.945***	20
Cognitive and operational capability of software theory	4.331	3.725	0.606	18.549***	17
Computational thinking and modeling capabilities	4.09	3.257	0.833	17.828***	11
Algorithm design and analysis capabilities	4.129	2.706	1.423	21.091***	1
Capability of computer software design and program development	4.119	2.821	1.298	20.903***	2
Basic design capability of computer application system	3.857	3.169	0.688	20.881***	14
Capability to apply computer for implementing apply system and conducting development and innovation	3.84	3.17	0.67	18.579***	15
Computer system development capabilities	3.6	3.009	0.591	15.894***	18
Design capability of computer hardware	3.357	2.885	0.472	11.539***	22
General capability to use and maintain computer application systems	3.944	3.245	0.699	20.181***	13
Mean	4.013	3.184	0.829	18.15***	None

Note: 1. Statistical significance: ***: P < 0.001

Table 4.14 shows the importance of 23 employability and the performance of the mean, difference, *t*-value and two-tailed significant probability. The results showed that under the 95% confidence interval, the two-tailed significance probabilities of the 23 factors were all less than 0.05, indicating that there is a statistically significant correlation between these factors, there are significant differences, which are suitable for IPA analysis. In addition, from the results, it is found that the difference of all 23 factors is positive, indicating that the performance of the 23 demand factors of the enterprise demand side is lower than the expected value. From the results of performance (satisfaction) results, the average of the 23 evaluation factors was between 2.706 and 3.725, with a total average of 3.184. It shows that the employability of IT major student can basically meet the needs of enterprises and their own expectations, but there is still room for improvement.

According to table 4.14, the top 5 items with largest absolute value of the difference between the importance level and the performance level are: algorithm design and analysis capabilities (1.423); capability of computer software design and program development (1.298); psychological endurance (1.2); creativity (1.185); planning capability (1.093). The top 5 items with smallest absolute value of the difference between the importance level and the performance level are using social relations capabilities (0.317); design capability of computer hardware (0.472); sense of career achievement (0.522); cognitive and operational capability of computer components and hardware (0.55); teamwork (0.557). And the test results are verified by paired samples t, all items have statistical significance differences. The absolute value of the difference between the importance level and the performance level is not effective indicator for the employability with most urgent need of improvement. For example, algorithm design and analysis capabilities (｜4.129-2.706｜=1.423), which is of high importance but low level of performance; using social relations capabilities (｜3.149-2.832｜=0.317), low importance, but high performance. Therefore, which IT undergraduate employability are the one with the most urgent need of improvement is left to next section.

4.4.2 Partition positioning of IPA

Importance-Performance Analysis use the importance of IT undergraduate employability as the X-axis and the performance IT undergraduate employability as the Y-axis. Then using on the average of the importance from the subject's evaluation of IT undergraduate employability as well as the average of the degree of performance as the separation points, a cross-matrix diagram of the "important-performance" is constructed and forming the four quadrants to measure the difference between importance and performance.

From importance analysis, it can be concluded that the importance of the employability of IT major graduate has an average of 4.013, and the average performance is 3.184. These two averages are the basis for dividing the IPA quadrant. Influential factors greater than 4.013 and performance factors greater than 3.184 were included in the keeping quadrant. Influencing factors less than 4.013 in importance and 3.184 in performance are included in the over supplying quadrant. Influencing factors less than 4.013 in importance and less than 3.184 in performance were included in the low priority quadrant. Influential factors greater than 4.013 and performance criteria of less than 3.184 were included in the high priority quadrant. Thus, the 23 variables are divided into 4 types—dominant variables, holding variables, weak variables, and improving variable. The IPA matrix is shown as Figure 4.12 and their distribution is shown in Table 4.15.

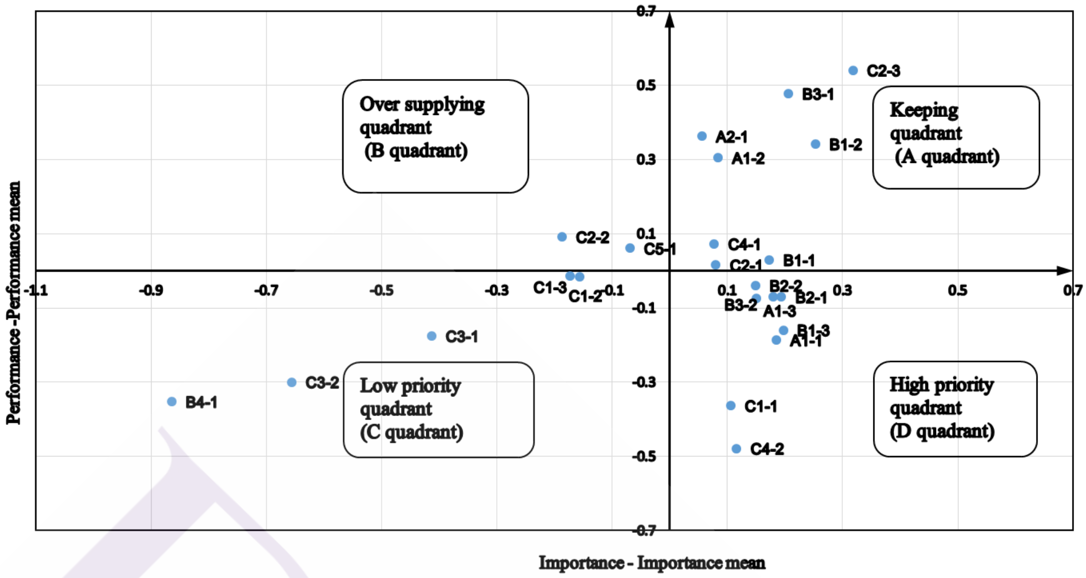


Figure 4.12 IPA matrix

Table 4.15 Indicator distribution of each quadrant

Quadrant	IT undergraduate employability indicator number	Number of indicators	Ratio distribution
Keeping	A1-2, A2-1, B1-1, B1-2, B3-1, C1-1, C1-3, C2-1	8	34.78%
Over supplying	C1-2, C5-1	2	8.70%
Low priority	B4-1, C3-1, C3-2, C4-1, C4-2	5	21.74%
High priority	A1-1, A1-3, B1-3, B2-1, B2-2, B3-2, C2-2, C2-3	8	34.78%

Note: The employability indicators are A1-1: Psychological endurance, A1-2: Professional ethics, A1-3: Sense of responsibility, A2-1: Sense of career achievement, B1-1: Executive capability, B1-2: Learning capability, B1-3: Creativity, B2-1: Planning capability, B2-2: Career planning capability, B3-1: Teamwork, B3-2: Communication and coordination, B4-1: Using social relations capabilities, C1-1: Capability of computer software design and program development, C1-2: Basic design capability of computer application system, C1-3: Capability to apply computer for implementing apply system and conducting development and innovation, C2-1: Cognitive capability of basic knowledge of computer, C2-2: Cognitive and operational capability of computer components and hardware, C2-3: Cognitive and operational capability of software theory, C3-1: Computer system development capabilities, C3-2: Design capability of computer hardware, C4-1: Computational thinking and modeling capabilities, C4-2: Algorithm design and analysis capabilities, C5-1: General capability to use and maintain computer application systems. See section 3.3

4.4.3 IPA analysis based on quadrant characteristics

With the partition positioning method of IPA, the employability indicators are located in the four quadrant of the IPA two-dimension matrix. Each quadrant of the matrix represent the different property of those employability indicators. There are eight indicators in the keeping quadrant, which means that the current status of those indicators are satisfying, thus those indicators do not require resource and attention for additional improvement. There are two indicators in the over supplying quadrant, which means that the performance of those indicators exceed the requirement of IT industry, thus those indicators do not require more investment and some of the resource of those indicators can be allocated to indicators with higher improvement priority. There are five indicators in the low priority quadrant, which means that those indicators' low level of performance match the low level of importance, therefore those indicators do not have urgent requirement of improvement and can be improved after the high priority indicators. There are eight indicators in the high priority quadrant, which means that those indicators' performance are not satisfying for their importance, therefore additional resource and attentions need to be allocated to those indicator to improve the overall IT undergraduate employability. The following sections will present the detailed analysis for each quadrant.

(1) Keeping Quadrant (A quadrant)

It can be seen that the keeping quadrant is a high importance and high-performance quadrant of the employability. The eight factors in the keeping quadrant play an important role in improving the satisfaction of the demand side of the enterprise. At the same time, its performance basically meets the expectations of the demand side of the enterprise. Since those indicators already meet the requirement of the demand side, further improving those indicators may not bring significant improvement of overall employability. However it is important to maintain the current investment for those indicators to keep the employability at suitable level.

From a practical point of view, computational thinking is a method of solving problems, designing systems, and understanding human behavior using the basic concepts of computer science, covering a series of thinking activities in computer science. For those engaged in computer science learning and applied to research, computational thinking ability is one of the necessary scientific literacy for computer professionals, and it is also one of the first conditions for innovative talents. Abstract modeling capabilities are an important part of computational thinking. Modeling languages and tools vary from field to field. Mathematical knowledge and its classical models are important foundations for solving continuous-domain problems. Formal languages and automata are important tools for solving discrete-domain problems. For the new system platform, new tool environment, new technical specifications, new ideas and methods, we can grasp the essence of development from the aspects of operational architecture, framework tools, solution strategies and thinking paradigms, and lay the foundation for adapting to the development of information technology. Therefore, the computational thinking and modeling capability is highly valued by the demand side of the enterprise, and the computational thinking and modeling capability of the IT major student are also recognized to some extent.

In addition, the computer principle recognition and operation ability are the basis of the professional quality and learning capability of computer hardware and software. Therefore, the demand side of the enterprise pays great attention to this ability. In addition, the demand side of the enterprise has higher and higher requirements for team leadership, development ability and professional ethics.

From the results of paired comparison, some factors' performance values are still different from its expected value. Those factors are the company's professional ethics (*t*-test=15.910, two-tailed p=0.000<0.05), career achievement (*t*-test=16.319, two-tailed p=0.000<0.05), learning capability (*t*-test=19.818, double Tail p=0.000<0.05), teamwork ability (*t*-test=15.997, two-tailed p=0.000<0.05), executive capability (*t*-test=26.834, two-tailed p=0.000<0.05), computer basic knowledge cognitive capability (*t*-test=25.991, two-tailed p=0.000<0.05), cognitive and operational capability of software theory (*t*-test=18.549, two-tailed p=0.000<0.05), computational thinking and modeling capability (*t*-test=23.302, two-tailed p=0.000 the actual evaluation of <0.05). There is still room for improvement in the above eight competencies.

(2) Over Supplying Quadrant (B quadrant)

The over supplying quadrant is a low-importance, high-performance quadrant of employability. Located in the area is the factor that is more satisfactory to the demand side of the enterprise, but does not have much importance paid attention to it. As shown in Figure 4.12, there are two element indicators in the over supplying quadrant of the IPA diagram, which are Cognitive and operational capability of computer components and hardware, and General capability to use and maintain computer application systems in the "IT professional ability" element group. From the results of the pairing comparison, the *t*-values of those factors are 15.945 and 20.181, respectively, and the two-tailed p value are both 0.00<0.05.

The results of over supplying quadrant shows that computer-based college students have a good computer composition principle and hardware cognitive and operational capabilities, the general capability to use and maintain computer application systems have been affirmed by the enterprise demand side. At the same time, the enterprises on demand side can explore the potential of the above-mentioned factors for further optimizing, so that these aspects can be further transformed into the competitive advantage of the employment ability of IT major student.

(3) Low Priority quadrant (C quadrant)

The low priority quadrant is a region with relatively low importance and satisfaction. The elements distributed in the region are low priority and need no key development. However, it is not completely unnecessary to be considered, but the demand side of the enterprise does not have high expectations for the above factors temporarily, and there is no need to give priority for their development. As shown in Figure 4.12, the five element indicators in the low priority quadrant are computer system development capabilities (*t*-test=15.894, two-tailed p=0.000<0.05), the design capabilities of computer hardware(*t*-test=11.539, two-tailed p=0.000<0.05), basic design capability of computer application system (*t*-test=20.881, two-tailed p=0.000<0.05), and general capability to use and maintain computer application systems (*t*-test=18.579) , two-tailed p=0.000<0.05) in the “IT professional capability” element group), using social relations capability (*t*-test=8.842, two-tailed p= 0.000 < 0.05) in the "general capability" element group.

The performance of the indicator in this quadrant is low, therefore investing resource in those indicators could improve the IT undergraduate employability. However the importance of those indicators is also quite low, which indicates that the demand side of the employment market do not have high requirements for those indicators. Therefore the investment in improving the indicators in this quadrant may not bring significant improvement of overall employability and those indicators are classified with low improvement priority. Since the indicators in this quadrant have lower priority, it is advised to first improve the indicators with high priority and then improve the indicators in this quadrant.

(4) High priority quadrant

The high priority quadrant is a region of high importance but low satisfaction. The elements of this quadrant represent the high expectations of the demand side of the enterprise, but are not satisfied with the performance of the employer's employability. There are eight elements in high priority quadrant. Those eight factors include Algorithm design and analysis capabilities (t-test=36.989,two tail value $p=0.000<0.05$), Ability of computer software design and program development (t-test=28.334,two tail value $p=0.000<0.05$) in the "IT professional ability" element group, creativity(t-test=29.325, two tail value $p=0.000<0.05$), career planning capability(t-test=27.577, two tail value $p=0.000<0.05$), planning capability (t-test=29.006, two tail value $p=0.000<0.05$), communication and coordination(t-test=32.025,two tail value $p=0.000<0.05$) in the "general capability" element group, sense of responsibility (t-test=33.543, two tail value $p=0.000<0.05$), pressure resistance (t-test=30.546, two tail value $p=0.000<0.05$) in the "personal quality" element group.

From the comparison results, the evaluation of above eight factors from the demand side of the enterprise is significantly lower than its expected value. The average difference between the importance and performance of the above eight factors located in the region is 1.169, which is far greater than the mean difference between importance and satisfaction of 0.829. This reflects a large gap between the above eight abilities of computer science students and the requirements of corporate positions.

For the employability indicators in the high priority quadrant, all relevant party should invest more resource in those employability indicators. Those indicators are the weak point of IT undergraduate employability, and their improvement could significantly improve the overall employability. The investment of those employability should not only include hardware or software investment, but also includes policy reform of current education curriculum. Two of those indicators are IT professional capability which is the core skill set of the IT undergraduate, therefore the analysis result shows that the current IT education system has weak point. Further studies are required for those two employability indicators to recommend suitable improvement of current IT education system.

4.4.4 PNI analysis

With IPA method, this study classifies the employability indicators into four groups with different priority. However the more detailed information about the priority within the same group is still not clear. In order to further analysis the improvement priority, this study use PNI analysis. PNI score was calculated using the subject’s "IT undergraduate employability" by importance mean * (importance mean - performance level mean). Sorting the scores from high to low, the higher the score indicates the higher the urgency of the employee’s need to improve; the lower the score, the lower the urgency that this employability needs to be improved. In this way, IT undergraduate employability can be prioritized to provide a basis for improving IT undergraduate employability in the future. After analysis, the IT undergraduate employability PNI value and the promotion priority ranking based on the enterprise perspective are as follows (Table 4.16)

From Table 4.16, the PNI value of employability, the ranking of improvement priority, the employability needed the improvement the most can be derived. algorithm design and analysis capabilities, skills of analyze, capability of computer software design and program development, psychological endurance, creativity, planning capability, sense of responsibility, communication and coordination, career planning capability are the employability indicators that urgently require the improvement from PNI analysis.

Those indicators are compared and integrated with the eight employability indicators from the D Quadrant IPA analysis to form the final version of employability indicators that urgently require the improvement. The study used two different analysis methods. On the one hand, the IPA method was used to measure the eight employability indicators that IT majors urgently need to upgrade. On the other hand, the top 8 employability of the IT professional undergraduate employability measured by PNI need to be improved. PNI also provides the priority and order of these capabilities, as shown in Table 4.16.

Table 4.16 IT undergraduate employability PNI value

No.	Indicators	Importance value	performance value	I-P value	PNI value	*t*-value
1	Algorithm design and analysis capabilities	4.129	2.706	1.423	5.876	21.091***
2	Capability of computer software design and program development	4.119	2.821	1.298	5.346	20.903***
3	Psychological endurance	4.198	2.998	1.2	5.038	18.175***
4	Creativity	4.210	3.025	1.185	4.989	16.172***
5	Planning capability	4.207	3.114	1.093	4.598	17.628***
6	Sense of responsibility	4.193	3.114	1.079	4.524	20.860***
7	Communication and coordination	4.164	3.111	1.053	4.385	21.539***
8	Career planning capability	4.162	3.145	1.017	4.233	21.217***
9	Executive capability	4.186	3.214	0.972	4.069	19.726***
10	Cognitive capability of basic knowledge of computer	4.093	3.200	0.893	3.655	19.942***
11	Computational thinking and modeling capabilities	4.090	3.257	0.833	3.407	17.828***
12	Learning capability	4.266	3.526	0.74	3.157	19.818***
13	General capability to use and maintain computer application systems	3.944	3.245	0.699	2.757	20.181***
14	Basic design capability of computer application system	3.857	3.169	0.688	2.654	20.881***
15	Cognitive and operational capability of software theory	4.331	3.725	0.606	2.625	18.549***
16	Capability to apply computer for implementing apply system and conducting development and innovation	3.840	3.170	0.67	2.573	18.579***
17	Professional ethics	4.097	3.489	0.608	2.491	15.910***
18	Teamwork	4.219	3.662	0.557	2.350	15.997***
19	Computer system development capabilities	3.600	3.009	0.591	2.128	15.894***
20	Sense of career achievement	4.069	3.547	0.522	2.124	16.319***
21	Cognitive and operational capability of computer components and hardware	3.826	3.276	0.55	2.104	15.945***
22	Design capability of computer hardware	3.357	2.885	0.472	1.585	11.539***
23	Using social relations capabilities	3.149	2.832	0.317	0.998	12.764***

From the PNI analysis, the top 8 ranking indicators are algorithm design and analysis capabilities, capability of computer software design and program development, psychological endurance, creativity, planning capability, sense of responsibility, communication and coordination, and career planning capability. According to the ranking results of IT undergraduate employability from PNI analysis, universities can differentiate the priority of IT undergraduate employability for improvement training needs, so as to establish an effective training system under the condition of limited resources, which is conducive to the management of IT majors in colleges and universities, can further improve the IT undergraduate employability, and can improve the quality of employment and the efficiency of training.

4.4.5 Summary

This section first uses the IPA to conduct a cross-analysis of the degree of importance and performance and classify the indicators into four group. Then this study use PNI analysis to obtain the priority ranking of all indicators. Combining the result of IPA and PNI analysis, this study not only decides whether the indictors require improvement, but also identify the degree of urgency for the improvement. Using both method on the employability improvement analysis to obtain comprehensive information is a significant contribution of this study.

Table 4.17 Compare the results from IPA and PNI analysis

Quadrant	Indicators	PNI value	PNI ranking
Keeping quadrant	executive capability	4.069	9
Keeping quadrant	cognitive capability of basic knowledge of computer	3.655	10
Keeping quadrant	computational thinking and modeling capabilities	3.407	11
Keeping quadrant	learning capability	3.157	12
Keeping quadrant	cognitive and operational capability of software theory	2.625	15
Keeping quadrant	professional ethics	2.491	17
Keeping quadrant	teamwork	2.35	18
Keeping quadrant	sense of career achievement	2.124	20
Over supplying quadrant	general capability to use and maintain computer application systems	2.757	13
Over supplying quadrant	cognitive and operational capability of computer components and hardware	2.104	21
Low priority quadrant	basic design capability of computer application system	2.654	14
Low priority quadrant	capability to apply computer for implementing apply system and conducting development and innovation	2.573	16
Low priority quadrant	computer system development capabilities	2.128	19
Low priority quadrant	design capability of computer hardware	1.585	22
Low priority quadrant	using social relations capabilities	0.998	23
High priority quadrant	algorithm design and analysis capabilities	5.876	1
High priority quadrant	capability of computer software design and program development	5.346	2
High priority quadrant	psychological endurance	5.038	3
High priority quadrant	creativity	4.989	4
High priority quadrant	planning capability	4.598	5
High priority quadrant	sense of responsibility	4.524	6
High priority quadrant	communication and coordination	4.385	7
High priority quadrant	career planning capability	4.233	8

Keeping quadrant is the quadrant indicates high degree of importance and high degree of performance for IT professional undergraduate employability. The subject considered that the IT undergraduate employability in this quadrant performed well and was a "successful learning" items. Eight employability in the keeping quadrant of IPA figure are listed as follow. Three indicators: cognitive capability of basic knowledge of computer, cognitive and operational capability of software theory, computational thinking and modeling capabilities from class “IT professional capability”. Three indicators: learning capability, teamwork, and executive capability from class “general capabilities”. Two indicators: professional ethics and sense of career achievement from class “personal quality”.

Over supplying quadrant is the quadrant indicates low degree of importance and high degree of performance for IT professional undergraduate employability. The subject considered that the IT undergraduate employability in this quadrant is enough and is "over invested" items. Two employability in the over supplying quadrant of IPA figure are listed as follow. Two indicators: cognitive and operational capability of computer components and hardware, general capability to use and maintain computer application systems from class “IT professional capability”.

Low priority quadrant is the quadrant indicates low degree of importance and low degree of performance for IT professional undergraduate employability. The subject considered that the IT undergraduate employability in this quadrant as less important and is a "secondary importance" items. Five employability in the low priority quadrant of IPA figure are listed as follow. Four indicators: computer system development capabilities, design capability of computer hardware, basic design capability of computer application system, capability to apply computer for implementing apply system and conducting development and innovation from class “IT professional capability”. One indicator: using social relations capabilities from class “general capabilities”.

High priority quadrant is the quadrant indicates high degree of importance and low degree of performance for IT professional undergraduate employability. The subject considered that the IT undergraduate employability in this quadrant as below the expectation and is an "improvement needed" item. The elements of this quadrant characterize the high expectations of the firm’s demand side, but with unsatisfying degree of employability performance. Eight employability in the high priority quadrant of IPA figure are listed as follow. Two indicators: algorithm design and analysis capabilities, capability of computer software design and program development from class “IT professional capability”. Four indicators: creativity, career planning capability, planning capability, communication and coordination from class “general capabilities”. Two indicators: sense of responsibility, psychological endurance from class “personal quality”.

What’s more, this study us PNI method to rank the priority of each IT undergraduate employability. From the PNI analysis, the top 8 ranking indicators are algorithm design and analysis capabilities, capability of computer software design and program development, psychological endurance, creativity, planning capability, sense of responsibility, communication and coordination, and career planning capability.

The top 8 employability indicators from PNI analysis and employability indicators from D Quadrant of IPA analysis are compared and integrated to form the final version of employability indicators that urgently require the improvement. The study used two different analysis methods. On the one hand, the IPA method was used to measure the eight employability indicators that IT majors urgently need to upgrade. On the other hand, the top 8 employability of the IT professional undergraduate employability measured by PNI need to be improved. The indicators selected by two methods are identical, and PNI also provides the priority and order of these capabilities. Because the indicator with highest and second highest PNI are all from IT professional capabilities, this study concludes that IT professional education system have significant weak point. It is important for all relevant party to increase the investment of IT professional education and conduct meaningful reform. This is a significant contribution of this study.

5. CONCLUSION

This study develops a structural IT undergraduate employability system and evaluates current status of Chinese IT undergraduate employability. Chapter1 introduces the background of the study, the research purposes and the research questions. Chapter2 reviews and analyses current studies on the topic of IT undergraduate employment, employability structure and related capability and competency theories to preliminarily develop an IT undergraduate employability structure. Chapter3 contains several parts, including: describing the research methods, presenting the focus group interview for the final employability structure, conducting small scale questionnaire for the reliability and validity test, and describing details of final questionnaire. Chapter3 concludes the qualitative research of developing the It undergraduate employability structure and starts the quantitative study of evaluating the current employability status. Chapter4 presents the analysis details and results. The general tendency of importance and performance scores is evaluated with statistical analysis. The influences of background variables and their interactions are analysed with four-way ANOVA. Lastly, the IPA and PNI analysis are conducted to prioritize the employability improvement demands.

This chapter concludes the study. Firstly, the answers for the research questions of this study will first be introduced and the main finding will be discussed. Secondly, this study also provides recommendations for improving the IT undergraduate employability based on the research findings. Then, the next section will discuss the theoretical and practical contributions of this study. Finally the limitations and future study planning are presented.

5.1 Conclusions of research questions and discussions

5.1.1 What is the structure of IT students' employability?

This study develops the structural IT undergraduate employability system through qualitative study and validation. The IT student employability system consists of three dimensions: personal quality, general capability, and IT professional capability. Those three dimensions represent the fundamental aspects of the employability and are defined on the basis of reviewing the current employability model. Under those three dimensions, this study summaries 11 second-level indicators and 23 third-level indicators. The IT undergraduate employability structure is presented in the table 5.1. Those indicators explain and extend the definitions of first three dimensions and provide detailed information. The second level indicators present the structure of employability system and organize the third-level indicators for easy understanding and application. What's more, the third-level indicators can be used as quantitative indicators for further study as the empirical study in this study

Table 5.1 IT undergraduate employability system

First level indicator		Second level indicator		Third level indicator	
Personal quality	A	Values and endurance	A1	Psychological endurance	A1-1
				Professional ethics	A1-2
				Sense of responsibility	A1-3
		Sense of career achievement	A2	Sense of career achievement	A2-1
General capability	B	Capability of developing	B1	Executive capability	B1-1
				Learning capability	B1-2
				Creativity	B1-3
		Planning and career planning capability	B2	Planning capability	B2-1
				Career planning capability	B2-2
		Team leadership	B3	Teamwork	B3-1
				Communication and coordination	B3-2
		Using social relations capabilities	B4	Using social relations capabilities	B4-1
IT professional capability	C	Design and develop capability of computer software system	C1	Capability of computer software design and program development	C1-1
				Basic design capability of computer application system	C1-2
				Capability to apply computer for implementing apply system and conducting development and innovation	C1-3
		Cognitive and operational capability of computer principle	C2	Cognitive capability of basic knowledge of computer	C2-1
				Cognitive and operational capability of computer components and hardware	C2-2
				Cognitive and operational capability of software theory	C2-3
		Computer hardware systems design and development capabilities	C3	Computer system development capabilities	C3-1
				Design capability of computer hardware	C3-2
		Computational thinking, modeling and algorithm capabilities	C4	Computational thinking and modeling capabilities	C4-1
				Algorithm design and analysis capabilities	C4-2
		General capabilities to use and maintain computer applications	C5	General capability to use and maintain computer application systems	C5-1

Personal quality, in many literatures, is also called personal characteristics and attitudes, personal attributes and so on. The IT undergraduate with strong internal drive, better motivation, and high emotional intelligence have better chance to obtain employment and succeed in the future. Based on the assessment of IT industry demand, those employability indicators of personal quality are psychological endurance, professional ethics, sense of responsibility, and sense of career achievement.

Generic Skills is often referred to in many literatures as Keys kills, Cores kills, employability skills, transferable skills. General skills are those that apply to any major, and are skills that can be transferred in different contexts, and it refers to the capability of transferring in learning and work. Based on the assessment of IT industry demand, those employability indicators of general capability are executive capability, learning capability, creativity, planning capability, career planning capability, teamwork, communication and coordination, and using social relations capabilities.

IT professional ability is the most important core competence of applied IT talents. The developing of IT professional competence indicators reflects professional cognition, practical ability, the thinking characteristics, and learning style of IT students. From the perspective of the employer, they most likely evaluate the students by how well they complete their degree and the entrepreneurial activities are most likely consistent with or related to their majors. Based on the assessment of IT industry demand, those employability indicators of IT professional capability are capability of computer software design and program development, basic design capability of computer application system, capability to apply computer for implementing apply system and conducting development and innovation, cognitive capability of basic knowledge of computer, cognitive and operational capability of computer components and hardware, cognitive and operational capability of software theory, computer system development capabilities, design capability of computer hardware, computational thinking and modeling capabilities, algorithm design and analysis capabilities, and general capability to use and maintain computer application systems.

Discussion:

(1) The developed IT undergraduate employability system comprehensively presents the characteristics of employability requirement. This study adopts the multi-dimensional model from the current study of the employability (Hillage & Pollard 1998; Yorke & Knight 2004; Ruth 2009). On the basis of current study, this study develops and summarises more sub-dimensional factors. For example, many researchers emphasis the emotional intelligence is the key aspect of the personal quality (Mayer et al., 2004; McMahon et al., 2003; Shen 2009).

This study adds sense of achievement to the personal quality to represent the motivation aspect of the students. ACM/IEEE-CS IT Curricula (2017) propose several aspects of IT professional capability and this study summaries and integrates those aspects according to classification of design and develop and classification of software and hardware. Comparing to the statement from IEET CAC (2016), this study adds the computer principle recognition, operational capability, computational thinking, modeling and algorithm capabilities to better present the professional characteristics of IT disciplines and the requirements of IT industry development.

(2) The developed IT undergraduate employability system reflect the demands of IT industry. Firstly, in the developing phase of the employability system, this study takes the demands of industry into account and focus on the studies that discuss employability in the context of industry. This study also select IT industry participants for a large percentage of the questionnaire to ensure that the study reflect the need of IT industry. Secondly, this study considers practical capability as an important aspects of the employability system. Many researchers agree that current education system do not cultivate enough practical capability (Crawley et al., 2014; Dacko, 2006; York, 2006). While this study emphasizes the IT professional knowledge, this study lists many practical capabilities such as capability to apply computer for implementing apply system and conducting development and innovation, and General capability to use and maintain computer application systems. Thirdly, this study also selects indicators that are demanded by the IT industry but are not cultivated by current education system. The using social relations capabilities are essential for the students to gain social support and succeed in the future challenge, however it is not valued in the education system. While many education institutions provide support for career planning capability, it is not a focus area for the IT students. Adding career planning capability into the employability could match the requirement of IT industry for long-term development and employee motivation.

5.1.2 What are the opinions of corporate IT practitioners on the importance and performance of IT undergraduate employability?

Through analysis of the statistics of the importance score and performance score, this study finds that significant gap exist between the general performance of IT undergraduate and the requirement of IT industry. Therefore the performance of IT undergraduates needs to be improved. This is because that the total average score of the performance of employability indicators is lower than the total average score of the importance score.

According to the survey results on the importance of IT graduate employability, the average scores of each of 23 indicators are between 4.331 and 3.149. The total average score is 4.013, which is higher than the "important" score of four. This result shows that subjects' views of IT graduate employability are generally important. According to the subjects of the survey, the top ten most important employability indicators are: psychological endurance (M=4.198), professional ethics (M=4.097), sense of responsibility (M=4.193), sense of career achievement (M=4.069), executive capability (M=4.186), learning capability (M=4.266), creativity (M=4.210), planning capability (M=4.207), career planning capability (M=4.162), and teamwork (M=4.219). According to statistics, among the employability indicators that the recipients found to be less important, the average scores are also at least 3.1 points. This statistics shows that most of the employability capability in this category is still important, however they are not as important as the other employability.

According to the survey results on the performance of IT graduate employability, the average scores of each of 23 indicators are between 3.725 and 2.706. According to the results of the survey, the top ten best performed employability indicators are: cognitive and operational capability of software theory (M=3.725), teamwork (M=3.662), sense of career achievement (M=3.547), learning capability (M=3.526), professional ethics (M=3.489), cognitive and operational capability of computer components and hardware (M=3.276), computational thinking and modeling capabilities (M=3.257), general capability to use and maintain computer application systems (M=3.245), executive capability (M=3.214), cognitive capability of basic knowledge of computer (M=3.200). Generally speaking, the respondents believe that the degree of performance of It graduate employability is generally low, mainly because the opinions of most of the respondents tend to be “very poor”, “poor” and “general”. This study believes that the ability of university education is not enough to prepare the graduate to face the challenges of the workplace, and that there is a considerable gap between students’ capability and workplace requirement.

(1)Discussion of importance opinion:

The importance opinion ranking of employability indicators is consistent with the current viewpoint that the employability is a comprehensive series of skill, knowledge and personality (Hu, 2015; Wang, 2017; & Yorke, 2006). The IT undergraduate employability indicators with the importance ranking above the average include employability indicators from all three dimensions of employability: personal quality, general capability and IT professional capability. This indicates that the recipients from IT industry not only value the undergraduate with adequate professional skills, but also have a high demand of the talents with comprehensive skill sets. The importance opinion ranking also proves the common viewpoints that the IT industry demand IT undergraduate student with practical skills (Dacko, 2006; Hui, 2008). The employability indicators that are considered as practical from the focus group interview generally received high importance ranking.

However, although IT professional capability is considered as core capability of IT undergraduates, the overall importance score IT professional capability is lower than the overall score of personal quality and general capability. Six indicators from IT professional capability have an importance score below the average importance score. This result suggests that the current recipients from IT industry have a higher requirement outside the professional skill sets. This is an interesting finding and deserves careful study in the future research.

(2)Discussion of performance opinion score

The performance score of IT undergraduate employability is generally low with the average of 23 employment ability scores ranged from 3.725 to 2.706. This trend could explain the employment situation of Chinese IT undergraduate. While there are considerable amount of IT undergraduates available, the booming IT industry in China still face talent shortage (Tan, 2009; Zong 2012). This study shows that the recipients from IT industry are not satisfied with the performance of general IT undergraduates, which could be a significant contributor to the employment dilemma.

The low performance score of employability could also indicates that the practical capability of IT undergraduates is generally insufficient, which is consistent with the study with general undergraduates (Dacko, 2006; Gokuladas 2014; Hui 2008). The development of IT employability structure emphasis the practical capability compare to current relevant study (Mequa, 2005; Pollard, 1998; Zhang, 2005). This employability system values the design, develop and operational capability, which are the core aspects of practical capability. Therefore, the low performance score could be interpreted as the reflection of IT industry's attitude towards the practical skill performance.

5.1.3 Do business IT practitioners with different background variables have different views on the importance and performance of IT undergraduate employability?

Through four-way ANOVA, this study finds that the background variable influences on the opinions of IT undergraduate employability are common phenomenon, however the degree of influences are generally low. Total of four background variables are studied in the study, and they are city size, work unit type, work unit size, and occupation. Among them, the work unit type and its interaction items have more significant influence on the IT undergraduate employability, while the influence of variable occupation and its interaction items are quite limited comparing to other variables. This study conduct simple effect analysis for the interaction with top influences and finds that some combinations of the background variables have more significant influence on multiple IT undergraduate employability indicators.

In the main effect analysis of background variables, the partial eta squared values of each statistically significant items are all below 0.03, which indicates that the effect sizes are generally small. However 9 employability importance scores are influenced by background variables, as well as 9 performance scores. The influenced indicators in above two groups are not the same. Many indicators from personal quality and general capability are influenced, while only 2~3 out of 11 indicators from IT professional capability are influenced.

For the interaction analysis, the variable occupation has less significant influence on the scores of employability indicators. This is because that, in the second-order interaction analysis, variable occupation affects less indicators and has a much lower effect size. The partial eta squared values are generally half of the other interaction items, and the only strong interaction of occupation is its combination with the strong influence factor wok unit type. On the other hand, the variable work unit type influences many indicators and have a higher partial eta values, some of which are close to the threshold of medium level influence 0.06. The notable combinations that influence the importance scores are: management in schools and research institution, professional IT technicians in schools and research institution, schools and research institution in all category of city size. The notable combinations that influence the performance scores are: private enterprise in large size city, private enterprise in small size city, the other types (including collective ownership company, sole proprietorship) of work unit in large size city, large size of the other types of work unit.

(1) Discussion of background variables

The variable work unit type has a relatively strong influence on both the importance and performance scores. This result is not surprising because the influence of the different work unit types are discussed by many research in various industry (Huang, 2015; Li, 2010). The significant influence in IT industry could be explained in two ways. The first reason is that W2 schools and research institutions are quite unique in the category because the rest of the work unit types are all enterprises. Since schools and research institutions focus more on education and research, while the enterprise focus more on business operation, it is reasonable to assume that the requirement of IT undergraduate employability could be quite different. Those differences are reflected in the influence on the importance score. The second reason is that the private enterprise and other types of work unit (including collective ownership company, sole proprietorship) usually face much higher level of competitive and are much fragile against the business operational pressure, therefore they are more sensitive about the performance of the employee (Liu, 2014; Liang, 2013). The state-owned enterprise and schools could receive significant amount of government support including policy level support and department finance support. The foreign invested enterprises could have relatively less difficulty in recruiting the high level talent, which means their performances are generally well (Zhang, 2002).

The influence degree of variable occupation is less significant compare to other variables. This result is relatively different from the research assumption that the occupation background variable influence the importance and performance opinion score. The reason for this result might be that the occupational difference in the questionnaire setting is not significant. Other researches usually study the influence of occupation on employability across various industries (such as manufacture, finance, and education) and various occupation types (such as account, management and transportations) (Huang, 2015; Xu, 2017). In this study, the occupations are all within the IT industry and are limited to three category. Although the aim of management, IT research and It technician are quite different, it seems that the requirement for IT related employment is generally the same.

The background of work unit size and city size have a moderate influence on the employability indicators compare to first two background variables. Some researches indicate that those two variables influence the employability in general undergraduate (Chu, 2011; Li, 2010; Song, 2015; Zhao, 2018). This study proves that the similar conclusion that those two variable have small influence, while limited on both number of affected indicators and the effect size. What's more, from the simple effect analysis, those two variables do not have significant influencing pattern in term of outstanding interaction combinations. Therefore they are not the focus of this study comparing to the first two background variable.

(2) Impact on the application of employability structure

The study on the background variable has several significances and applications. The first is that the schools and research institutions can conduct targeted reform of education system. For example, the schools cultivating practical IT talent can focus on the employability indicators that the enterprises consider as important. While the university cultivating research-oriented students can focus on enhance the employability that schools and research institutions demand. For example, the university and research institutions in large city general consider computer system development capabilities, algorithm design and analysis capabilities as more important employability indicators. Therefore if the university cultivates research-oriented students, the university need to focuses more on those capabilities. The second is that the students can use those information for better career planning. Through understanding the demand preference of certain types of employer, the students can develop relevant employability that could better prepare them for the future challenge. For example, from the performance score simple effect analysis, the private enterprises in large size city consider the performance of psychological endurance, sense of career achievement and creativity to be significantly low. Therefore if the students focus more on those three capabilities, they would have more competitive advantages being employed by that type of enterprise.

5.1.4 What is the priority of IT undergraduate employability?

From the results of IPA and PNI, this study identifies the improvement priority of employability indicators to provide guidance for enhancing employability. The indicators from the high priority quadrants of IPA are the same as the indicators with top PNI, which indicates that those indicators are the employability aspects urgently required improvements. Those indicators are algorithm design and analysis capabilities, capability of computer software design and program development, creativity, career planning capability, planning capability, communication and coordination, sense of responsibility, psychological endurance.

For the IPA method, eight employability indicators located in keeping quadrant, accounting for 34.78% of employability capability. The capabilities in keeping quadrant have high importance and high performance, therefore the organisation need to keep up the good work and maintain the current status. Two employability indicators located in over supplying quadrant, accounting for 8.70% of employability capability. Those two employability indicators have high performance and low importance scores, which indicates over investment in those capabilities and non-necessary improvement. Five employability indicators located in low priority quadrant, accounting for 21.74% of employability capability. The capabilities in low priority quadrant have low importance and low performance score which means they do not have high priority of improvement and do not need additional investment. There are eight employability indicators in high priority quadrant, accounting for 34.78% of the total indicators. Those eight capabilities have high importance and low performance score, which indicates that they require attention and have high improvement priority.

The employability indicators in high priority quadrant are algorithm design and analysis capabilities, capability of computer software design and program development, creativity, career planning capability, planning capability, communication and coordination, sense of responsibility, psychological endurance. Among them, algorithm design and analysis capabilities, and capability of computer software design and program development are worth noticing. Within the indicators with high priority, those two have the highest PNI value and those are IT professional capabilities. This results shows that the IT professional capability are probably most urgently requiring improvement. It could be conclude that the IT professional education system has significant weak point and require urgent additional investment and reform.

This study also adopts PNI index to evaluate IT major graduate employability, and obtain IT major graduate employability cultivate prioritization. Compare the prioritization with the eight employability indicators in the high priority quadrant from IPA analysis, this study concludes that eight employability that urgently require attention and improvement are the same as the result in IPA. The ranking order of the top employability indicators from high to low are algorithm design and analysis capabilities, capability of computer software design and program development, creativity, career planning capability, planning capability, communication and coordination, sense of responsibility, psychological endurance. According to the ranking results of the employability PNI of IT major student, colleges and universities can distinguish the priority of IT major students' ability to improve their training, so as to establish an effective training system under the condition of limited resources, which is conducive to the management of IT major student in colleges and universities. It can further improve the employability of IT major student, improve the quality of employment and the efficiency of training.

Discussion of priority analysis result:

Several factors contributed to the different level of improvement priority. From the perspective of university, some of the capabilities in the personal quality and general capability are currently not valued in the education system (Pratt, 2012; Xie, 2005; Woods, 2013). The aim and content of education do not emphases those capability. The evaluation system also lacks the necessary means to accurately measure those capability of the students. Thus certain employability indicators become the weak points of the IT undergraduate employability. For the IT professional capability, modern higher education and training systems focus on the cultivation of hard abilities based on knowledge and related skills, while neglecting the development of soft capabilities represented by designing and developing capability within the practical environments. From the perspective of the students, college students' awareness of career planning is weak, therefore students' value orientation is biased and utilitarian. Besides, colleges and universities lack specificity in career planning education to redirect the focus of the students.

These issues require long-term attention, development, and advancement in society, schools, and students themselves. These issues also requires targeted promotion strategy from policy mechanisms at macro level, the education and social management at middle level, and individual development at micro level.

The top priority employability indicators identified by this study are generally supported by related literature. Creativity and related innovation are the focused area of study because the innovation is the driven force for the developing of the enterprise in the current society (Liang, 2008; David, 2017). The communication and coordination capability, psychological endurance employability indicators are also frequently mentioned in the study related to the quality of students (Xun, 2017; Xie et al, 2018; Que, 2011). Some indicators require improvement because the current studies find that they are difficult to cultivate and evaluate, such as psychological endurance, planning capability, sense of responsibility, and career planning capability (Wu, 2010; Conlon, 2008; Yang, 2018).

5.2. Recommendations

Based on the research findings, this study proposes recommendations to promote the IT undergraduates employability.

5.2.1 Recommendations for university

5.2.1.1 Promoting education and teaching reform with the guidance of structural employability system

The IT undergraduate employability structure could be used as a guideline for the education reform. Firstly, the schools and training unit could use the employability structure to reform the circumlunar in order to ensure the comprehensive development of student employability. The employability structure could be used to evaluate the education system of the university to check if any of the employability indicator is not properly cultivated. What's more the university can also adopt this structural system to assess the degree of talent training matching the IT industry demands.

Secondly, the schools and training unit could also adjust the course content according to the IT undergraduate employability structure. Some aspects of the employability, such as sense of responsibility, are not emphasised in the current course setting. Besides, the course contents are not suitable for the development of some aspects of the employability, such as creativity and algorithm design. The schools and training unit can use the employability system to evaluate the fitness of current course contents.

Thirdly, the evaluation system of the students should also be reformed according to the employability structure. Currently the evaluation system overemphasizes the test-score system of the student and the publications of the student. However many aspects of the IT undergraduate employability cannot be evaluated with current system, such as psychological endurance. The reform of the evaluation system could enable the schools and training unit to more accurately assess the employability of IT students. Therefore the schools and training unit can make suitable adjustment to improvement the bottleneck of IT undergraduate employability.

5.2.1.2 Establish an industrial-oriented professional education adjustment mechanism

This research recommends that colleges and universities should better adapt to the needs of society in the training of IT students' employability to meet the talents needs of developing IT industry. This is because the performance assessment score is generally lower than importance score, which indicates the IT undergraduate employability is not satisfying.

Firstly, the schools and training units need to establish a professional dynamic adjustment mechanism to solve the time lag between the university personnel training cycle and market demand. Colleges and universities should conduct professional talent demands assessment and adjust enrolment plans in advance according to professional setting. At the same time, adding IT minors to expand the professional setting of calibre to cultivate highly adaptable talents. When the labour market and employers change the supply and demand of certain types of talents, training unit can also flexibly adjust the number of enrolment of relevant majors.

Secondly, encourage interdisciplinary training of IT major students. The IT industry is a new economic growth point, but it faces the problem of lack of talent. Colleges and universities should seize the current opportunities, advocate resource in cross-disciplinary, encourage professional integration. When setting up a new major, it is necessary to comprehensively consider actual and future development, scientifically predict, evaluate and demonstrate the new major, and then open the new major after having the necessary conditions. In this way, the IT students trained in colleges and universities can be matched with the needs of the labour market to its greatest extent, increasing employability and making IT students more approvable by employers.

Thirdly, as mentioned in the last section, the reform of the education system should be based on the demand of the IT industry. Colleges and universities must strengthen discipline construction to lay a solid foundation for professional major cultivation. Disciplinary construction should also be adapted to the new professional requirements arising from changes in the socio-economic structure. Colleges and universities should combine the theory and practice to adjust the professional curriculum. The training units should reduce the difference between the level of talent performance and the level of employers' requirement, strengthen the cultivation of IT professional knowledge and capability from all aspects, enable students to acquire the knowledge and skills that can be applied in the future work from the classroom, and cultivate students' sense of innovation. So IT graduates can meet the requirements of employment and become the professional and technical talents favoured by enterprises.

5.2.1.3 Implementing career planning guidance and feedback mechanism to help student adapt to the influence of background variables

Students should have adequate access to the information related to the influence of background variables on the opinion of the employability importance and performance. With those information, the students can adjust their study plan to suit the demands of the city and workplace they desire and be better prepared for the future challenges.

Firstly, the schools should establish a long-term mechanism for employment guidance throughout the students' study process. The employment guidance of colleges and universities should be the whole process of guiding the implementation of different contents throughout different stages. The career planning education at the student stage can be implemented in four stages: the exploration stage of professional interest, the preliminary orientation stage of professional intention, the initial trial stage of professional intention, and the basic stability process of professional intention. The determination of professional intention is a process that needs constant adjustment. The professional interests and professional intentions of IT college students may change with the progress of their learning stages. Some factors, including the progressing of the learning stage through professional knowledge, the development of research activities, and the in-depth study phase, are likely to influence their professional intentions.

Secondly, schools need to open up new ways to provide employment guidance. Most IT college students have no work experience and lack basic understanding of social competition and business needs. Therefore they might not realise the importance of those information and guidance. The creative way of delivering those information could significantly improve the students' motivation of study and readiness of employment. Taking the employment guidance course as the main form of employment guidance, students can participate in the curriculum in a flexible and diverse way such as case teaching and scenario simulation. This can not only inspire the thinking of college students, but also enable the theoretical knowledge in textbooks to be practiced in the process of students' personal participation.

In order to ensure that the objectives meet the needs of the society, it is necessary to construct a feedback evaluation mechanism to evaluate the employment capacity. The regional and occupational employability difference is a complex issue and difficult in measurement, therefore constant focus is need in order to prepare the students for various background and challenges. The feedback on the quality of IT college students' employment is first and foremost from graduates. Colleges and universities should establish a follow-up survey system for graduates' employability, and evaluate graduates' employment quality by interviewing IT graduates, questionnaires, and collecting feedback from employers. In addition, colleges and universities should also establish a feedback system for graduates (alumni) employability's improvement, through the follow-up survey of alumni, to obtain feedback from graduate alumni on the improvement of employability of IT college students. Colleges and universities can conduct long-term tracking, investigation and analysis of graduates' career development status information through professional analysis systems. So that the university could obtain effective information on the career development of graduate alumni, and offer feedback to colleges and universities. Therefore university could broaden the path of IT students' employability, and then improve the goals and specific measures for the improvement of IT students' employability.

5.2.1.4 Building a modular design curriculum system to ensure improvement priority

The "modular" design of the applied curriculum system could enhance the pertinence and flexibility of the curriculum setup. Eight employability indicators are identified as the employability indicators that urgently require the improvement. In order to focus on those employability, the schools need to make changes to the curriculum system and provide additional resources to the related course. What's more, the relevant evaluation systems are also required to monitor the progress of the improvements. Those issues can be adequately addressed with modular designed curriculum system. The "modular" design can introduce the latest scientific and technological achievements according to the latest changes in industry demand, and select the combination of curriculum modules suitable for students' career development according to different career development directions, so as to realize the personalization of IT college student cultivation. According to the empirical research on the employability structure of IT college students, the IT module includes three major modules: professional ethics and cultivation, basic and development capability improvement, and IT professional capability improvement.

The first module is personal quality cultivation module. This capability module focuses on cultivating the moral quality and professionalism that an IT engineering technical talent should possess, and cultivates the IT students' capability to resist stress, professional ethics, and responsibility and career accomplishment. The aims of course module are mainly to guide IT students to fully understand the unique value of technology science and social progress, to stimulate the strong interest in transforming science into technology, and to establish a value orientation that is determined to make a difference in the field of technology science. What's more, this module also needs to achieve: Guide IT students to love their careers, and have a high sense of accomplishment because of their career, so as to develop professional habits that are good at studying technology. Guide IT college students to capture information from the field of engineering technology innovation. Specific courses include engineering philosophy, computer ethics, science and technology philosophy, history of science and technology, and social science courses in humanities, economics, and management. In the implementation of teaching, it is necessary to implement course classified teaching according to different professional categories, and arrange teaching implement level according to students' learning ability and personal interest.

The second module is general capability module. This part mainly trains students' ability to self-seek, perform, and develop in a formal or informal learning environment. This module includes three parts: innovation consciousness, innovative thinking and innovative skills. The core is innovative thinking. Among them, planning and career planning capability is the basic capability of college students to engage in the computer industry. For example, whether the purpose of the plan is clear, whether the scope is clear, whether the schedule is reasonable, and whether the resource allocation is reasonable, and all those questions require comprehensive consideration. One of the most important aspects of planning ability is career planning ability. This part is based on career planning classes to improve the career planning ability of IT students. The IT university curriculum system should increase the career planning curriculum, clarify the course objectives, course content, curriculum implementation, credit requirements and evaluation criteria. Therefore the IT University could prepare corresponding career planning instruction materials according to the subject classification.

The third module is IT professional capability module. This competency module focuses on cultivating IT professionals' career performing expertise and technology entrepreneurship. Enhancing professional competence is an inherent requirement for the training of IT college students with professional needs. The capability of computational thinking, modeling and algorithm focuses on cultivating college students' spatial thinking ability, mathematical thinking ability and algorithm ability. The design and development capabilities of computer software systems focus on developing the ability to build software systems or software components in systems based on user requirements, and to develop software systems that include requirements collection, requirements analysis, design, implementation, and testing. This course modules mainly include IT professional basic courses, IT professional core courses, interdisciplinary courses, experimental design courses and technical application course modules, which form the IT professional course modules. The development and construction of the IT professional course module is inseparable from the support of industry enterprises. It should highlight the cultivation of engineering practice ability, highlight the concept of “thick basic theory, board frontier knowledge, and emphasis practical application”, and emphasis the needs of enterprises as the basic principle of IT college curriculum. Combine the production practice of the enterprise to establish a link between production practice and theoretical knowledge, thus the university could construct a practical application-oriented practical curriculum system.

5.2.2. Recommendations for IT major students

Students should acknowledge the gap between the employability they currently have and the employability the enterprises demands, and change the attitude towards learning. Due to the changes in the social environment and the popularization of higher education, most scholars generally believe that today’s college students lack the intention of "successful learning". This leads to the phenomenon of no goal in life and no direction in learning, especially insufficient attention to the employability necessary for workplace after graduation. Although the average score of importance given by subjects in the 23 IT professional employability indicators ranged from 3.149 to 4.331, none of the average performance score was higher than 4. This shows that the subject believes that the degree of performance of IT professional college students in employment still has great room for improvement.

The students need to focus on cultivating the employability indicators with high improvement priority. In recent years, under the strong guidance of the Chinese government's teaching policy, the schools of higher education in China have changed from the past instruction paradigm to the learning paradigm. The focus of university education has shifted from "teacher teaching" to "student learning." Effective teaching and learning emphasizes and requires the initiative from learners. Therefore, if the students could take the initiative to assess their employability with the IT undergraduate employability structure and improve the employability they lack, they could have employability that is more suitable for the IT industry.

5.2.3 Recommendations for the IT industry

The IT industry could provide appropriate training for the IT undergraduate student to prepare them for the future working environment. As this thesis have find out, the gap between the employability of students and the industry demands is significant. In the current employment market, the enterprise needs to invest in the new employees and reduce the employability gap by themselves. With the guidance of the IT undergraduate employability structure, the enterprise could allocate their resource and training programmes for the employability indicators with high priority. This could enhance the efficiency of the training programme. What's more, the enterprise should also pay attention to the effect of enterprise type on the employability demands. For example, the university and research institutions should pay more attention in stimulate the learning capability and creativity of the new employees.

5.2.4 Recommendations for future researchers

This thesis develops an IT undergraduate employability structure system, and this system could be refined with more specific sub IT industry. IT industry is a diverse industry and different aspects of IT industry may have different emphasis on the employability (Len, 2014; Si, 2010). Therefore, future researchers could refine and expand the IT undergraduate employability systems by applying the system in certain IT industry areas. What's more, the IT industry is fast developing industry with constant innovation, thus it is important to monitor the demands of the IT industry.

This thesis proves that certain demographic variables could influence the opinion of the IT undergraduate employability. However, the influences of background variables on the employability are not sufficiently studied due to the limitations of this study. This thesis recommends that future researchers put more effort in examine the relation between the background variable identified in this thesis and the employability opinions. The detail information of the influence could serve as an important guidance for the improvement of IT undergraduate employability.

5.3. Contributions of the thesis

On the basis of learning and drawing on the existing research results, this paper systematically conducts qualitative study and empirical studies on the employability structure of IT major student and the gap of employability from the perspective of enterprises, and achieves the purpose of research and realizes initial innovative concept in the research design.

5.3.1 Theoretical contributions

(1) This thesis designs and develops an indicator system for the employability of IT major student. The developing of IT undergraduate employability structure could enrich the research on employability of college graduates. The indicator system includes three primary indicators, 11 secondary indicators, and 23 third-level indicators of the IT major student employability, reflecting the inherent structural characteristics of the science and engineering students' entrepreneurial ability elements. Those character could ensure the solid foundation for further employability study.

(2) Based on the perspective of enterprise demand, this paper analyses the importance and performance of college students' employability. The findings of this thesis could enrich the human resources development for the computing industry. Through revealing the total average of performance is lower than the total average of importance, this study confirms that the current IT undergraduate employability require improvements. Through ANOVA, this thesis concludes that several background variables have significant influence on the opinion of the importance and performance scores, which suggest a significant research direction.

(3) This thesis compares the importance and performance scores to identify the priority of employability indicator improvement. The finding of improvement priority will enrich the study on the improvement of quality of higher education. The IPA analysis method is used to obtain the eight capabilities that the demand side of the enterprise has high expectations, but their performances are not satisfying. The PNI method is used to analyse the priority of the employability. Combining the result of IPA and PNI analysis,

this study not only decides whether the indictors require improvement, but also identify the degree of urgency for the improvement. Using both method on the employability improvement analysis to obtain comprehensive information is a significant contribution of this study. This study also finds that IT professional education system has significant weak point because the top two PNI indicator are all from IT professional capabilities. According to those findings, universities can distinguish the priority of the training needs for IT major students. Therefore, an effective training system can be established under the condition of limited resources. The capacity improvement training can be carried out in a targeted manner, which can further improve the employability of IT major student and improve the quality of employment and the efficiency of training.

5.3.2 Practical contributions

This study develop comprehensive employability structure and identify the improvement priority, which provide practical guideline for improving the quality and efficiency of IT undergraduates training and development of higher education. The university could use this well-established IT employability structure to assess the education quality and design targeted improvement plan. On the basis of analysing the IT major graduates employability, this paper proposes an effective path to improve the employability of IT major students based on the indicator-oriented role of strengthening the employability.

This study also provides considerable useful information for IT undergraduates to improve their employability by themselves. This thesis describe the current state of the employability, which could rise the attention of IT undergraduate students and motivate them for self-improvement. This thesis also provide background variable influence assessment, which could be used as a guide for seeking long-term career planning with different types of employer and working locations.

This study is based on the perspectives of IT industry demands. The finding of this study could help narrow the gap between the IT undergraduate cultivation and IT industry demands. The education system could direct the resource towards the employability aspects that require the improvement the most. The enterprise could also design training programme to enhance the capability with top improvement priority for the IT undergraduate. Therefore this study could have the contribution of improve the employment quality and ease the employment pressure.

5.4. Limitation of the study and future research plan

Although the research in this paper has drawn some meaningful conclusions, there are some shortcomings and regrets in the research, which need to be further explored and improved in future research. The IT employability is a multi-factor, multi-variable complex system, and research literature related to the employability of IT college students is not sufficient for this research. This research is also limited by factors such as time, conditions and cost. Therefore the limitations of this study mainly include:

(1) In the design of the indicator system, this paper attempts to construct an indicator system for the employability of IT college students. Due to limited research conditions, although with the support of the Ministry of Industry and Information Technology and other departments, the sample size has yet to be further expanded. Therefore, in the future research, it is necessary to continue to verify and improve the employability indicator system in practice.

Some aspects of the sample quality for this study could be improved. For background variable work unit type and occupation, the numbers of sample for each items are not the same. Some demographic option, such as professional IT technicians, have significantly larger number than other options. Therefore the analysis research might be biased towards some demographic groups. In order to avoid this kinds of error, this study has choose the suitable analysis methods. However this still remain to be the limitation of this study.

(2) In the evaluation subject, IT engineering technicians, enterprise managers and university IT teachers were selected. However, because the IT employer's employability structure system is a multi-factor, multi-variable complex system, if the study can add some relevant evaluation subjects (such as the administrators of higher education department, the parents of the students) to evaluate the employability first, and then comprehensively evaluate the results, the research Accuracy will be improved and research conclusions will have greater application value. Therefore, in the future follow-up study, some evaluation indicators for relevant evaluation subjects can be added, and interviews and questionnaires could be used to obtain relevant first-hand data.

However, due to the research and statistical analysis of this task require a large amount of research funding, time, energy and personnel, it is not currently suitable for me to conduct and can be used as a direction for further research.

(3) Limited by the research time, this research fails to conduct a round of tracking and conduct empirical research to verify the improvement path proposed in this study. If we can conduct the 3-4 years of follow-up evaluation, this study may have a better

understanding of the development trend of IT students from the first year, which is more important and valuable to understand the employability. This subject deserve continue study for exploring in the future research.

It is the purpose and value of this research to improve the training level of IT major talents and promote the economic development and industrial structure transformation. This study further improved the evaluation of the employability of IT college students by establishing a scientific evaluation system. Based on the results of the assessment and the problems identified in the assessment, this study provides recommendations and improved the IT professional education and employment guidance work. The purpose of the establishment of the indicator system is to present the true state of the object of evaluation. However, due to the influence of research ideas, research techniques, research conditions, and research processes, this study has certain limitations. In order to achieve more representative and universal results, only by continuous accumulation and breakthrough, can we gradually improve the research results. It is hoped that this paper will play a certain reference role in establishing a scientific IT major employability structure system and promoting the employability of IT college students.

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Appendix

Appendix I Questionnaire for IT undergraduate employability

Dear computer industry practitioners:

Hello! We are engaging in the research and development of IT undergraduate employability. This questionnaire will be filled out by practitioners or peers in the computer industry. The research results will only provide reference for the training of computer professionals. The questionnaire is anonymous, and the research results are for research purposes only. **Please fill in the questionnaire according to the actual situation!** Your authentic answer will affect the reliability of the research results. I would like to express my sincere respect and gratitude for your full assistance!

The first part - the basic information

1. What is the current location city size of your work unit?

○ Large size city

○ Medium size city

○Small size city

2. What is your work unit type?

○ State-owned enterprises

○ Schools and research institutes

○ Foreign investment enterprises

○ Private enterprise

○ Other

3. The unit size of your job is (the unit that signed the contract with you):

○ 300 or more

○ 100-300 people

○ 10-100 people

4. What is the occupation of your job?

○ Managers

○ Professional IT technicians

○ Professional IT teachers

The second part - Employability

The following are the elements of the employability of computer major graduates. Please rate according to your actual situation or the desired idea. Please pay attention to the degree of distinction when scoring. You cannot place the highest score or the same score on every element. Score 1 means not suitable at all, score 2 means less suitable, score 3 means not sure, score 4 means relatively suitable, and score 5 means completely suitable. Importance refers to the importance of a certain aspect of competence to competent work; Performance refers to the performance of most job seekers.

No	Employability Indicator Name	Importance					Performance				
		1	2	3	4	5	1	2	3	4	5
A1-1	Psychological endurance										
A1-1-1	Believe that bad things will always pass, and tomorrow will be better										
A1-1-2	Will not be depressed by failure										
A1-1-3	Good at self-regulation in the face of stress										
A1-2	Professional ethics										
A1-2-1	Honest, trustworthy and have good credit for both people and things										
A1-2-2	For everything you do, attention is										

	always very concentrated										
A1-2-3	Comment on things without prejudice										
A1-3	Sense of responsibility										
A1-3-1	Never make excuses for your own mistakes										
A1-3-2	Do not quit halfway of doing things, even if you encounter difficulties, don't give up										
A1-3-3	Complete duty with high standard										
A2-1	Sense of career achievement										
A2-1-1	Believe that career success is an important value of life										
A2-1-2	Can be greatly satisfied at work										
A2-1-3	Can sacrifice other things for success										
B1-1	Executive capability										
B1-1-1	Can handle multiple complex tasks properly										
B1-1-2	Transform vision into specific behavioral ability										
B1-1-3	Do not need pressure applied to be able to better perform tasks										
B1-2	Learning capability										
B1-2-1	Always want to learn new knowledge										
B1-2-2	Able to learn continuously										
B1-2-3	Hard work and hard work in study										
B1-3	Creativity										
B1-3-1	Good at discovering new connections between things or phenomena										
B1-3-2	Willing and ease to accept new things, new ideas										
B1-3-3	Have an open mind and are willing to challenge the status quo										
B2-1	Planning capability										
B2-1-1	Do everything with clear goals and plans										
B2-1-2	Be able to use your time reasonably and efficiently										
B2-1-3	In the implementation of the plan, not causing unnecessary waste of time										
B2-2	Career planning capability										
B2-2-1	Clear career planning and clear employment goals										
B2-2-2	Know the skills needed to achieve your career goals										
B2-2-3	Adjust the career plan according to the situation										

B3-1	Teamwork										
B3-1-1	Organizational awareness (such as focusing on interests of organizational)										
B3-1-2	Understand the company's organizational structure and effectively assess organizational needs										
B3-1-3	Ability to work well with team members and share resources										
B3-2	Communication and coordination										
B3-2-1	Can handle all kinds of complicated interpersonal relationships with ease										
B3-2-2	Express yourself and understand others in a unfamiliar environment										
B3-2-3	Adjust the content or manner of expression according to different objects										
B4-1	Using social relations capabilities										
B4-1-1	Relatives can provide resources for the career and career development										
B4-1-2	Parents have some friends with strong economic strength and high social status										
B4-1-3	Friends can provide some favourable social network										
C1-1	Capability of computer software design and program development										
C1-1-1	Small- and large-scale programming										
C1-1-2	Configuration and integration program system										
C1-1-3	Develop business solutions										
C1-2	Basic design capability of computer application system										
C1-2-1	Determine the overall structure of the functional design software system according to the requirements, and form the specific design of the software										
C1-2-2	Design application (basic office software)										
C1-2-3	System software programming										
C1-3	Capability to apply computer for implementing apply system and conducting development and innovation										
C1-3-1	Implementing the application										
C1-3-2	Configuration application										
C1-3-3	Develop a new software environment										
C2-1	Cognitive capability of basic knowledge of computer										

C2-1-1	Master the basic knowledge and basic principles of computers										
C2-1-2	Understand the basic methods of computer analysis and problem solving										
C2-1-3	Ability to judge and select computer tools and methods										
C2-2	Cognitive and operational capability of computer components and hardware										
C2-2-1	The basic composition principle of each subsystem of the computer, and the technology that each subsystem is connected to each other to form a complete system										
C2-2-2	Basic computer hardware system composition and hardware system performance										
C2-2-3	Ability to effectively master and operate computer hardware										
C2-3	Cognitive and operational capability of software theory										
C2-3-1	System software composition										
C2-3-2	Software system performance										
C2-3-3	Skilled in using software										
C3-1	Computer system development capabilities										
C3-1-1	Design and implement an embedded system										
C3-1-2	Design computer peripherals and complex sensor systems										
C3-1-3	Computer hardware integration and systematic test										
C3-2	Design capability of computer hardware										
C3-2-1	Design and implement digital circuits										
C3-2-2	Design the chip and program the chip										
C3-2-3	Understand hardware interface standard										
C4-1	Computational thinking and modelling capabilities										
C4-1-1	Symbolic representation of the problem, and the symbolic representation of the solution process										
C4-1-2	Logical and abstract thinking, formal proof										
C4-1-3	Model building and using computer technology to achieve model calculation										
C4-2	Algorithm design and analysis capabilities										
C4-2-1	Simple algorithm design and analysis										

	to prove theoretical results										
C4-2-2	Design and analysis of complex algorithms to prove theoretical results										
C4-2-3	Develop a solution to the programming problem, and determine if there is a better solution										
C5-1	General capability to use and maintain computer application systems										
C5-1-1	Computer assembly and maintenance										
C5-1-2	Computer application technology theory, computer system hardware and software fault diagnosis and maintenance capabilities										
C5-1-3	Apply computer application system to solve practical problems										

Thank you very much for your cooperation!

Appendix II Documentations of focus group interview

Discuss the "IT undergraduate employability indicator structure"

Time: 9:30am, October 10, year 2017

Location: Office 411 in School of Law and Law, University of Science and Technology Beijing

Host: Professor from Institute of Education and Economics, University of Science and Technology Beijing

Researcher: Benqing Dong

Attending experts and scholars:

Professor from School of Software and Microelectronics, Peking University

Professor from School of Internet of Things Engineering, Hohai University

Professor from School of Software, Dalian University of Technology

Professor from Department of Computer Science, Nanjing University

Professor from School of Computer Science, Xidian University

Professor from School of Software, Shandong University

Professor from School of Information Engineering, Jinan University

Table 1. Experts in focus group interview

Name code	University	Occupation	Position
A	Beijing University	Professor	Currently in Microelectronics Institute …… Previously in ……
B	Hohai University	Professor	Currently in Internet of Things Engineering Institute …… Previously in …
C	Dalian University of Technology	Professor	Currently in Software College …… Previously in …
D	Nanjing University	Professor	Currently in computer science …… Previously in …
E	Xidian University of Electronic Technology	Professor	Currently in IT Academy …… Previously in …
F	Shandong University	Professor	Currently in Software College …… Previously in …
G	Jinan University	Professor	Currently in School of Information Engineering …… Previously in …

Interview description

This "focus group interview" mainly selected 7 domestic scholars and experts who have been engaged in IT education for a long time. For the initial design of the IT undergraduate employability, including the "3 first level indicator, 11 second level indicator, 26 third level indicator", whether the design of the indicator structure is considered as appropriate is discussed as well as related issues. Under the auspices of the instructor, the researcher creates an atmosphere of group interaction, which encourages scholars and experts involved in focus group interviews to freely express their views or opinions. This will condense the relevant consensus on the structure and connotation of the evaluation indicators of this study, in order to improve the consensus of the content of the draft. The results of the discussion served as the basis for the preparation of the “IT undergraduate employability questionnaire”.

Main discussion topic

Is the initial structure of the IT undergraduate employability initially constructed in this study (3 first level indicators, 9 second level indicators, 27 third level indicators) appropriate? Experts and scholars are invited to provide insights to facilitate adjustment and concise consensus, and to prepare the next stage of the "Delphi Method Expert Questionnaire".

Illustration

As an important engine of the modern economy, the IT industry plays an important role in accelerating the pace of industrial structure changes and raising the national economy. The rapid development of the IT industry has caused a significant talent gaps. At the same time, the problem of insufficient employability of IT university graduates has become increasingly prominent. Based on this background, this study aims to construct an objective and complete IT undergraduate employability structure. From the perspective of enterprise needs, the difference between the importance and performance of IT undergraduate’s employability and its priority are taken as the research topics of this paper. This can be used as a reference for colleges and universities to promote IT professional teaching mode, curriculum reform, and improve teaching efficiency.

This research hopes to achieve following research goals:

1. Construct an IT undergraduate employability indicator system

2. Based on the perspective of the company, understand the degree of importance and

performance of IT undergraduate employability according to the opinion of corporate IT practitioners.

3. Exploring the improvement priority of IT undergraduate employability for higher education.

4. Inductive research findings to provide college IT professionals and IT educators with unique insight to understand the difference between employability and importance and employability performance, as a basis for planning, design and intensive counselling.

At present, researchers have initially completed the IT undergraduate employability indicator system. Construct a structural system containing "3 first level indicators, 9 second level indicators, 27 third level indicators" (as shown in Table 1). This study is based on the ACM/IEEE-CS IT Curricula (2017), Chinese computer education expert Jiang Zongli (2011), the employment of the Higher Education Academy (UK) (Gulc et al., 2014), The Pedagogy for Employability Group, Confederation British Industry (UK) (CBI, 2009) in the 2009 report, Bennett et al. (1999), Yorke and Knignt, Dacre Pool & Sewell , Ruth, CDIO Initiative (2010), IEET CAC (2017) (Sabin et al., 2016) model. At the same time, this study combines the views of industry experts and educators to analyze the characteristics of IT undergraduate employability in line with industry characteristics, and expects to further absorb the opinions of students and experts in the future, so that the construction of evaluation indicators of this research is more perfect and practical.

Table 2. Preliminary structure of IT undergraduate employability

First level indicator	Second level indicator	Third level indicator
IT professional capability	cognitive and operational capability of computer principle	cognitive capability of basic knowledge of computer
		cognitive and operational capability of computer components and hardware
		cognitive and operational capability of software theory
	computer system theory design and development capability	computational thinking and modeling capabilities
		algorithm design and analysis capabilities
		computer hardware design and development capabilities
		capability of computer software design and program development
	capability of using computer application system use and innovation	understanding of knowledge and processes in the application domain
		general capability to use and maintain computer application systems
		basic design capability of computer application system
		capability to apply computer for implementing apply system and conducting development and innovation
General capabilities	planning and practical ability	planning capability
		planning capability
		hand-on capability
	teamwork and communication	organisation and teamwork
		communication and coordination
		adaptability
		using social relations capabilities
	capability of developing	executive capability
		learning capability
		creativity
		comprehension and expression
		skills of analyze
Personal quality	comprehensive ability	psychological endurance
		problem solving ability
	Personal quality	professional ethics and sense of responsibility
	sense of career achievement	sense of career achievement