Title

STAKEHOLDERS' SATISFACTION WITH CIVIL ENGINEERING GRADUATES

Thesis

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Declaration

This thesis contains no material which has been accepted for the award of any other degree in any institution.

This thesis contains no material previously published by any other person except where due acknowledgement has been made.

All of data are original from the participants.

Signature   :……………….

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Abstract

Engineering education is being viewed as a fundamental matter in modern industry because engineering education produces graduates that are very important to the continued development of industry. Because of its importance, the quality of the engineering education should be improved continuously. Basically, the quality of education can be divided into the quality of the process and the quality of the outcome. The process includes the quality of the teaching, learning and curriculum, and the quality of the outcome is the quality of the competencies possessed by graduates. While the quality of curriculum and learning have been discussed in many scientific reports, the quality of competence is rarely discussed. Therefore, a study on the quality of graduates' competence will be useful to augment recent studies on the quality of engineering education.

The objective of this study is to analyse data of graduate quality so that useful information is obtained to help engineering education providers put strategies in place to improve its quality. The information includes the models linking quality and satisfaction.

Data for this study including competence of graduates, performance of graduates, satisfaction of stakeholders, and expectations of stakeholders were obtained by survey with the questionnaire sets developed based on established variables and indicators. The targeted respondents are industry personnel monitoring graduates in workplaces. For comparison, data from academicians and professionals also were collected. Because of the diverse nature of engineering disciplines, the survey is limited to Civil Engineering graduates completing their studies from universities in Australia in recent years.

The collected data were analysed using statistical methods in levels of samples and population. The variables related to competencies have been ranked so that the weaknesses and strengths of the competencies can be understood. The variables related to the expectations of stakeholders are also ranked so that the competencies that should be prioritized in education are identified. The characteristics of stakeholders' satisfaction is defined based on the performance of graduates. Reliable models linking graduates' competence and the stakeholders' satisfaction have been developed. These findings will be useful to improve the quality of engineering education especially in the division of Civil Engineering.

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1. INTRODUCTION

The purpose of the thesis is to study the quality of graduate attributes of Civil Engineering in higher education. The attributes would include competence and performance of graduates. To analyse the quality, other factors such as the satisfaction and expectations of stakeholders with the graduate also would be studied to obtain useful information for providers of Civil Engineering education to improve its outcome quality.

The study has been conducted by reviewing literature, collecting data and analysing data. The data were collected using questionnaire sets developed based on factors, variables and indicators. The respondents were industry personnel who have closely monitored graduates working in workplaces. For comparison, data from academicians and professionals were also collected. All the data were analysed using statistical techniques.

The results of analyses will reveal useful information. The variables of competencies are ranked so that the weaknesses and strengths of the competence of graduates can be defined. The variables of expectations are ranked so that the competencies that should be prioritized by in education can be known. The characteristics of stakeholders' satisfaction will be defined based on the performance of graduates and reliable models linking the graduates' competence and the stakeholders' satisfaction can be developed. These findings will be useful to improve quality of engineering education especially in the division of Civil Engineering. Section 1.1 presents the background to the study exploring the importance of higher education in general and more especially in the Civil Engineering field.

1.1. Background of the study

Higher education or post-secondary education is non-compulsory education provided by tertiary institutions such as universities and other higher education institutions that award academic degrees. Studies in higher education are undertaken at undergraduate and postgraduate levels. The undergraduate level emphasizes the realm of teaching whereas the postgraduate level emphasizes research. Students at undergraduate level are awarded Bachelor degrees after completing a designated period of study while those who undertake postgraduate receive Masters or a Doctoral degree.

The main activities of higher education can be categorised into: teaching; research and social service. Teaching is the activity that directly delivers knowledge, skills and attitude to students and communities; Research is an activity to develop science and technology useful for communities; and Social service is an activity to improve quality of communities. These activities indicate that higher education is very important in modern society. UNESCO, the international organization specializing in educational affairs, states that higher education now acts as an essential component of development for individuals, communities and nations (*Reforming Higher Education* 2005). Because of the importance of higher education, the percentage of the population undertaking it can be an indicator of the development of a country. In developed countries, a high proportion of the population, up to 50 %, enters higher education at some time in their lives to develop knowledge and skills (*Higher education: Overview* 2007).

The importance of higher education can also affect the socio-economic sector because it significantly generates economic activities. One report has stated that higher education is very important as a significant industry in its own right (*Higher education: Overview* 2007). Hundreds or thousands of people can be employed in higher education institutions so that they can generate a multiple economic effect. In a developed country, higher education has been acknowledged as a contributor to the country's intellectual, economic, cultural and social development (*Higher education summary* 2007). Higher education is very important to economies, industries, individuals and communities (Spinks, Silburn & Birchall 2007; Tryggvason & Apelian 2006).

One of the prominent products of higher education is trained and skilled personnel namely graduates. Graduates of higher education in various workplaces can contribute valuable knowledge and skills to industry as they are trained and educated personnel (*Higher education: Overview* 2007). Through technical entrepreneurship, they can bring about technical revolutions that can meet the challenges in modern society (Wani, Garg & Sharma 2003). Graduates are also the future professional workforces, future leaders that may provide jobs, drive the economy, facilitate cultural and trade activities, and improve international relationships (*Higher education summary* 2007).

In an education-industry relationship, higher education institutions are viewed as suppliers of trained and skilled personnel to industry as the majority of graduates begin their careers in industry (Richter & Loendorf 2007). Many strategic positions in industries are held by graduates. For example, the management of construction has traditionally been the function of the civil engineer i.e. Civil Engineering graduates (Haltenhoff 1986).

Finally, because of the importance higher education, especially its graduates, its quality is an interesting topic of study. The study in this area needs to be focused on a certain faculty or division because each division relates to a certain industry. There are faculties and divisions representing different fields of study or academic disciplines. The number and type of faculty can vary depending on the development of industries, careers, professions and market needs. One such academic discipline is the engineering field.

1.1.1. Engineering in higher education

Engineering has a number of definitions based on contexts, but according to the Accreditation Board for Engineering and Technology (ABET), it is defined as:

> The creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behaviour under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property (Crnjac Milic, Martinovic & Fercec 2007).

Based on this definition, engineering discipline can be defined as a division or discipline in higher education studying the applied sciences to design, analyse, and construct works for practical purposes.

The field of engineering, like many other academic disciplines, encompasses several specialised sub-disciplines which are concern with different areas of engineering work and to some extent can be outlined as follows:

1. Aerospace Engineering - The design of aircraft, spacecraft and related topics;
2. Chemical Engineering - The conversion of raw materials into usable commodities;
3. Civil Engineering - The design and construction of public and private works, such as bridges and buildings;
4. Electrical Engineering - The design of electrical systems, such as transformers, as well as electronic goods;

5. Mechanical Engineering - The design of physical or mechanical systems, such as engines, kinematical chains and vibration isolation equipment;
6. Mining Engineering - The extraction of raw materials from the earth, including ores, natural gases and crude oils; and
7. Software Engineering - The design and development of software for use in digital systems (Pavlov et al. 2007).

The sub disciplines focus on specific issues. In each of these fields, there exists considerable overlap, especially in the areas of the application of sciences to their disciplines such as physics, chemistry and mathematics (Pavlov et al. 2007). Although initially an student engineer is trained in a specific discipline, throughout continued engineering education, the engineers may become multi-disciplined, having worked in several of the outlined areas (Pavlov et al. 2007). People who practice engineering are called engineers and one of the requirements as licensed engineers is the completion of education in the engineering field.

1.1.2. Civil engineering in higher education

According to the Institution of Civil Engineers (ICE), Civil Engineering is defined as:

> A great art, on which the wealth and well-being of the whole of society depends. Its essential feature, as distinct from science and the arts, is the exercise of imagination to fashion the products, processes and people needed to create a sustainable physical and natural built environment. It requires a broad understanding of scientific principles, knowledge of materials and the art of analysis and synthesis. It also requires research, team-working, leadership and business skills." (*What is Civil Engineering?* 2007).

Based on this definition, Civil Engineering can be defined as a sub-discipline of engineering that entails applied sciences to design, analyse, or construct public and private works, such as bridges, roads, railways, dams, water supply and wastewater treatment, harbours, tunnels and mining construction, power projects, offshore structures, and domestic, commercial, and industrial buildings. Civil Engineering is the oldest engineering discipline after military engineering (*Civil engineering* 2007) and it was defined to distinguish it from military engineering (Allendoerfer et al. 2007). Civil engineering is traditionally broken into several sub-disciplines including:

1. Construction engineering;

2. Environmental engineering;
3. Geotechnical engineering;
4. Structural engineering;
5. Transportation engineering
6. Water resources engineering;
7. Materials engineering; and
8. Coastal engineering (*Civil engineering* 2007).

Civil Engineering graduates generally work in the industry as civil and construction engineers, consulting engineers, general contractors or specialist subcontractors (*Civil Engineering* 2005).

1.1.3. Issues in engineering education

Although issues in engineering education are a multifaceted problem (Upadhyay et al. 2007), the issues can be examined under several categories. Firstly, one issue is enrolment in engineering education. Secondly, there is the issue of the education process of students.

1.1.3.1 Enrolment in engineering education

Enrolment is an important issue in engineering education because it can affect its quality. In order to boost the development of engineering education, the enrolment should be improved (Luo, Qi & Mao 2005). This basically, may be solved by encouraging students in Kindergarten to Year 12 (K-12) programs to enrol in engineering education. However, this approach could produce a distorted perception that many students enrolled in engineering programs drop out or complete with a low competency level (Mountain & Riddick 2005). Therefore, this impact can affect the quality and nature of engineering education resulting in graduates not meeting industry and professional standards and expectations.

1.1.3.2 Process in engineering education

The education process is an important issue in engineering education because graduates are developed through the process. The process can be examined in three main areas: teaching; learning and the curriculum,, all of which can affect the quality of engineering education.

Teaching is a process of providing students with knowledge, skills and professional attitudes by teachers or lecturers which is usually conducted in classrooms but can include activities such as fieldwork. Teaching in tertiary education is vital to producing qualified graduates who are employable. In order to meet the expectations of the engineering profession, engineering education needs to continuously learn new approaches of effective teaching (L Dee Fink, Ambrose & Wheeler 2005).

Learning is the conscious manner of students' acquisition of different types of knowledge, skills or attitudes, both in and out of classroom supported activities (*Learning* 2008). Recent studies on student learning in higher education indicated that there are relationships between the characteristics of the learning methods and the quality of graduates (Christiansson 2005; F. K. Fink & Kjaersdam 2004; Tynjala et al. 2005; Zualkernan & Sakka 2005).

The curriculum in education can be viewed as a guide or the goal of education. It is the set of courses, course work, and content offered at a school or university through which students should be graduates who would be a success in professional society (*Curriculum* 2008). The role of the curriculum is very important and many reports have discussed it high-lighting efforts that need to be made to develop curriculum so that it meets with the expectations of practices in professions and industries (Earnest 2005; Heitmann 2005; Luo, Qi & Mao 2005; Powell 2005). Fulfilment leads to the improvement of the quality of graduates. In practical terms, quality can be defined as employability of the graduate. Effective curricula in design and delivery are, therefore, important for graduates' quality.

1.1.4. Education outcome

All the issues indicate that the matter of education outcomes is important that is graduates must obtain certain competencies developed through the process of education. Therefore, a qualified graduate is the goal of the education.

However, some reports indicate that the quality of graduate competence seriously needs to be improved to meet the requirements of industry (Earnest 2005; Heitmann 2005; Luo, Qi & Mao 2005; Powell 2005). The quality can be examined based on assessment and expectations of the industry and profession.

1.2. Formulation of the problem

As mentioned in section 1.1, the role of engineering education is very important for industry. One of main contributions of engineering education is to provide qualified graduates and because of the importance, the quality of graduates is an aspect that should be measured continuously (*Higher Education and Education for All* 2005).

Recently, some reports as presented in section 1.1.4 have indicated that the quality of engineering graduates needs to be improved to meet industry needs. The improvement of graduates quality can be achieved by improving enrolments and the education process including teaching methods, learning methods, and the curriculum. Any improvements should be followed up by investigating the outcome of education.

Many studies as presented in section 1.1.3 have been conducted to improve the quality of engineering education graduates, however, no extensive investigation has not been reported in scientific journals on how well engineering graduates fit stakeholders' expectations in an industry that is undergoing rapid change.

This investigation should be conducted within a framework of education and industry relationship (Gregory 2006; Stansfield 2005). The industry can be assumed as stakeholders of engineering education. The investigation in this framework needs to focus on a certain faculty or division because each division has own specific needs and Civil Engineering would be the focus of an investigation as explained in sections 2.4.

1.3. Objectives of the study

As stated in section 1.2, this study will focus on the quality of graduates of Civil Engineering. In order to make this study specific, the objectives are formulated as follow.

The **first objective** of this study was to measure the quality of Civil Engineering graduates. The quality is defined as competencies mastered by graduates, so the measurement was focused on the graduates' competence. The measured competence can be viewed as actual or existing competence mastered by the graduates. The actual competence could also be ranked that show the seeds of graduates' actual competence. This is the main objective of this study.

Once this objective is understood, several related factors are very valuable to be examined and analysed. The factors include: stakeholders' expectations and satisfaction with their competence; and graduates' performance in workplace.

The **second objective** of this study was to measure the stakeholders' expectations with graduates' competence. The expectation was measured to know the importance levels or rankings of the competence that should be mastered by graduates. With certain methods, the importance levels were compared with rankings of actual competence. Comparison between the actual and expectation would produce lists of priority of competence.

The **third objective** of this study was to compare between stakeholders' expectations. This objective needs to be achieved because the stakeholders consist of various groups. The comparison revealed differences among groups of stakeholders (King & Fries 2003).

The **fourth objective** of this study was to select competencies that should be prioritised to be mastered by graduates. The prioritised competencies was achieved based on comparison between rankings of expected competence and rankings of actual competence.

The **fifth objective** of this study was to investigate the relationship between graduates' performance and stakeholders' satisfaction. The investigation revealed the characteristics of stakeholders' satisfaction based on graduates' performance. In order to investigate the relationship, these factors that conceptually have relationships with graduates' competence were measured.

The **sixth objective** of this study was to develop models linking graduates' actual competence and stakeholders' satisfaction with graduates. The models formulate the relationship between the two concepts. The formulation can be used to understand the relationship between them.

The **seventh objective** of this study was to feedback to civil education providers because this study should benefit large communities especially in engineering education. The rankings of competence, the rankings of expectations, the differences among stakeholder groups, the prioritised competencies, the characteristic of stakeholders' satisfaction and the models could provide valuable information to improve the quality of Civil Engineering education. For instant, the seven objectives in this study were:

1. to investigate actual graduates’ competence and its rankings;
2. to investigate rankings of expected graduates’ competence;
3. to compare expectations on the graduates’ competence;
4. to select competencies that should be prioritised to be mastered by graduates;
5. to investigate relationship between graduates’ performance and stakeholders’ satisfaction with graduates’ competence;
6. to develop models linking graduates’ competence and stakeholders’ satisfaction; and
7. to provide feedback to education providers.

To achieve the objectives, the theoretical framework, the definitions, the relationships and the variables are needed. Justification and development of these objectives will be presented in section 2.4.

1.4. Outline of the study

An outline of the study is proposed to briefly explain its stages, limitations and benefits of this study. The stages are a breakdowns of this study that each part has specific aim. The limitations are definitions of objects of this study so that this study could be conducted within certain constrains. The benefits are positive effects of this study for communities..

1.4.1. Stages of the study

To conduct a scientific study, the topic must have a systematic method that includes stages with certain targets or aims. Table 1-1 shows the seven stages or seven chapters contained in this thesis. Each stage will be a chapter.

Table 1- 1 Tasks of study completion

Task	Chapter
1. Introducing the background, objectives and outline of the study	1
2. Presenting the literature review related to the theory, concepts, variables and their relationship	2
3. Developing a methodology to collect primary data	3
4. Investigating the quantity and quality of collected data	4
5. Analysing collected data	5
6. Discussion of the findings	6
7. Drawing conclusions and making recommendations	7

Source: Resume of section 1.4.1

The first task was to introduce the background, the problems, and the objectives. This task has been explained in the introduction chapter. The second task was to develop a theory including concepts, variables and the relationship between them. The concepts consist of competence, performance, satisfaction and expectation. Examination of the relationship between them should deliver new information as to the objectives and this dealt with in the literature review. The third task i.e. the chapter on methodology developed and established methods to obtain the data needed. The fourth task was to present and describe the collected data so that its quantity and quality can be understood. This task will be contained in chapter of data collected. The fifth task, data analysis, will analyse the data so that new information as stated in the objectives can be obtained. The sixth task is to discusses the findings so that the advantages and disadvantages of this study can be understood. This task will be contained in chapter of finding and discussion. The seventh task is to draw conclusions the study and make recommendations.

1.4.2. Limitations of the study

There are many graduates, branches and levels of engineering education with variety in learning methods and varying curricula. There are too many different stakeholders of engineering education. It is impossible to cover every aspect of the problems so limitations must be made to enable the study to be conducted within the planned timeframe.

The limitations include: kinds of engineering institutions; graduates; stakeholders; and the locations of samples. Institutions will be limited to civil engineering and construction education. Kinds of graduates would be limited to 4-year program graduates who have completed the education less than three years i.e. 2004, 2005 or 2006. Stakeholders would be limited to industry personnel, academicians and professionals. Data collection would be limited to Australia. For instance, this study is limited to:

1. Civil engineering and construction education;
2. 4-year education or undergraduate program;
3. Graduates that completed the education in 2004, 2005 or 2006;
4. Stakeholders that are industry personnel, academicians and professionals; and
5. Data that would be collected in Australia.

The limitation in data sources would be explained in section 3.6.

1.4.3. Benefits of the study

Improvement of the quality in education is very difficult task (Bilsel & Erdil 2004), hence studies in the quality of education are very useful. The findings of this study will benefit to society in the following ways:

6. Actual graduates' competence could be used to evaluate the effectiveness of the education processes.
7. Expectations could be used to improve the quality of the education.
8. Comparisons could be made to understand differences between or among stakeholders in the expectations of graduates.
9. Prioritised competencies could be used to gradually improve the quality of education.
10. The models could be used to predict the satisfaction level based on graduates' competence.
11. The models could be used by human resource departments as a job application support system to select required personnel in the construction industry.
12. The model also could be used to evaluate and improve the curriculum and learning methods.

The study would be useful for communities to improve the quality of education, especially in the civil engineering and construction fields. Improvement of the quality should increase the employability of their graduates (Middleton 2005).

1.5. Summary of the introduction

A study on the competence of engineering graduates is very important in evaluating and improving current engineering education. Others factors related to graduates' competency such as graduates' performance, stakeholders' satisfaction and stakeholders' expectations also need to be investigated in order to make the study more valuable. Many benefits will be achieved if this study is properly undertaken.

The aim of this chapter is to introduce the problem, to design the objectives and to present an outline of the study. The problem is formulated based on the gap between the actual quality and expected quality of engineering education. The objectives assume factors that have relations with the quality and have been arranged so that new information can be obtained. The outline described the stages, limitations and benefits of the study. The introduction has given general information of the study so the next i.e. chapter 2 contains the literature review to develop and justify the objectives of the study.

2. LITERATURE REVIEW

The aim of this chapter is to review the literature in order to develop the objectives of study so that the framework of the study can be established. It introduces engineering education (in section 2.1), reviews the competencies of graduate (in sections 2.2), reviews the recent studies (in section 2.3) and reviews the design or theory of the study (in section 2.4). From these reviews the objectives of this research into graduate competencies in Civil Engineering education are developed and justified.

2.1. Recent condition in engineering education

Engineering education allows students to develop engineering related competencies through teaching, learning and the curriculum. At tertiary levels, engineering education is conducted intensively in various disciplines to train and educate graduates.

The role of engineering education is viewed as a fundamental matter in the modern world (Tryggvason & Apelian 2006). This review focuses on the quality of graduates delivered by engineering education to industry in which majority of graduates begin their careers working on practical engineering problems (Richter & Loendorf 2007).

Recently, engineering education faces many challenges relating to the quality of the graduates. The challenges can be categorised into the enrolment and the process of education. In an education-industry relationship, the quality of graduates can be defined as the compatibility between competencies mastered by graduates and the expectations of industry.

Many reports have indicated that there are major changes in industry related to the development of technology and globalization. Engineering education faces significant challenges to meet the expectations of the engineering profession and industry (L Dee Fink, Ambrose & Wheeler 2005). Expectations that graduates are more “job-ready” and those who are able to compete in the global economy are increasing (Richter & Loendorf 2007). The number of engineering students, however, has been declining in some countries and the challenge for engineering educators is to meet industry expectations when working with students whose entry into education may be less robust than the past (Gregory 2006; Qing Li et al. 2008).

These changes and expectations create new requirements which can only be met by reforming engineering education (Lehto 2006), hence, efforts to meet any reasonable expectations should be conducted through engineering education where the challenges can be properly addressed. Although some engineering education institutions have changed in response to various societal changes (Yeung 2006), stakeholders still question the quality of engineering education and its graduates (Upadhyay et al. 2007).

The efforts to meet the expectations of industry should start by identifying the existing state of engineering education and the expectations of industry. Any gaps between what exists and expectations would suggest the need for future improvement in engineering education. Improvement of engineering graduates based on industry's expectations would strengthen ties between industry and engineering education (Gregory 2006). The link could avoid misleading of change in engineering education (Stansfield 2005). Thus, improved engineering education would be useful for the community and especially for the industry.

2.2. Competence of graduates

The competency of graduates is ability mastered by graduates as the outcome of their education. During the process of education, it is tested by examinations and assignments so that the graduates have academic records and certificates indicating their competence. The quality of competence is usually indicated by marks in five levels from low to high.

After completing their education, graduates must use their competencies to undertake their jobs. Success of graduates in workplaces and communities is affected by their competence levels. The competencies levels should be monitored by employers, clients and communities where the graduates work. Hence, the measurement of competencies of graduates could be conducted based on information from the employers, the clients of the graduates. However, as there is no uniform method in place to test or measure the competence of graduates in workplaces, factors of the competence must be established.

Although there are many kinds of competencies to be mastered by graduates, they can be categorized into three factors, i.e. knowledge, skills and attitudes. Eunok and Janghyun (2005) stated that new curricula in engineering education should focus on fostering practical skills in order to meet technical and industrial needs. Jordan et al. (2005) showed that among the outcomes of courses, improvement of knowledge and attitudes were important. Massa, Masciadrelli and Mullett (2005) stated that engineering education should prepare their students with knowledge, skills, and attitudes needed to succeed in a workplace. Pomales-Garcia, Liu and Soto (2006) concluded that the current literatures on excellence in engineering education should stress the importance of knowledge, skills and attitude expected by stakeholders.

Knowledge is a theoretical understanding of a engineering subject acquired by graduates through education with the ability to use it for a specific purpose (*Knowledge* 2008). It is useful for: analysing, learning, associating, reasoning, understanding and communicating engineering problems in workplaces.

Skill is the capacity of graduates to carry out pre-determined engineering jobs with the minimum outlay of time or energy (*Skill* 2008). It is useful for executing engineering jobs in the workplace.

Attitude is a mental state or judgment of graduates connecting them to problems of their job (*Propositional attitude* 2008). Judgement is the result of observational learning of graduates from their environment (*Attitude in psychology* 2008). Attitude is useful for supporting job success in workplaces.

Graduates' competence that includes those three factors should be a base of investigation of both the existing competence of engineering education and the expected competence of stakeholders. With using the same factors, the gaps between them could be measured. Such investigation needs to review recent studies related to competencies of graduates (as in section 2.3) so that a design of the study can be established.

2.3. Recent studies conducted in engineering education

The quality of engineering education has gained increased attention by communities of educators, researchers and industry personnel since the 1990s (Paladini 2006; Pomales-Garcia, Liu & Soto 2006). Yet, the quality of engineering education is still an interesting topic for study because of issues that are developing as changes in the profession and industry emerge.

At the beginning of the 21st century, the National Academy of Engineering released a national report calling for major educational reform in the United States in order to improve the quality of graduates (Mead et al. 2007). The report underscores the need to advance teaching and learning (Mead et al. 2007).

Since then, to improve quality, many scientific journal articles have been published reporting and discussing development in engineering education. Moreover, a leading international organization, United Nations Educational Scientific and Cultural Organization (UNESCO), has established the Unesco International Centre for Engineering Education (UICEE) that has many satellite centres across the world. However, engineering education still faces several fundamental problems.

In scientific journals and at conferences around the world, studies and discussions on how to improve the quality of engineering education have been reported. Many universities have been making efforts to recognize the challenges faced by engineering education institutions and making improvements to achieve excellence in engineering education (Pomales-Garcia, Liu & Soto 2006). Studies conducted in the quality of engineering education could be divided into several categories, i.e. theoretical, teaching, learning, curriculum and outcome.

2.3.1. Theoretical category

Some theoretical studies of engineering education have been conducted. McDermott, Nafalski et al. (2004) examined the drivers and their implications in engineering education. Grasso et al. (2004) identified that there is a compelling need to reconsider, rejuvenate and realign engineering education because of its shortcomings in engineering education. Luo, Qi & Mao (2005) suggested improving the curriculum and increasing the student population to boost the development of engineering education. McAlpine et al. (2005) presented an approach to enhance engineering education that involved collaboration between engineers and educators. Upadhyay et al. (2007) identified parameters that influence the quality of an engineering education system such as teaching, learning and the curriculum. The studies generally concluded that a better quality of graduates should be achieved by appropriate teaching methods, learning methods and curricula.

2.3.2. Teaching category

A number of researchers have conducted studies on teaching of engineering education. Fink, Ambrose and Wheeler (2005) introduced a theory for identifying what educators and institutions can do to generate more powerful forms of engineering education. Jordan et al. (2005) discussed improvements and the significant effects of an engineering course on students' attitudes and knowledge in a class. Powell (2005) indicated the importance of lecturers with industry experience in engineering education. Richter & Loendorf (2007) also endorsed the advantages of lecturers with industrial experience in engineering education as students became more “job-ready”.

Based on such reports, it can be concluded that teaching can significantly affect students' attitudes and knowledge and graduates’ success. Although improvement in teaching methods in engineering education have been discussed in some reports, new methods of effective teaching need to devised to meet the expectations of the engineering profession (L Dee Fink, Ambrose & Wheeler 2005).

2.3.3. Learning category

Developments in learning methods have been reported in many scientific journals . The learning methods include problem-based learning, work-based learning, project-based learning, laboratory-based learning, resource-based learning, experience-based learning, case-based learning, simulation-based learning, context-based learning, computer-based learning, web-based learning, Java-based learning, multimedia-based learning, internet-based learning, and digital-based learning.

In the problem-based learning (PBL) method, Chiang and Fung (2004) reported that its implementation using a certain tool was useful for enhancing critical thinking skills. Gijbels, van de Watering et al. (2005) also noted that it had a positive effect on written assessment tasks. De Camargo Ribeiro & Mizukami (2005) stated that it was an learning method that can be used to respond to the challenges in engineering education because the method effectively worked to developed knowledge, skills and attitudes. In the work-based learning (WBL) method, Brodie and Irving (2007) stated that it was increasingly viewed as a valuable and essential learning method in a wide variety of sections in higher education. Costley and Armsby (2007) also stated that WBL was undertaken in education because of its advantages. Other reports on learning methods can be found in Wall and Sarver (2003), Mathew and Earnest (2004b), Burgstahler et al (2004), Chenail (2004), Howell et al. (2004), Song et al. (2004), Stewart (2004), Kiili (2005) and Tallent-Runnels et al. (2005).

From these reports it can be concluded that proper learning methods can significantly improve the quality of engineering education graduates. However, the effectiveness of some methods in engineering education needs to be further examined (Zualkernan & Sakka 2005) and further studies need to be conducted to identify what learning methods are appropriate for engineering students (Dym, Rossmann & Sheppard 2004).

2.3.4. Curriculum category

As regards the curriculum in engineering education, some studies have been conducted. A curriculum is traditionally defined as content of knowledge that should be acquired by students (Lemaitre et al. 2006) and should focus on developing student competencies (Lohmann, Rollins & Hoey 2006). The development of curriculum in engineering education has been reported in several scientific journals although it has not changed appreciably since the 1950s (Lang et al. 1999). Several extra subjects or courses have been suggested for the addition of knowledge, skills or attitudes to the engineering curriculum to improve the quality of graduates.

Mgangira (2003) noted that institutions of higher education should design their programs to meet the expectations or demands of industry to ensure that the graduates acquire the knowledge and skills that will be used in employment. Devon et al. (2004) specifically suggested that the curriculum in engineering needs to be reorganized because the design ideas and methods that cut across most fields of engineering have grown rapidly in the last two or three decades. Prados et al. (2005) reported new criteria for qualified engineering graduates developed by the Accreditation Board for Engineering and Technology (ABET). Lohmann, Rollins and Hoey (2006) presented a curriculum model for instilling certain competence. Froyd, Layne and Watson (2006) presented a framework for the process of curricular change including goals for change; objects for change; barriers of change; mechanisms of change; models of change; agents of change; and the role of faculty development.

Based on their reports, it can be concluded that curriculum is important guide for engineering education but it is difficult to make a suitable curriculum fits in with development in the professions and industries. Therefore, further study should be conducted. In practice, teaching methods, learning methods and curricula combine to produce qualified graduates. The outcome of teaching, learning and curriculum in engineering is graduates' competence (Winkelman 2006).

2.3.5. Outcome category

The outcome can be defined as competencies possessed by the graduates. Saunders and Saunders (2004) presented a tool used to assess certain competence qualifications i.e. business skills required by engineering graduates. Powell (2005) notified a deficiency of engineering education outcome offered by engineering education. Luo, Qi & Mao (2005) indicated that the development of engineering education seriously falls behind the growth of industry because the engineering education institutions were unable to meet the expectations of industry. Lehto (2006) reported an ongoing work carried out in Finland since the early 1990s aimed at restructuring engineering education to meet the requirements of the European high-tech industry in the 2010s.

Based on these reports, the quality of graduate competence needs to be improved to meet the expectations of industry. Although some studies have been conducted, the quality of engineering education is an interesting topic to study because quality follows development and the changes in the profession and industry.

Based on the review, a design of the study would be established. The design would include other factors such as graduates' performance and stakeholders' satisfaction. The design is explained in section 2.4.

2.4. Theory of the study

As suggested in section 2.3, further studies about the quality of engineering education needs to be undertaken. They basically relate to the quality of the graduates' competencies so the study should be conducted in that area. Furthermore, reports of improvement in outcomes of engineering education were rarely discussed in scientific reports.

This study would focus on the outcome of engineering education which accords to a new trend in engineering education, i.e. the outcomes-based education. This trend has been inspired by the rapid technological development in the profession and industry. The emergence of outcomes-based approaches requires new instruments to measure the success of engineering education programs offered by universities (Chong & Crowther 2005).

This study has to be viewed in the context of education-industry relationship. This view is essential because one of the fundamental problems faced by engineering education is how well their education prepares graduates to enter a profession (engineering), (Jones & Jones 2007) that has been transformed by technological development and globalization in industry (Brito, Ciampi & Budny 2007; Jones & Jones 2007).

2.4.1. Theoretical framework for the study

The theory in this study, has four elements or concepts, i.e. the graduates' competence, stakeholders' expectation on graduates' competence, the graduates' performance in workplaces, and the stakeholders' satisfaction with graduates shown diagrammatically in Figure 2-1. Explanation of the theory will focus on the definition of concepts, the relationships between them, and the establishment of variables.

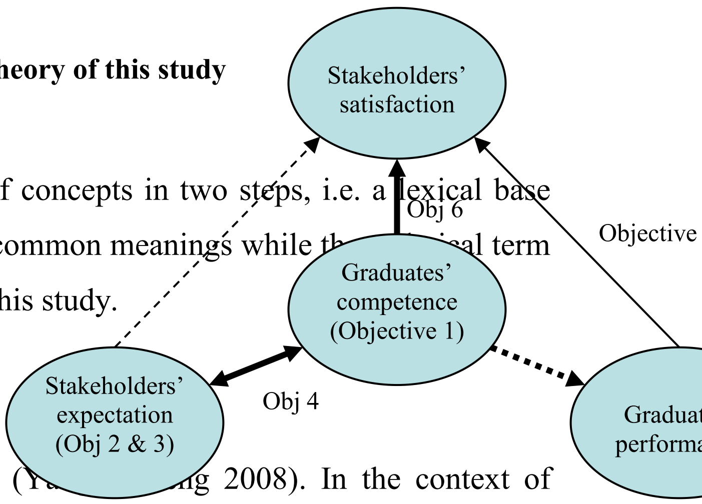

Figure 2-1 Diagram of the theory of this study

2.4.2. Definitions of the concepts

The theory of study starts with definitions of concepts in two steps, i.e. a lexical base and a technical base. The lexical definitions deliver common meanings while the technical term definitions deliver specific meanings that prevail in this study.

2.4.2.1 The concept of graduates' competence

Competence is the ability to perform tasks (Y[illegible]ng 2008). In the context of human resources, competence is a standardized requirement for an individual to properly perform a specific job (*Competence: human resources* 2007). It encompasses a combination of knowledge, skills and attitudes utilised to improve performance (*Competence: human resources* 2007).

Competence would be examined using information provided by employers and users of the graduates so it can be viewed as the actual competence or the existing competence of Civil Engineering graduates in workplaces. In other words, actual competence is defined as the actual level of ability mastered by Civil Engineering graduates to perform their jobs in the workplace. Graduates' actual competence may affect the their performance in workplaces and influence stakeholders' satisfaction with the graduates (Richards 2006).

Data of the actual competence could be ranked so that ranking of actual competence mastered by graduates can be understood. The ranking would indicate the order of elements of competence mastered by graduates. The ranking of actual competence can be compared with ranking of competence expected by stakeholders.

The examination of graduates' competence would be limited as the result of their education. The object of examination i.e. Civil Engineering graduates is limited for those completed their undergraduate study in three year later, i.e. 2004, 2005 and 2006.

2.4.2.2 The concept of stakeholders' expectations

Expectations means something which is expected or looked for (*Expectation* 2008). In this study, the expectation of stakeholders with Civil Engineering graduates is ranked so that the importance of competencies that should be mastered by the graduates was understood. Competence would be limited for that to conduct jobs in workplaces. The ranking can be viewed as expected competence should be mastered by Civil Engineering graduates and can be compared with the ranking of actual competence.

As the importance level of expected competence may be different from actual competence, a comparison will reveal those that must be prioritised in process of Civil Engineering education. However, a comparison can only be conducted if factors and variables of expected competence are similar to actual competence. The Civil Engineering graduates also were limited for those completed their undergraduate study in three year later, i.e. 2004, 2005 and 2006.

2.4.2.3 The concept of graduates' performance

Performance lexically is an achievement of activities (*Performance* 2008). In this study, the performance of graduates will be investigated based on their performance in workplaces. The performance is a factor that may affect stakeholders' satisfaction (Richards 2006).

Because the investigation of graduates' performance in workplaces was limited for performance or achievement in their job, the factors and variables of the performance would refer how well they did their job. Civil engineering graduates also were limited for those completed their undergraduate study in three year later, i.e. 2004, 2005 and 2006.

2.4.2.4 The concept of stakeholders' satisfaction

Satisfaction lexically is a perception of fulfilment of needs or expectations (*Satisfaction* 2008). In this study, the satisfaction of stakeholders on graduates' competence and performance will be investigated and again limited to graduates that completed their studies and undertook jobs in three year later, i.e. 2004, 2005, and 2006. The satisfaction is a purely perception of respondents on graduates' performance. Therefore, the satisfaction assessment is based on the perception of respondents.

The satisfaction of stakeholders or customers is an important indicator of success of products including education (Grisaffe 2004). Studies of customer satisfaction have been conducted in various areas such as market segmentation (Wu & DeSarbo 2005), E-Commerce (Peide 2007), telecommunication (Turkyilmaz & Ozkan 2007), residential construction (Forsythe 2007) and construction project management (Yang & Peng 2008). In the education sector, only limited number of studies have been conducted. Aldridge and Rowley (1998) conducted reported on students' satisfaction with services delivered by a educational institution. Robson (2005) described marketing co-operative education in an attempt to increase customer satisfaction. However, these studies did not investigate competencies of graduates as outcomes or products of education.

2.4.3. The relationship between the concepts

As stated in section 2.4.1, the relationships between the concepts must be defined in order to develop the objectives. The relationship would be a base and direction of analyses to obtain the objectives.

Generally, there two kinds of the relationship in this study i.e. comparison and correlation. A comparison will reveal the similarities and differences between concepts, while a correlation will discover the effect of one concept to others. With assumptions of data, the relationship would be lead for prediction of findings of this study as described in section 3.1.

2.4.3.1 The relationship between actual competence and expected competence

The relationship between these two competences was comparisons to discover gaps or differences between them. Gaps would exist if the value of expectation was higher than actual competence. The gaps should be eliminated in the process of Civil Engineering education. Their elimination will lead to increased of stakeholders' satisfaction (Azapagic, Perdan & Shallcross 2005; Heng Li, Scott & Love 1999; Markes 2006; UNESCO 2006; Whitman et al. 2004). The intensity of the gaps would indicate the importance of competencies that should be prioritised in engineering education as stated in the fourth objective of study.

2.4.3.2 The relationship between graduates' competence and graduates' performance

According to Saeed, Grover and Hwang (Saeed, Grover & Hwang 2005) the relationship between graduates' competence and graduates' performance is a positive correlation. Competence is the cause; while performance is the effect. If competence is high, performance is also high. Understanding the correlation is important to improve the graduates' competence and performance. Based on a positive relation, Chalidabhongse, Jirapokakul and Chutivisarn (2006) developed the Job Application Support System to aid interviewers screening candidates based on competencies accepting only those what have shown good performance in workplaces. The relationship between graduates' competence and performance is important to as it can help to improve quality of education.

2.4.3.3 The relationship between graduates' performance and stakeholders' satisfaction

The relationship between graduates' performance and stakeholders' satisfaction is a positive correlation (Haaijer & Rosbergen 2005; Peide 2007; Wu & DeSarbo 2005; Yang & Peng 2008). Performance is viewed as the cause; while satisfaction is the effect. If performance is high, satisfaction is also high. In this study, this relationship will be used to explain the characteristic of satisfaction of stakeholders.

In order to understand the characteristic of satisfaction, the correlation between graduates' performance and stakeholders' satisfaction needs to be investigated. It can indicate which factors of performance affecting stakeholders' perceptions of satisfaction. The investigation of correlation can help in understanding the characteristic of satisfaction as stated in the fifth objective of the study.

2.4.3.4 The relationship between graduates' competence and stakeholders' satisfaction

The relationship between graduates' competence and stakeholders' satisfaction should be a positive correlation based on the relationships that have previously been explained. They are: the relationship between graduates' competence and graduates' performance; and the relationships between graduates' performance and stakeholders' satisfaction. In this relationship, competence was the cause; while satisfaction was the effect. If the competence is high, the satisfaction is also high. Understanding the correlation is important to improve graduates' competence and stakeholders' satisfaction.

To understand deeply the relationship, models that formulate links between competence and satisfaction need to be developed. If the models have high reliability, they could be used to develop curriculum and learning method design and lead making reliable models as stated in the sixth objective of study.

2.4.3.5 The relationship between expected competence and stakeholders' satisfaction

There was not a direct relationship between expected competence and stakeholders' satisfaction. However, expected competence may be used to discuss the characteristics of stakeholders' satisfaction. The expected competence also could be used to validate stakeholders' satisfaction.

2.5. The establishment of variables

Variables are key elements of concepts that can be measured by planned instruments (Singarimbun & Effendi 1989). There are two concepts in this study for which variables should be established i.e. graduates' competence and performance. Competence variables will be used in the measurement of graduates' actual competence and stakeholders' expectations (expected competence) and performance variables will be used to measure of graduates' performance. This section will establish these variables of graduates' competence and performance.

2.5.1. Variables of graduates' competence

As stated in sections 2.4.2, and 2.4.3, graduates' competence is the actual ability of graduates of Civil Engineering that relate to their performance and stakeholders' satisfaction. Variables need to be developed and established because there is no set that can exactly represent graduates' competence.

Establishing competence variables is crucial but it is not a simple matter because of several reasons. Firstly, the term "competence" has many definitions. Lemaitre et al. (2006) state that there are many terms referring to the "notion of competence" in a broad sense. Secondly, competence is likely to include a huge number of variables. Rodrigues, Oliveira and De Souza (2005) stated that a simple classification is not sufficient for the identification of competence. Furthermore, the variables will not satisfy all stakeholders. Lohmann, Rollins and Hoey (2006) maintain that although there was abroad agreement within the engineering community for better prepared engineers, there was much less agreement as to what competence should be mastered.

However, in this study variables will be derived from attributes of competence that have been promoted by professional and educational organizations. This method may be simpler because several competence sets that have been promoted by organizations (Chisholm 2003).

Engineers Australia (EA), an institution that accredits engineering programs carried out by universities in Australia has identified 10-generic attributes that should be mastered by engineering graduates including Civil Engineering graduates (Bradley 2005). Although the attributes are very general, they can be rearranged according to needs of the study. The promoted attributes are:

1. the ability to apply knowledge of basic science and engineering fundamentals;
2. the ability to communicate effectively, not only with engineers but also with the community at large;
3. an in-depth technical competence in at least one engineering discipline;
4. the ability to undertake problem identification, formulation and solution;
5. the ability to utilise a systems approach to design and operational performance;

6. the ability to function effectively as an individual and in multi-disciplinary and multi-cultural teams, with the capacity to be a leader or manager as well as an effective team member;
7. an understanding of the social, cultural, global and environmental responsibilities of the professional engineer;
8. an understanding of the principles of sustainable design and development;
9. an understanding of professional and ethical responsibilities and commitment to them; and
10. an expectation of the need to undertake lifelong learning, and a capacity to do so.

Education providers generally establish attributes that should be mastered by their graduates. Curtin University of Technology, for example, has nine attributes for engineering graduates including its Civil Engineering graduates (Scott & Gribble 2005; Yeo 2006). They can be used as references for establishing variables and specify that that graduates should be capable of:

1. Applying discipline knowledge, principles and concepts;
2. Thinking critically, creatively, and reflectively;
3. Accessing, evaluating and synthesising information;
4. Communicating effectively;
5. Using technologies effectively;
6. Utilising lifelong learning skills;
7. Recognising and applying international perspectives;
8. Demonstrating cultural awareness and understanding; and
9. Applying professional skills.

Based on the attributes promoted by Engineers Australia and Curtin University of Technology, the variables of competence were arranged. Firstly, the graduates' competence can be divided into three factors, i.e. knowledge, skills and attitude as described in section 2.2. Secondly, the number of variables in each factor should be nine so there will be twenty-seven variables in three factors as shown in Table 2- 1.

Table 2- 1 Established factors of competence and number of variables

No	Factors of competence	Arranged number of variables
1	Knowledge	9
2	Skills	9

3	Attitude	9

Source: Resume of section 2.5.1

The number of competence variables in each factor affects workability of this study especially in the data collection. Based on experience (Musyafa 2003), a nine-variable in each factor or twenty-seven variables in all are likely to be appropriate numbers. Knight and Banks (2003) presented a set of 26 generic statements about competencies that should be mastered by the engineering graduates. A similarity of numbers in each group will facilitate data collection and analysis.

2.5.1.1 The variables of competence in knowledge

The arrangement of knowledge variables with its unique code is shown in Table 2- 2. The codes will be used for identification of variables. Each variable refers to the attributes promoted by Engineers Australia or Curtin University of Technology or scientific reports as discussed in the following paragraphs.

Table 2- 2 Established variables of knowledge competence and their codes

Code	Variables of knowledge competence
K1	Understand principles and concepts associated with Civil Engineering
K2	Understand basic science and engineering fundamentals associated with Civil Engineering
K3	Understand in-depth technical knowledge in at least one Civil Engineering discipline
K4	Understand problem identification, formulation and solution associated with Civil Engineering
K5	Understand how to utilise a systems approach to design and operational performance associated with Civil Engineering
K6	Understand the principles of sustainable design and development associated with Civil Engineering
K7	Understand laws, regulations and standards associated with Civil Engineering
K8	Understand the principles of management and business associated with Civil Engineering
K9	Understand other disciplines associated with Civil Engineering i.e. electrical, mechanical, architectural or urban planning fundamentals

Source: Resume of section 2.5.1.1

The first knowledge competence (K1), "**understanding principles and concepts associated with Civil Engineering**", means that graduates must understand and apply principles and concepts or phenomena in Civil Engineering such as structures, loading, and equilibrium. This variable accords to the first attribute demanded by Curtin and is an important component of a graduate's competence. Profound mastery of relevant principles and concepts provides an essential foundation for the attainment of knowledge and understanding in engineering subjects (Savander-Ranne & Kolari 2003). The principle and concepts have significant correlations with performance in the engineering workplace (Brandon 2006).

The second knowledge competence (K2), "**understand basic science and engineering fundamentals associated with Civil Engineering**", means that graduates must understand and apply basic science, mathematics, physics, and statistics. This variable accords to the first attribute demanded by EA and is an important component of graduate' competence. According to Grunwald and Schott (2004), a knowledge of mathematics and basic sciences is crucial for conducting creative work.

The third knowledge competence (K3), "**understand in-depth technical knowledge in at least one Civil Engineering discipline**", means that graduates must be able to understand and apply in-depth technical knowledge, such as design methods. This variable accords to the third attribute demanded by EA and could be a graduates' special competence.

The fourth knowledge competence (K4), "**understand problem identification, formulation and solution associated with Civil Engineering**" means that graduates must be able to understand and apply a systematic approach to solve problems in the workplace. This variable accords to the fourth attribute demanded by EA. According to Savander-Ranne and Kolari (2003), acquisition of problem-solving is an important goal of engineering education. ABET EC 2000 states that engineering graduates must have an ability to identify, formulate and solve engineering problems (Mourtos, DeJong Okamoto & Rhee 2004). Oehlers (2006) even stated that the main objective of a university design course is not the design project itself but to train students to solve problems.

The fifth knowledge competence (K5), "**understand how to utilise a systems approach to design and operational performance associated with Civil Engineering**" means that graduates must be able to understand and apply a systemic approach to undertake their job. This variable accords to the fifth attribute demanded by EA. To utilize the system, graduates need an integrated knowledge structure which according to Liu and Fang (2002) is very important.

The sixth knowledge competence (K6), "**understand the principles of sustainable design and development associated with Civil Engineering**", means that graduates must be able to understand and apply a sustainable approach. This variable accords to the eighth attribute demanded by EA. Because of its importance, Delft University of Technology in the Netherlands conducted an exercise with sustainable development as an integral part of the exercise (Melkert 2003). To utilize sustainable design and development, it is very important for graduates to possesses an integrated knowledge structure (Liu & Fang 2002).

The seventh knowledge competence (K7), "**understand laws, regulations and standards associated with Civil Engineering**" means that graduates must understand and apply related regulations in their jobs. Jobs in the construction industry often relate to laws, regulations and standards. This variable could be categorized into soft engineering issues. According to Caspersen (2002), qualified graduates must understand soft engineering competence to achieve business goals especially in a global company. Training in legal matters is very important for graduates (Curtin 2005)

The eighth knowledge competence (K8), "**understand the principles of management and business associated with Civil Engineering**" means that graduates must be able to understand and apply management and business. The ability to compete in global business should be mastered by graduates (Richter & Loendorf 2007). This variable could be categorized into soft engineering issues. This variable must be mastered by qualified graduates to achieve business goals especially in a global company (Caspersen 2002). Graduates, through technical business or entrepreneurship, can bring a about technical revolutions that can meet the challenges in modern society (Wani, Garg & Sharma 2003).

The ninth knowledge competence (K9), "**understand other disciplines associated with Civil Engineering i.e. electrical, mechanical, architectural or urban planning fundamentals**" means that graduates must be able to understand and apply other disciplines. This competence could be important because of reality in the workplace. In many engineering projects, graduates need a close working relationship with other groups such as planners, architects, and environmentalists (Curtin 2005).

2.5.1.2 The variables of competence in skills

The arrangement of skill variables with its unique code is shown in Table 2-3. The codes will be used for identification of variables. Each variable refers to the attributes promoted by EA, Curtin University of Technology or scientific reports as discussed in the following paragraphs.

Table 2- 3 Established variables of skill competence and their codes

Code	Variables of skills competence
S1	Apply in-depth technical skills in at least one Civil Engineering discipline
S2	Use technologies appropriately
S3	Access, evaluate and synthesise information
S4	Communicate effectively not only with engineers but also with the community at large
S5	Function effectively as an individual
S6	Function effectively in multi-disciplinary or multi-cultural teams
S7	Function effectively in teams with the capacity to be a member
S8	Function effectively in teams with the capacity to be a manager
S9	Function effectively in teams with the capacity to be a leader

Source: Resume of section 2.5.1.2

The first skill competence (S1), "**apply in-depth technical skills in at least one Civil Engineering discipline**" means that graduates must be able to apply in-depth technical skills such as expertise in construction methods and computer software. This variable accords to the third attribute demanded by EA. Jobs in the construction industry need to be conducted using technical skills for enhancing quality and efficiency, therefore, an ability to apply in-depth technical skills, especially in information technology, is crucial. According to Udaipurwala and Russell (2002), construction professionals expect fast and reliable access to rich data sources.

The second skill competence (S2), "**use technologies appropriately**" means that graduates must be able to apply certain technology related to a job. This variable accords to the fifth attribute demanded by Curtin. Modern industry, including the construction industry, uses technologies to enhance quality and efficiency. Graduates should able to apply technology appropriate to their jobs.

The third skill competence (S3), "**access, evaluate and synthesise information**" means that graduates must able to seek new information as part of an effort to make innovations. This variable accords to the third attribute demanded by Curtin. Abilities of innovation are very important in industries (Liu & Fang 2002), so that graduates should be able to access, evaluate and synthesize information.

The fourth skill competence (S4), "**communicate effectively not only with engineers but also with the community at large**" means that graduates must able to apply effective communication in the workplace to express their ideas. This variable accords to the second attribute demanded by EA and to the fourth attribute demanded by Curtin. Communication skills are very important for Civil Engineering graduates since they have to communicate with many people in their community and in the construction industry (Ravesteijn, De Graaff & Kroesen 2006). Because of its importance, communication skills including oral, written and presentation techniques should be one goal of Civil Engineering education (Liu & Fang 2002). Communicative competence also involves in creating a social base for innovation (Ravesteijn, De Graaff & Kroesen 2006).

The fifth skill competence (S5), "**function effectively as an individual**" means that graduates must be able to work individually. This variable accords to the sixth attribute demanded by EA. This important competence can be a reality if graduates have an integrated knowledge structure and multi-level knowledge (Liu & Fang 2002).

The sixth skill competence (S6), "**function effectively in multi-disciplinary or multi-cultural teams**" means that graduates must be able to work with peoples of different cultures or disciplines. Abilities of adaptation, cooperation, communication and organization are very important for graduates (Liu & Fang 2002) as engineering tasks are carried out in interdisciplinary teams (Warnecke, Ostermayer & Koklu 2004). This variable accords to the sixth attribute demanded by EA.

The seventh skill competence (S7), "**function effectively in teams with the capacity to be a member**", means that graduates must be able to function effectively as member of the organization. This variable accords to the sixth attribute demanded by EA. Abilities of cooperation and organization should be a goal of Civil Engineering education (Liu & Fang 2002).

The eighth skill competence (S8), "**function effectively in teams with the capacity to be a manager**", means that graduates must be able effectively to manage a job. This variable accords to the sixth attribute demanded by EA. Abilities of cooperation and organization should be a goal of Civil Engineering education (Liu & Fang 2002). Many civil engineers become managers in the construction industry and as managers, they control human resources, equipment, and funds. Hence, Civil Engineering graduates have to master the art of management especially construction management.

The ninth skill competence (S9), "**function effectively in teams with the capacity to be a leader**" means that graduates must be able to lead persons or people to achieve goals. This variable accords to the sixth attribute demanded by EA. Abilities of cooperation and organization should be a goal of Civil Engineering education (Liu & Fang 2002).

2.5.1.3 The variables of competence in attitudes

The arrangement of skill variables with its unique code is shown in Table 2-4. The codes will be used for identification of variables. Each variable refers to the attributes promoted by EA, Curtin University of Technology or scientific reports as discussed in the following paragraphs.

Table 2- 4 Established variables of attitude competence and their codes

Code	Variables of attitude competence
A1	Think critically, creatively, reflectively in their work
A2	Committed to undertake lifelong learning
A3	Committed to meeting ethical responsibilities in their work
A4	Committed to meeting environmental responsibilities in their work
A5	Work with international and global perspectives
A6	Committed to developing further his or her professional skills
A7	Committed to working effectively with different cultural groups
A8	Committed to using effective group skills in his or her workplace
A9	Committed to develop effective interpersonal skills in his or her workplace

Source: Resume of section 2.5.1.3

The first attitude competence (A1), "**think critically, creatively, reflectively in their work**", means that graduates are committed to generate new ideas or innovations. For that reason, the graduates are required to think creatively and critically (Abdul-Shukor 2003). This variable accords to the second attribute demanded by Curtin. Innovation should be one goal of Civil Engineering education (Liu & Fang 2002).

The second attitude competence (A2), "**committed to undertake lifelong learning**", means that graduates are committed to improve their competence in the workplace. This variable accords to the sixth attribute demanded by Curtin and accords to the tenth attribute demanded by EA. This variable is important because although science and technology continue to develop, the curriculum is very limited. Competence in life-long learning is identified as a challenge to the graduates in the 21st century (Burns & Chisholm 2003) and self-directed learning competence is of prime importance in the success of innovation processes (Bary & Rees 2006).

The third attitude competence (A3), "**committed to meeting ethical responsibilities in their work**", means that graduates are committed to apply ethical responsibility in the workplace. This variable accords to the ninth attribute demanded by EA. Because of its importance, an interest in engineering ethics education focusing on individual professional responsibility and technology development has developed significantly (Herkert 2000). Ethical responsibility develops along with the development of engineers' roles in their societies. In fact, many civil engineers become construction managers who have policymaking duties.

The fourth attitude competence (A4), "**committed to meeting environmental responsibilities in their work**" means that graduates are committed to applying environmental responsibility. This variable accords to the seventh attribute demanded by EA. Recently, the environment has become an important issue in societies.

The fifth attitude competence (A5), "**work with international and global perspectives**" means that graduates are committed to international and global perspectives. This variable accords to the seventh attribute demanded by EA and Curtin. Global competence of the ability to work and live in an international environment and global society should be mastered by graduates (Lohmann, Rollins & Hoey 2006). They should learn to work together in teams with team members from different countries (Caspersen 2002).

The sixth attitude competence (A6), "**committed to developing further his or her professional skills**" means that graduates are committed to the development of professional skills. This variable accords to the ninth attribute demanded by Curtin and EA. Competence associated with Continuous Professional Development (CPD) is identified as a challenge for the graduates in the 21st century (Burns & Chisholm 2003).

The seventh attitude competence (A7), "**committed to working effectively with different cultural groups**" means that graduates are committed to working effectively with other cultural groups. This variable accords to the eighth attribute demanded by Curtin and accords to the seventh attribute demanded by EA. Graduates should learn to work together in teams with team members from various cultural groups (Caspersen 2002).

The eighth attitude competence (A8), "**committed to using effective group skills in his or her workplace**", means that graduates are committed to using group skills effectively in the workplace. This competence includes the ability to organize. Abilities in cooperation and organization should be goals of Civil Engineering education (Liu & Fang 2002).

The ninth attitude competence (A9), "**committed to develop effective interpersonal skills in his or her workplace**", means that graduates are committed to using interpersonal skills effectively in the workplace. This competence includes emotional intelligence that has been identified as a challenge to graduates in the 21st century (Burns & Chisholm 2003).

2.5.2. Variables of graduates' performances

As mentioned in sections 2.4.2, 2.4.3, and 3.1, graduate performance is how far jobs undertaken by graduates of Civil Engineering relate to stakeholders' satisfaction. Variables should be developed and established because there is no set that can exactly represent performance.

Establishing variables of performance of a graduate's job is not simple because the jobs vary. However, variables can be derived from attributes of performance that have been promoted by professional organizations and scientific reports. Usually performance of jobs is measured by three project constrains, i.e. time, cost and quality (Chen & Huang 2006; Gao, Hu & Zhong 2007; Sun & Matsui 2007). The constrains could also be used to measure graduates' performance.

Graduates' performance variables are shown in Table 2- 5 presenting the codes, factors and variables. Each factor has a variable referring to the performance of jobs promoted by professional organisation or scientific reports. Three variables are used to measure performance i.e. time, cost and quality.

Table 2- 5 Established factors of satisfaction and variables

No	Factors of performance	Variable
P1	Time	Comparison between actual and planned time

P2	Cost	Comparison between actual and planned cost
P3	Quality	Comparison between actual and planned quality

Source: Resume of section 2.5.2

The first performance variable (P1), "**comparison between actual and planned time**", means that graduates' performance is indicated by the duration needed by graduates to complete their jobs. The second performance variable (P2), "**comparison between actual and planned cost**", means that graduates' performance is indicated by the cost needed by the graduates to complete their jobs. The third performance variable (P3), "**comparison between actual and planned quality**", means that graduates' performance is indicated by the quality of jobs conducted by graduates.

2.6. Summary

In this chapter, the recent condition of engineering education has been introduced, the factors of graduates' competence have been identified and previous studies on how to its improve the quality have been explored. The design of the study to improving quality of engineering education has been presented including the framework, concepts and variables of the study. The theory of the study is summarised in Table 2- 6.

This study needs data of actual competence, expected competence, graduates' performance and stakeholders' satisfaction. They would be analysed to achieve the findings. If the objectives are achieved, useful feedback would be available to improve the quality of engineering education. The next chapter describes the methodology to obtain data.

Table 2- 6 Summary of the theory of the study

No	Concepts	Definitions	Relationship with other concepts	Variables
1	(1) Graduates' competence	See section 2.4.2.1	(2) See section 2.4.3.1 (3) See section 2.4.3.2 (4) See section 2.4.3.4	See Table 2- 1 to Table 2- 4
2	(2) Expected competence	See section 2.4.2.2	(1) See section 2.4.3.1 (4) See section 2.4.3.5	See Table 2- 1 to Table 2- 4
3	(3) Graduates' performance	See section 2.4.2.3	(1) See section 2.4.3.2 (4) See section 2.4.3.3	See Table 2- 5

4	(4) Stakeholders' satisfaction	See section 2.4.2.4	(1) See section 2.4.3.4 (2) See section 2.4.3.5 (3) See section 2.4.3.3	-

Source: Resume of chapter 2.

3. METHODOLOGY

The aim of this chapter is to establish a methodology to obtain data for analysis according to the objectives of study. Methodology affects the quality of data for analysis which in turn affects the quality of findings (Sugiyono 1999). Because the methodology will affect quality of data and then findings; it should be based on reliable articles in the scientific literature from various disciplines. In sampling method, it must enable to obtain qualified data i.e. data that have high precision with the population (Sugiyono 1999).

The methodology includes instrument development, data source selection, and data collection method. The instrument is a tool to collect data (Riduwan 2003) about graduates' actual competence, graduates' performance, stakeholders' expectation and satisfaction from data sources (respondents). The data sources are people assumed to possess the information to become respondents, i.e. employers, graduates, academicians and professionals relating to Civil Engineering graduates. The data collection method is a manner to deliver the instruments to respondents.

As selected data sources and data collection will affect each other, these two factors will be conducted simultaneously. The methodology establishment would be started with the hypotheses of the study (section 3.1), instrument development (sections 3.2, 3.3, 3.4, and 3.5), data sources (section 3.6) and data collection method (section 3.7).

3.1. Hypotheses of the study

To develop the methodology, the hypotheses or predicted findings are needed to presented. The hypotheses are made based on the objectives presented in section 1.3, the theory of the study presented in section 2.4 and the variables presented in section 2.5. The presentation will use illustrations or tables.

3.1.1. Investigation of graduates' competence

The first objective of the study was to investigate graduates' actual competence. Investigation in this area may be to be conducted (Burgess et al. 2005). To develop this objective, several terms need to be defined including terms graduates and competence.

Graduates, as stated in sections 1.4.2 and 2.4.2.1, are those with a 4-year civil engineering and construction education certificate of higher education completed in 2004, 2005 or 2006. Competence, as stated in section 2.5.1, is defined as the 27 variables divided into the three groups i.e. knowledge, skills and attitude.

Based on the definitions, this objective would examine to understand levels of each competence variable from graduates who completed in those years. The levels of competence variables in the group is shown in Figure 3- 1. According to the theory, graduates' competence would be linked with stakeholders satisfaction enabling models to be developed.

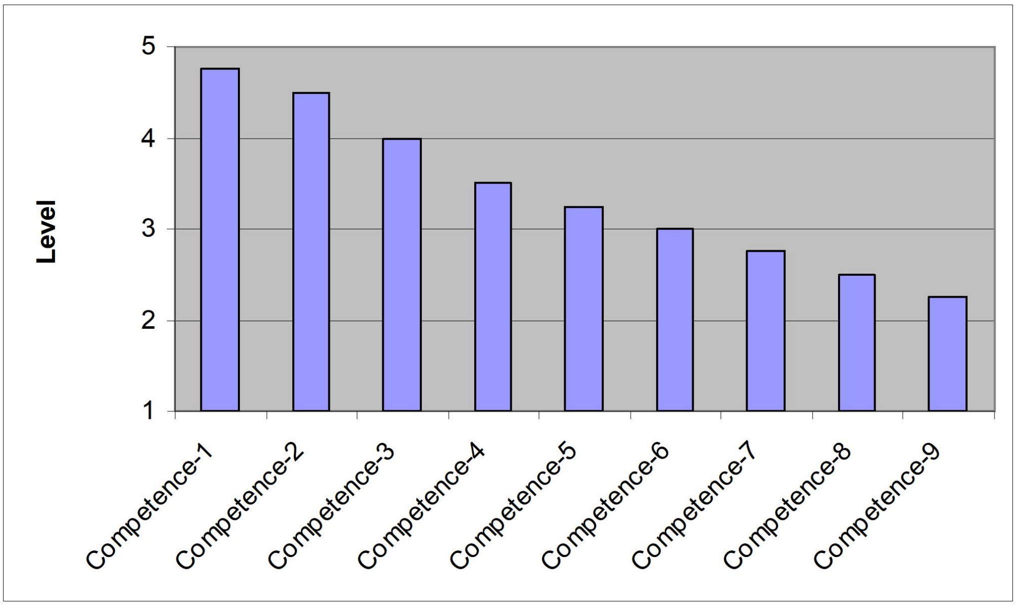

Figure 3- 1 The predicted results of graduates' competence

Graduates' competence also would compared with stakeholders expectation. Because the expectation would be in form of ranking, graduates' competence must be ranked too. The predicted result of the ranking is illustrated in Figure 3- 2. The ranking will be useful for identifying which competence variables, high or low, are possessed by graduates. Moreover, along with ranking of expected competence, prioritised competencies can be made.

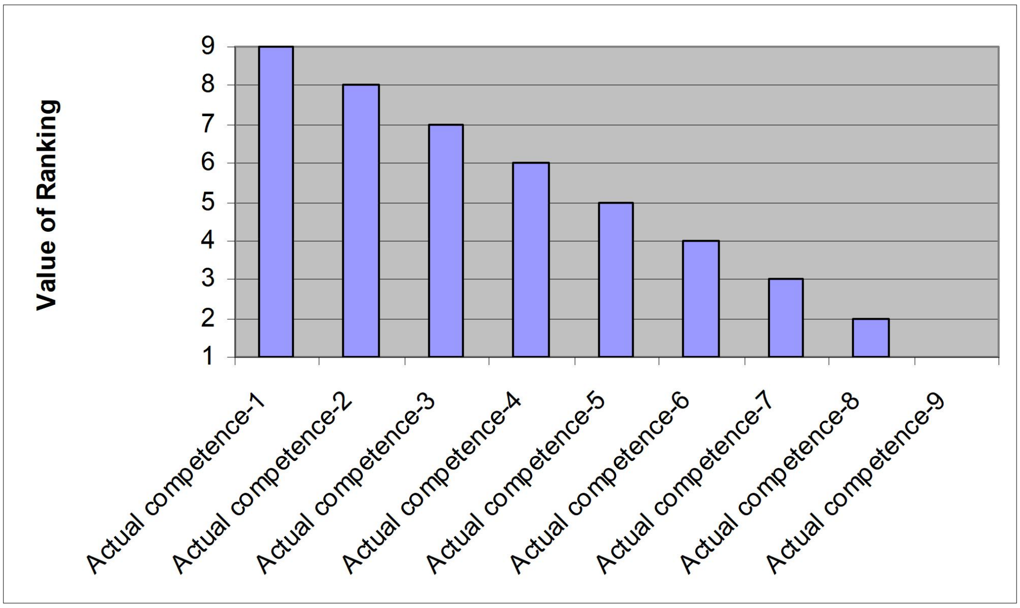

Figure 3- 2 The predicted results of the competence ranking

This investigation was conducted in workplaces of the construction industry in Australia with the graduates working in the industry. Data of competence was collected from graduates and employers complemented by academicians and professionals. Respondents, therefore, were encouraged to assess the graduates' actual competence. Therefore, the result could indicate the effectiveness of education process and therefore be a benchmark for quality improvement

Based on the predicted finding, a method to measure the competence variables could be established. In this study, the measurement used the Likert Scale in five levels as presented in sections 3.2.1 and 3.3.1.

3.1.2. Investigation of stakeholders' expectations

The second objective of this study was to investigate the stakeholders' expectations on graduates' competence. Understanding the expectations from stakeholders would be useful for improving education outcomes because they could also be a target for quality improvement of the education process. To develop this objective, several limitations applied including terms of expectation and stakeholders. If the investigation were not limited, it would be very difficult to undertake relating to the number of expected competencies and measurement methods.

The expectation was limited as expectation with the importance rankings of competencies. Because it would be compared with the actual competence as stated in section 2.4.3.1, variables in the expectation must be similar to those of actual competence. Stakeholders are those related to graduates in both education process and workplaces. Therefore, this objective examines stakeholders' expectation to understand the ranking of importance of competence variables that should be mastered by graduates who completed their studies in 2004, 2005 or 2006

The predicted results of this objective are illustrated in Figure 3-3 indicating the importance rankings of nine variables of expected competence. The rankings will be useful for identifying which competence variables, high or low, are expected by stakeholders. The rankings can be viewed as stakeholders' hopes of the graduates' competence that they should have in order to undertake their jobs, so the expectations are needs that should be fulfilled by education. In addition, the ranking of expected competence can also be compared with the ranking of actual competence that would indicate gaps between actual and expected competencies. The information would lead to making prioritised competencies as discussed in section 3.1.4.

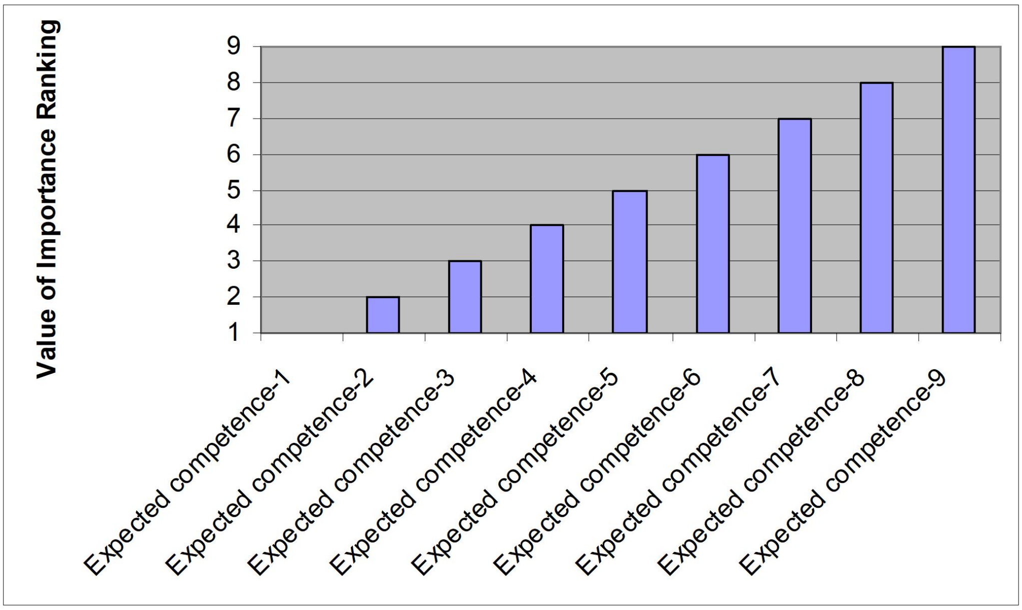

Figure 3- 3 The predicted results of the expectation investigations

Like the investigation in the first objective, this investigation was conducted in workplaces of the construction industry in Australia with the graduates working in the industry. To get this result, data of expectation was collected from appropriate people of stakeholders including industry personnel (employers and graduates), academicians and professionals. Based on the predicted finding, a method to measure the expectation could be established. In this study, the measurement used ranking as presented in section the 3.3.4.

3.1.3. Comparison between expectations

The third objective of this study was to compare expectations based on kind of stakeholders. This comparison will deliver validated statements of similarities and differences of stakeholders' expectations. The statements would be useful for improving education outcomes (Abu-Eisheh 2004). There were indications that such expectations would be different. King and Fries (2003) stated that there were differences between expectations of stakeholders in biomedical engineering. Furthermore, Heng Li, Scott and Love (1999) stated that there was a gap of expectation in construction IT skills/ knowledge between academic preparation and industrial expectations.

Two kinds of comparison were made, i.e. a comparison between two stakeholders and a comparison among all stakeholders. The results of comparison between stakeholders are illustrated in Table 3- 1 showing the differences between two stakeholders calculated based on certain statistical techniques. The results were validated with a appropriate probability for the circumstance (Santoso 2001; Sugiyono 1999).

Table 3- 1 The predicted results of the comparisons of expectations between stakeholders

Stakeholder / Stakeholder	Stakeholder-1	Stakeholder-2	Stakeholder-3	Stakeholder-n
Stakeholder-1	-	Competence-1	Competence-1	Competence-1
Stakeholder-2	-	-	Competence--n	-
Stakeholder-3	-	-	-	Competence-2
Stakeholder-n	-	-	-	-

Source: Prediction result of comparison between stakeholders

The results of a comparison among stakeholders is illustrated in Table 3- 2 showing differences among all stakeholders calculated based on certain statistical technique. The results were validated with a appropriate probability for the circumstance (Santoso 2001; Sugiyono 1999).

Table 3- 2 The predicted results of the comparisons of expectations among stakeholders

Attribute Code	Stakeholder-1	Stakeholder-2	Stakeholder-3	Stakeholder-n	Inference
Competence-1	1	2	3	4	Different
Competence-2	3	3	3	3	Not Different
Competence-3	4	4	4	4	Not Different
Competence-n	1	1	1	1	Not Different

Note: 1, 2, 3 and 4 are values or rankings of expectations from stakeholders
Source: Prediction result of comparison among stakeholders

A statistical technique would be used to conduct the calculations. The method will be discussed in section 5.3.

3.1.4. Prioritised competencies

The forth objective of this study was to arrange graduates' competencies that should be prioritised by the education institutions based on stakeholders' assessment and expectations. Paying attention to the prioritised competencies, the education providers could improve stakeholders' satisfaction (Miles, Styers & Nesbit 2007).

To develop this objective, a definition and method of prioritised competencies must be established. The prioritised competencies are defined as competencies that deserve prior attention by education provider in order to improve stakeholders' satisfaction.

The method of arranging prioritised competencies was a comparison between actual and expected competencies. The expected competence values are subtracted by the actual competence values. If the results are positive (more than nil) or if the value of expected competence is more than the value of actual competence, the competence needs to be prioritised (Abu-Eisheh 2004). In order to make comparison, expectation and assessment values must be in the same form. More details about the method will be explained in the section 5.3.3.

The results of the prioritisation are illustrated in Figure 3- 4 calculated on a comparison between expected competencies (as illustrated in Figure 3- 2) and actual competencies (as illustrated in Figure 3- 3). As defined in sections 2.4.2.1 and 2.4.2.2, the actual competencies were those that were mastered by graduates based on stakeholders' assessments while the expected competencies were competencies that graduates should have based on stakeholders' expectations. The figure shows that "competence-9, 8, 7, 6, 5, 4, 3, 2, 1" should be prioritised respectively.

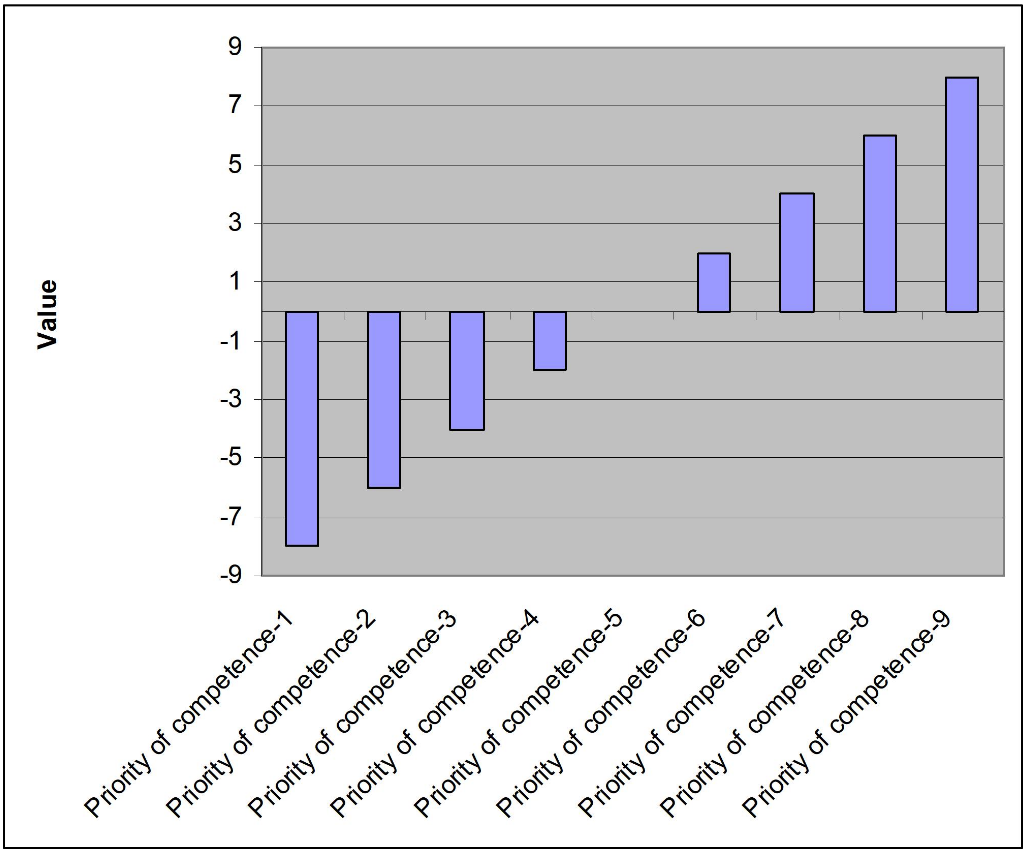

Figure 3- 4 The predicted results of the competence prioritisation

3.1.5. Investigation of satisfaction

The fifth objective of this study was to investigate characteristics of stakeholders' satisfaction. As defined in section 2.4.2.4, the satisfaction is a perception of stakeholders on graduates' performance in undertaking their jobs. The perception is an assessment that fully depends on respondents so that satisfaction does not have a variable. Therefore, the investigation should be related to graduates' performance (Burns & Chisholm 2003; Middleton 2005).

As defined in section 2.4.2.3, the graduates' performance is the way in which graduates' jobs run. In a workplace, performance can be indicated by performance of a jobs. The performance can include several factors or variables so that the investigation would reveal which the factors significantly relate to satisfaction. The relationship can be tested by certain statistical techniques so that it would lead to model development (Santoso 2001; Sugiyono 1999).

According to the theory, graduates' performance would be related to stakeholders' satisfaction. The investigation produced correlations between variables of performance and satisfaction. The result of the investigation is illustrated in Figure 3- 5 showing that the strongest factor related to satisfaction is "Performance-1".

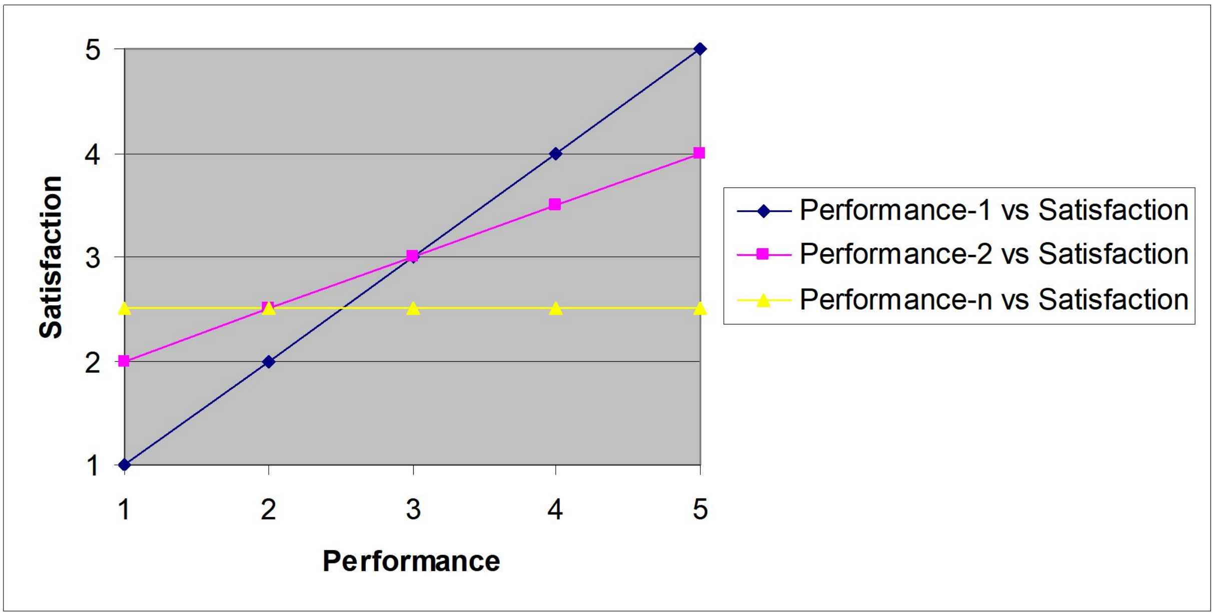

Figure 3- 5 The predicted results of the satisfaction investigation

The correlation will be useful for identifying the characteristic of satisfaction. According to Burns and Chisholm (2003), education providers should produce graduates whose performances will satisfy stakeholders. If the characteristic is understood, the correlation between satisfaction and actual competence can be investigated so that models can be developed. This correlation method will be explained in section 5.5.

This investigation was conducted in workplaces of the construction industry in Australia with the graduates working in the industry. Data of performance and satisfaction were collected from graduates and employers. Respondents, therefore, were encouraged to assess the performance and satisfaction. Based on the predicted finding, a method to measure the competence variables could be established. In this study, the measurement used the Likert Scale in five levels as presented in sections 3.3.2 and 3.3.3.

3.1.6. Development of models

The sixth objective of this study was to develop models that link competence and satisfaction. According to the theory, graduates' competence would be related to stakeholders' satisfaction. By developing models, a deeper understanding of the complex relationship between competencies and satisfaction can be gained. The models of relationship between them will be useful for formulating satisfaction improvement. According to Xu and Duhovic (2004), the stakeholders' satisfaction can be achieved by improving graduates' competence.

To achieve this objective, a method had to be developed. The models were developed in mathematical equations linking a dependent variable and independent variables. The satisfaction level was a dependent variable while the actual competence could be independent variables. Therefore, the developed models could predict a satisfaction level based on competence levels.

The results of model development is illustrated in Equation 3-1. In the development, regression techniques were used so that simple and reliable models could be established. Hence, a method including data requirement must be established.

$$S_L = a + b.C_L$$ ***Equation 3-1***

S_L = Stakeholders' satisfaction levels
a, b = Constants
C_L = Graduates' competence levels in certain variables

Figure 3-6 shows the plot of an illustrated model with values of a = 2 and b = 0,5. It shows a linear line indicating a relationship between graduates' competence and stakeholders' satisfaction. Although in the development, simple models are desired, a minimum accuracy of 50 % must be achieved. More detail about the model development will be discussed in section 7. .

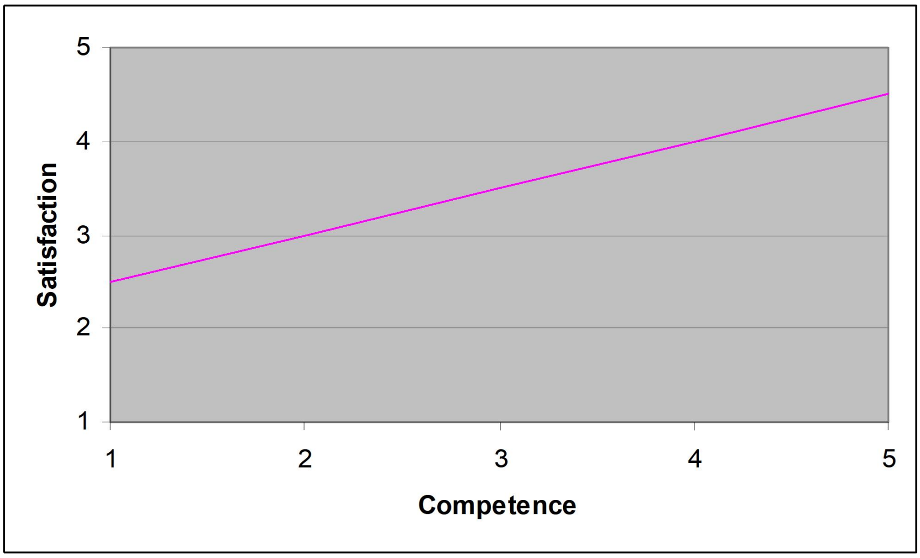

Figure 3- 6 The predicted results of the model description

3.2. Variant of variable

Since all the variables have been established and the findings have been predicted, the measurement method for each variable had to decided. The aim of measurement is to measure the quantity of variables that have been established.

There are basically four types of measurement result or data; i.e. ratio, interval, ordinal and nominal data (Riduwan 2003; Sugiyono 1999). The ratio and interval data are data that have levelled values that can be operated mathematically such as height in meters, weight in grams and temperature in Celsius (Sugiyono 1999). Ordinal data are data that have levelled values but can not be operated mathematically such as rankings of competence or expectation (Sugiyono 1999). Nominal data are data that do not have levelled values such as gender and location (Sugiyono 1999).

Each data type has advantages and disadvantages. In term of measurement, nominal data are the easiest to handle, while metric data are the most difficult (Santoso 2000). In terms of analyses, nominal data have many limitations, metric data, however, have fewer limitations.

However, the variables must be measured by appropriate methods so that measurements and analyses can be conducted easily. Hence, measurement methods of ordinal data would be used in this study.

3.2.1. Competence

Competence mastered by graduates must vary from very low to very high as shown in Table 3- 3. The number of variants for each competence variable is five. This number is decided based on the experience.

Table 3- 3 Variant of competence level and the value

Competence Level	Value
Very low	1
Low	2
Somewhat	3
High	4
Very high	5

Source: Ordinal data (Sugiyono 1999)

3.2.2. Performance

Performance graduates in workplaces must vary from very low to very high as shown in Table 3- 4. The number of variants for each performance variable is five. This number must be similar with the number of variants in satisfaction variable.

Table 3- 4 Variant of performance level and the value

Performance level	Value
Very low	1
Low	2
Somewhat	3
High	4
Very high	5

Source: Ordinal data (Sugiyono 1999)

3.2.3. Satisfaction

Satisfaction of stakeholder with graduates must vary from very low to very high as shown in Table 3- 5. The number of variants is five. It has to be similar with the number of variants in competence variables.

Table 3- 5 Variant of satisfaction level and the value

Satisfaction Level	Value
Very low	1
Low	2
Somewhat	3
High	4
Very high	5

Source: Ordinal data (Sugiyono 1999)

3.2.4. Expectation

Ranking of importance of competence should be mastered by graduates must vary from extremely very low to extremely very high as shown in Table 3- 6. The number of rankings has to be similar to the number of variables, i.e. 9.

Table 3- 6 Variant of importance level and the value

Importance Level	Value
Extremely very low	1
Very low	2
Low	3
Rather low	4
Somewhat	5
Rather high	6
High	7
Very high	8
Extremely very high	9

Source: Ordinal data (Sugiyono 1999)

To develop measurement methods, the indicators had to be decided (Singarimbun & Effendi 1989). The indicator for each variant in the variables are described in section 3.3.

3.3. Indicator of variant

Since variants for each variable have been established, the indicator must be decided. Indicators are need to avoid errors in the measurement of variables.

3.3.1. Indicator of variants in competence

As stated in section 3.1.1, the respondents of competence study are employers, graduates, academicians and professionals. Considering the targeted respondents' workload and questionnaire delivery method, the indicator of competence should be simple but scientific.

As has been previously established, there were 27 competence variables divided into 3 factors as shown in Table 2- 2, Table 2- 3 and Table 2- 4. To measure the variables, the Likert scale was used (Riduwan 2003) with indicators as shown in Table 3- 7.

Table 3- 7 Competence level, value and indicator

Competence Level	Value	Indicator
Very low	1	Respondents strongly disagree with statements of competence
Low	2	Respondents disagree with statements of competence
Somewhat	3	Respondents are not sure about statements of competence
High	4	Respondents agree with statements of competence
Very high	5	Respondents strongly agree with statements of competence

Source: Likert scale (Riduwan 2003)

3.3.2. Indicator of variants in performance

The respondents of performance data are employers and graduates. Considering the targeted respondents' workload and questionnaire delivery method, the indicator of competence had to be simple, even though simple, it had to be scientific. Although, indicators of the performance, except quality, could be measured in metric, the measurement of performance was conducted using ordinal measurement because the ratio measurement system creates difficulties in practice relating to the respondent's documents (Riduwan 2003).

Three performance variables divided into 3 factors as shown in Table 2- 5 and the Likert scale was be used (Riduwan 2003) with indicators as shown in Table 3- 8, Table 3- 9 and Table 3- 10.

Table 3- 8 Time performance level, value and indicators

Time performance level	Value	Indicators
Very low	1	The actual duration of jobs undertaken by the graduate is much longer than the planning
Low	2	The actual duration of jobs undertaken by the graduate is longer than the planning
Somewhat	3	The actual duration of jobs undertaken by the graduate is same as the planning

Time performance level	Value	Indicators
High	4	The actual duration of jobs undertaken by the graduate is shorter than the planning
Very high	5	The actual duration of jobs undertaken by the graduate is much shorter than the planning

Source: Likert scale (Riduwan 2003)

Table 3- 8 shows that time performance is good if graduates can undertake their jobs in a shorter time than planned.

Table 3- 9 Cost performance level, value and indicators

Cost performance level	Value	Indicators
Very low	1	The actual cost of jobs undertaken by the graduate is much more than the planning
Low	2	The actual cost of jobs undertaken by the graduate is more than the planning
Somewhat	3	The actual cost of jobs undertaken by the graduate is same as the planning
High	4	The actual cost of jobs undertaken by the graduate is Less than the planning
Very high	5	The actual cost of jobs undertaken by the graduate is much less than the planning

Source: Likert scale (Riduwan 2003)

Table 3- 9 shows that cost performance is good if graduates can undertake their jobs cheaper than planned.

Table 3- 10 Quality performance level, value and indicators

Quality performance level	Value	Indicators
Very low	1	The actual quality of any jobs undertaken by the graduate is much less than the planning
Low	2	The actual quality of any jobs undertaken by the graduate is less than the planning
Somewhat	3	The actual quality of any jobs undertaken by the graduate is same as the planning
High	4	The actual quality of any jobs undertaken by the graduate is more than the planning
Very high	5	The actual quality of any jobs undertaken by the graduate is much more than the planning

Source: Likert scale (Riduwan 2003)

Table 3- 10 shows that quality performance is good if graduates can undertake their jobs better in quality than planned.

3.3.3. Indicator of variants in satisfaction

The stakeholders' satisfaction is a purely perception of respondents on graduates' performance. Therefore, the satisfaction assessment is based on the perception of respondents. The measurement of satisfaction was be conducted using ordinal measurement in the Likert scale with indicators as shown in Table 3- 11.

Table 3- 11 Satisfaction level, value and indicator

Satisfaction Level	Value	Indicator
Very low	1	Respondents' perception
Low	2	Respondents' perception
Somewhat	3	Respondents' perception
High	4	Respondents' perception
Very high	5	Respondents' perception

Source: Likert scale (Riduwan 2003)

The table shows that there is no variable of the satisfaction measured in five levels in the Likert scale (Riduwan 2003).

3.3.4. Indicator of variants in expectations

The respondents of the expectations data are employers, graduates, academicians and professionals. Considering the targeted respondents' workload and questionnaire delivery method, the indicator of competence has to be simple.

The variable of expected competence was exactly the same as the variable of actual competence so there are 27 competence variables divided into 3 factors as shown in Table 2- 2, Table 2- 3 and Table 2- 4. The expectations would be measured in a rank scale (Riduwan 2003) as shown in Table 3- 12. The measurement is in nine levels because there are nine variables in the group. The respondents were given 9 variables of competence factor to rank in order of importance (Pomales-Garcia, Liu & Soto 2006).

Table 3- 12 Expectations (Importance Level), value and indicator

Importance Level	Value	Indicator
Extremely very low	1	Respondents' perception
Very low	2	Respondents' perception
Low	3	Respondents' perception

Importance Level	Value	Indicator
Rather low	4	Respondents' perception
Somewhat	5	Respondents' perception
Rather high	6	Respondents' perception
High	7	Respondents' perception
Very high	8	Respondents' perception
Extremely very high	9	Respondents' perception

Source: Rank scale (Riduwan 2003)

3.4. Measurement of variables

Since the variables, variants and indicators have been decided, measurement of variables could be conducted. There are four variable groups that should be measured e.g. measurements of competence, performance, satisfaction and expectations.

3.4.1. Measurement of competence

The 27 competence variables were measured by making 27 positive statements about graduates' competence in five levels (Riduwan 2003). Respondents were encouraged to choose only one of the variant of competence level based on the indicators shown in Table 3- 7. The statements are divided into three categories of competence as shown in Table 3- 13 to Source: Variables and measurement in Table 2- 3 and Table 3- 7

Table 3- 15.

Table 3- 13 Measurement of Knowledge

No	Statements about Knowledge The graduate:	Variants				
1	Understands **principles** and **concepts** associated with civil engineering	1	2	3	4	5
2	Understands **basic science** and **engineering fundamentals** associated with civil engineering	1	2	3	4	5
3	Understands **in-depth technical knowledge** in at least one civil engineering discipline	1	2	3	4	5
4	Understands **problem identification, formulation** and **solution** associated with civil engineering	1	2	3	4	5
5	Understands to utilise a **systems approach** to design and operational performance associated with civil engineering	1	2	3	4	5
6	Understands the principles of **sustainable design** and **development** associated with civil engineering	1	2	3	4	5
7	Understands **laws, regulations and standards** associated with civil engineering	1	2	3	4	5
8	Understands the principles of **management and business** associated with civil engineering	1	2	3	4	5
9	Understands **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	1	2	3	4	5

Source: Variables and measurement in Table 2- 2 and Table 3- 7

Table 3- 14 Measurement of Skills

No	Statements about Skills **The graduate is able to:**	Variants				
10	Apply **in-depth technical skills** in at least one civil engineering discipline	1	2	3	4	5
11	Use **technologies** appropriately	1	2	3	4	5
12	Access, evaluate and synthesise **information**	1	2	3	4	5
13	**Communicate** effectively not only with engineers but also with the community at large	1	2	3	4	5
14	Function effectively as **an individual**	1	2	3	4	5
15	Function effectively in **multi-disciplinary** or **multi-cultural teams**	1	2	3	4	5
16	Function effectively in teams with the capacity to be **a member**	1	2	3	4	5
17	Function effectively in teams with the capacity to be **a manager**	1	2	3	4	5
18	Function effectively in teams with the capacity to be **a leader**	1	2	3	4	5

Source: Variables and measurement in Table 2- 3 and Table 3- 7

Table 3- 15 Measurement of Attitude

No	Statements about Attitude **The graduate is able to:**	Variants				
19	T**hink** critically, creatively, reflectively in their work	1	2	3	4	5
20	Committed to undertake **lifelong learning**	1	2	3	4	5
21	Committed to meeting **ethical** responsibilities in their work	1	2	3	4	5
22	Committed to meeting **environmental** responsibilities in their work	1	2	3	4	5
23	Work with **international** and **global perspectives**	1	2	3	4	5
24	Committed to developing further his or her **professional skills**	1	2	3	4	5
25	Committed to working effectively with different **cultural groups**	1	2	3	4	5
26	Committed to using effective **group skills** in his or her workplace	1	2	3	4	5
27	Committed to develop effective **interpersonal skills** in his or her workplace	1	2	3	4	5

Source: Variables and measurement in Table 2- 4 and Table 3- 7

The final development of competence measurement can be seen on the third page of each questionnaire.

3.4.2. Measurement of performance

The 3 performance variables were measured by setting three questions about a comparison between the actual and the planned outcome of graduates' jobs with five choices to answer each question (Musyafa 2003). Respondents were encouraged to choose only one choice describing the existing condition. The questions and variants are shown in Table 3- 16.

Table 3- 16 Measurement of performance

No	Question about performance	Variants				
1	What is the **actual duration** of any jobs undertaken by the graduate?	1 Much longer than the planning	2 Longer than the planning	3 Same as the planning	4 Shorter than the planning	5 Much shorter than the planning
2	What is the **actual cost** of any jobs undertaken by the graduate?	1 Much more than the planning	2 More than the planning	3 Same as the planning	4 Less than the planning	5 Much less than the planning
3	What is the **actual quality** of any jobs undertaken by the graduate?	1 Much less than the planning	2 Less than the planning	3 Same as the planning	4 More than the planning	5 Much more than the planning

Source: Variables and measurement in Table 2- 5, Table 3- 8, Table 3- 9 and Table 3- 10

The final development of performance measurement can be seen on the fourth page of questionnaires for employers and graduates.

3.4.3. Measurement of satisfaction

The satisfaction was measured by asking about respondents' satisfaction on graduates' performance with five answers describing the satisfaction levels (Riduwan 2003). Respondents are encouraged to express their satisfaction by choosing only one answer describing the existing condition. The question and variants are shown in Table 3- 17.

Table 3- 17 Measurement of satisfaction

No	Question about satisfaction	Variants				
1	How satisfy are you with the outcome of any jobs undertaken by the graduate?	1 Highly Dissatisfied	2 Dissatisfied	3 Not sure	4 Satisfied	5 Highly Satisfied

Source: Measurement in Table 3- 11

The final development of satisfaction measurement can be seen on the fourth page of questionnaires for employers and graduates.

3.4.4. Measurement of expectations

The expectation was measured by encouraging respondents to give assessment for each variable. The assessment is delivering a ranking for each variable in a group (Riduwan 2003). The correlations between rankings and importance levels are shown in Table 3- 12. The 27 expectation variables are divided into three groups so that variables in each group have rankings 1 to 9. The measurements of expectation are shown in Table 3- 18 to Table 3- 20.

Table 3- 18 Measurement of expectation with Knowledge

No	Statements about Knowledge **The graduate should:**	Rank
1	Understand **principles** and **concepts** associated with civil engineering	……..
2	Understand **basic science** and **engineering fundamentals** associated with civil engineering	……..
3	Understand **in-depth technical knowledge** in at least one civil engineering discipline	……..
4	Understand **problem identification, formulation** and **solution** associated with civil engineering	……..
5	Understand how to utilise a **systems approach** to design and operational performance associated with civil engineering	……..
6	Understand the principles of **sustainable design** and **development** associated with civil engineering	……..
7	Understand **laws, regulations and standards** associated with civil engineering	……..
8	Understand the principles of **management and business** associated with civil engineering	……..
9	Understand **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	……..

Source: Variables and measurement in Table 2- 2 and Table 3- 12

Table 3- 19 Measurement of expectation with Skills

No	Statements about Skills **The graduate should be able to:**	Rank
1	Apply **in-depth technical skills** in at least one civil engineering discipline	……..
2	Use **technologies** appropriately	……..
3	Access, evaluate and synthesise **information**	……..
4	**Communicate** effectively not only with engineers but also with the community at large	……..
5	Function effectively as **an individual**	……..
6	Function effectively in multi-disciplinary or multi-cultural **teams**	……..
7	Function effectively in teams with the capacity to be **a member**	……..
8	Function effectively in teams with the capacity to be **a manager**	……..
9	Function effectively in teams with the capacity to be **a leader**	……..

Source: Variables and measurement in Table 2- 3 and Table 3- 12

Table 3- 20 Measurement of expectation with Attitude

No	Statements about Attitude **The graduate should be:**	Rank
1	Able to t**hink** critically, creatively, reflectively in their work	……..
2	Committed to undertake **lifelong learning**	……..
3	Committed to meeting **ethical** responsibilities in their work	……..
4	Committed to meeting **environmental** responsibilities in their work	……..
5	Able to work with **international** and **global perspectives**	……..
6	Committed to developing further his or her **professional skills**	……..
7	Committed to working effectively with different **cultural groups**	……..
8	Committed to using effective **group skills** in his or her workplace	……..
9	Committed to develop effective **interpersonal skills** in his or her workplace	……..

Source: Variables and measurement in Table 2- 4 and Table 3- 12

The final development of expectation measurement can be seen on the fifth page of questionnaires for employers and graduates or in the fourth page for academicians and professionals.

3.5. Instrument development

Instruments for the data collection must be developed as simply as possible but they must measure variables accurately. Based on the measurement methods shown in section 3.4, the instrument to collect data of this study was the questionnaire. According to Richardson (2006), survey with questionnaires is a useful tool for monitoring qualification indicators.

A questionnaire must consist of variable measurements and additional information (Riduwan 2003). The measurement of variables, the main component of the questionnaires, have been presented in section 3.4, so this section will develop the additional information. The additional information was developed so that respondent could enthusiastically and correctly respond to it. The additional information includes its title, respondent's detail, graduate's detail, and respondent's opinion.

3.5.1. The questionnaires title

The title is used to primarily identify the type of questionnaire so that by reading it, respondents can understand its topic (Riduwan 2003). The title of this questionnaire is "Attributes, job performance, satisfaction and expectation of Civil Engineering graduates". The title was decided based on the kinds of variables. Because there are four respondent groups, each group needs a subtitle. The subtitles are:

1. “Employer/supervisor of Civil Engineering graduates questionnaire”;
2. “Civil engineering graduates’ questionnaire”;
3. “Civil engineering educators’ questionnaire”; and
4. “Experts in a professional organisations’ questionnaire”.

The titles and subtitles can be seen on the first pages of each questionnaire presented in Appendix A to Appendix D.

3.5.2. The introduction to questionnaires

The introductory part of the questionnaire set was designed to introduce its aims and to encourage targeted personnel to participate in the study (Arikunto 1998). In the introduction, the key personnel, contact details, institution, benefits, rights and obligation are presented. In order to make respondents respond correctly, their role is also explained. The final development of introduction can be seen on the first pages of each questionnaire presented in Appendix A to Appendix D. Beside of the introduction, the questionnaires also were provided by letters of the head of civil engineering department as presented in Appendix E to Appendix H. As the summary of information about the study, the information sheet also needs to be attached in the questionnaire. The information sheet is shown in Appendix I.

3.5.3. Details of respondents, graduates and jobs

Questions about these details were used to validate the data and to analyse the findings. Details about respondents that need to be obtained are sex, address, relationship with graduate, and the experience. Details about graduate that need to be obtained are sex, institution of education, completion year, professional education, experience and training, Details about graduates’ job that need to be obtained are the nature, inputs, tools, outcomes. The final development of questions about the respondent and graduate detail can be seen on the second pages of each questionnaire presented in Appendix A to Appendix D.

3.5.4. Opinions of respondents

On the last page of each questionnaire, respondents have space to express their opinion about the study, especially the questionnaire, so its advantages and disadvantages can be noted. The opinion can be used to improve further studies in this area. Contact details of respondents also need to be provided if further communication is needed.

In summary, there are four questionnaire sets for four respondent groups, i.e.: employer of Civil Engineering graduates; Civil Engineering graduates; Civil Engineering educators; and experts in a professional organisations. The final development of introduction can be seen in Appendix A for the first respondent group, Appendix B for the second respondent group, Appendix C for the third respondent group, and Appendix D for the forth respondent group. Generally, the questionnaire were made by considering the roles of each respondent group. For example, there are no performance and satisfaction questions for academicians and professionals. Before distribution to respondents, questionnaires were tested for their reliability improvements. The tests were conducted by distributing questionnaire sets to several people representing respondents.

3.6. Sources of data

Targeted respondents of the study are employers, graduates, academicians and professionals. Employers are people employing or supervising Civil Engineering graduates in the construction industry. Graduates are those who have completed a Civil Engineering undergraduate education and worked in the construction industry. Academicians are trainers and educators of the graduates. Professionals are experts in professional organizations developing competencies in the workplace. The respondents were believed as educated people, therefore a survey with a self-administered questionnaire was used.

3.6.1. Respondents and stakeholders

The respondents could be viewed as a representation of stakeholders of Civil Engineering education. The stakeholders included in this study are representations of broad community of industry, education and the profession. The employers and the graduates working in the construction industry are industry personnel who can provide valuable information to improve the quality of engineering education. Engineering education should understand the demands or expectations of industry through its personnel (L Dee Fink, Ambrose & Wheeler 2005). Academicians are responsible for teaching and training in the education process. Professionals are personnel developing competence in the workplace. The respondent and represented stakeholders are shown in Table 3- 21. Targeted respondents have been selected carefully and play significant role in this study as they have provided the data for analysis.

Table 3- 21 Respondents and represented stakeholders

Respondent	Stakeholder
Employers	Industry
Graduates	Industry and Education
Academician	Education
Professionals	Profession

Source: Resume of section 3.6.1

3.6.1.1 Employers

The importance of industries as an education stakeholder has been noted in many reports (Burns & Chisholm 2003; Gol et al. 2004; Green & Bonollo 2004; Lwakabamba & Lujara 2003; Mathew & Earnest 2004a; Short, Garside & Appleton 2003; Xu & Duhovic 2004). Industries are important stakeholders in engineering education (Robson 2005). According to McMasters (2004), industry is one representation of the broader community of education. Many graduates of Civil Engineering work in and have careers in industry. Haltenhoff (1986) reported that the management of the construction industry has traditionally been the function of the civil engineer. Expectations of industry should be met by engineering education by producing graduates meeting those expectations (L Dee Fink, Ambrose & Wheeler 2005). To improve quality, Gregory (2006) suggested that ties between industry and engineering education should be strengthened.

Industry personnel represented by employers in the construction industry can assess graduates' competence and performance. They can also deliver their expectations and satisfaction.

3.6.1.2 Graduates

Graduates is the focus of study so their participation in this study is very substantial. Graduates working in the construction industry can assess their competence needed to undertake jobs in a workplace. Graduates, as the definition in this study, can represent education and industry as well since they are the product of the education, former students and construction industry personnel. However, students are stakeholders of education (Aldridge & Rowley 1998; Wright & O'Neill 2002) and their involvement in this study can strengthen and improve ties and the quality of engineering education and industry (Gregory 2006).

3.6.1.3 Academicians

Education is provided in institutions where graduates primarily develop their competence where the curriculum and learning methods have been established by authorities (Anwar & Rasolomampionona 2005). According to McMasters (2004), industry and academicians are representations of the broader community whose participation is also substantial. The education personnel can assess the graduates' competence when the graduates leave the education. The personnel can also deliver their expectations In this study, the education is represented by educator, lecturers or academicians.

3.6.1.4 Professionals

A professional organization is an institution where professionals develop their ability according to expectations in workplace. Their participation in this study is very important (Herkert 2003; Mischenko et al. 2003). Engineers Australia (EA), for example, is responsible for accrediting the curricula for Civil Engineering education in all Australian universities. A professional can assess the competence and deliver their expectations on graduates' competence (L Dee Fink, Ambrose & Wheeler 2005). In this study, the professionals are represented by experts accredited by professional organizations related to Civil Engineering.

3.6.2. Respondents and data

Respondents have different roles and must deliver data accord to their role. Data on expectations and competence should be delivered by industry personnel, education staff and professionals. Data of performance and satisfaction was provided by the construction industry personnel as shown in Table 3-22.

Table 3- 22 Data and their sources

Respondent	Supplied data
Employers	Competence, Performance, Satisfaction and Expectation
Graduates	Competence, Performance, Satisfaction and Expectation
Academicians	Competence and Expectation
Professionals	Competence and Expectation

Source: Resume of section 3.6.2

Data from stakeholders can be analysed by comparing between stakeholders and relating between concepts. Interaction between education providers and their stakeholders is very important (Abu-Eisheh 2004; Gol et al. 2004; McDermott, Nafalski & Gol 2004).

3.7. Data collection method

There are many methods of data collecting. Macintyre (1994) presented ten typical methods used to measure customer satisfaction: a self-administered questionnaire; direct observation; participant observation; telephone/mail surveys; focus groups; semi-structured interviews; structured interviews; open-ended interviews; critical incident interviews; and content analysis (letters of complaint or praise). Roscino and Pollice (2004) stated that to derive a measure of customer satisfaction, data usually are collected through questionnaires. This study used the self-administered questionnaire. The data collection method was decided based on the characteristics of data, the instrument and respondents.

3.7.1. Characteristics of data

Based on experience (Musyafa 2003), the study would need at least 80 cases as samples. If the number divided evenly, as follow:

1. 20 from employers or supervisors in the workplace;
2. 20 from graduates;
3. 20 from educators or academicians in the education providers (universities); and
4. 20 from experts in professional organizations.

Based on sample percentage in population, there are two methods of data collection i.e. census and sampling. A census is a method of collecting data for the whole population while sampling is a method to collect data of parts of the population.

The number of employers or supervisors of Civil Engineering graduates in Australia run into thousands. They can be traced based on the companies that employ graduates. Names, positions and addresses are in company websites on the Internet. Based on the expected sample number and the population, the method of data collection must be sampling.

The number of Civil Engineering graduates working in construction industry in Australia must be thousands. Although graduate details are confidential, the number can assumed based on the number of students in Civil Engineering education in recent years. For this study the sample will be collected based on data from graduates of Curtin University of Technology.

The number of academicians or educators of Civil Engineering in Australia must also very large. Their names, positions and addresses traceable on university websites on the Internet. Based on the expected number of samples and the population, data collecting must be sampling.

The number of professionals must be thousands. Their names, positions and addresses can be traced based on the organization websites on the Internet. Based on the expected number of samples and the population, the method of data collection must be sampling.

3.7.2. Characteristics of instruments and respondents

The instruments were questionnaires. The respond is very simple i.e. multiple choice so that respondents can easily respond the questionnaire.

Respondents must educated people who can respond to a questionnaire individually. Based on trials, it was decided that the respondents could complete the questionnaires by themselves. Based on the characteristics, the data collection was conducted by sampling and self-administration as shown in Table 3- 23.

Table 3- 23 Method of data collecting

Researcher	Institution of Respondents	Respondents
Identifying respondents in websites		
Developing questionnaire sets		
Sending sets to institutions		
	Sending sets to targeted respondents' addresses	
		Response to the sets
		Sending back to researcher
Collating data into spreadsheets		
Sending data to respondents		

Source: Resume of method of data collection

3.8. Quality of data

The quality of collected data in this study is defined as randomness and distribution of data. Randomness is a must in a sampling study method because without randomness, cases in a population could not represent the population. Distribution in a sample will indicate the quality of the data. Qualified data in a sample should follow the distribution in their population.

3.8.1. Randomness

Basically, there are two kinds of randomness, i.e. randomness of cases and randomness of data. The randomness of the cases in this study was guaranteed by the data collecting method as presented in section 3.7, while randomness of the data would be tested by the Run Test method (Sugiyono 1999). The formula is presented in Equation 3- 2.

$$Z = \frac{r - \left[\frac{2n_1n_2}{n_1+n_2} + 1\right] - 0.5}{\sqrt{\frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1+n_2)^2(n_1+n_2-1)}}}$$ ***Equation 3- 2***

Based on Z, if the probability > 0.05, data is random

Note: *r = number of runs*
n_1 = number of data in the left of median
n_2 = number of data in the right of median

To understand how the formula works, an example needs to be presented. In this example, the data is a assessment of respondents with competence of graduates in the variable K1 as shown in Table 3- 24.

Table 3- 24 Data of Run and Normal Distribution Test

No	Respondent Code	Competence of graduates (K1)	No	Respondent Code	Competence of graduates (K1)	No	Respondent Code	Competence of graduates (K1)
1	12000	4	14	12031	5	27	12075	4
2	12003	5	15	12034	5	28	12086	4
3	12005	4	16	12039	4	29	12087	4
4	12006	1	17	12042	4	30	12100	4
5	12007	4	18	12043	4	31	12105	4
6	12010	3	19	12046	4	32	12106	4
7	12013	4	20	12048	5	33	12107	5
8	12016	4	21	12060	4	34	12109	4
9	12017	5	22	12061	4	35	12117	4
10	12019	4	23	12062	4	36	12120	4
11	12021	4	24	12066	3	37	12122	4
12	12024	4	25	12069	5	38	12129	5
13	12025	4	26	12070	5	39	12130	4

Source: Respondents

The purpose of this test is to examine if the data in the variable K1 are random significantly or not. The calculation of the test is as follow:

1. The median of the data = 4
2. r (the sequential differences) is 7
3. n_1 = 3 and n_2 = 36
4. Z calculated by Equation 3- 2 = 0.000
5. Based on the value of Z, the probability of random (in the Z table) is 100%
6. The conclusion is that the data are random because probability of random is more than 5 %

The data and the result of this calculation are also presented in section 4.3.2.

3.8.2. Distribution

There are two kinds of distribution, i.e. the distribution of cases and the distribution of data in each variable. The distribution of cases would fully follow the participation level of selected respondents, and the distribution of the data would be tested by One-Sample Kolmogorov-Smirnov Test (Santoso 2001). The formula is presented in Equation 3- 3.

$$Z = \frac{X - \mu}{s}$$ ***Equation 3- 3***

Based on Z maximum, if the probability > 0.05, data have normal distributions

Note: *X = data*
μ = average of dat.
s = standard deviation

To understand how the formula work, an example needs to be presented. In this example, the data is a assessment of respondents with competence of graduates in the variable K1 as shown in Table 3- 24. The purpose of this test is to examine if the data in the variable K1 have normal distribution or not. The calculation of the test is as follow:

1. Value of Kolmogorov-Smirnov Z of the data is calculated based on Table 3- 25.

Table 3- 25 Calculation of Kolmogorov-Smirnov Z

No	Respondent Code	Data (X)	Z= (X - μ)/s	Z standard (A)	Probability (B)	Difference (D = A – B)
1	12006	1	-4.32114	Z table	0.02564103	Z table –B
2	12010	3	-1.53561	Z table	0.05128205	Z table –B
3	12066	3	-1.53561	Z table	0.07692308	Z table –B
4	12000	4	-0.14285	Z table	0.1025641	Z table –B
5	12005	4	-0.14285	Z table	0.12820513	Z table –B
6	12007	4	-0.14285	Z table	0.15384615	Z table –B
7	12013	4	-0.14285	Z table	0.17948718	Z table –B
8	12016	4	-0.14285	Z table	0.20512821	Z table –B
9	12019	4	-0.14285	Z table	0.23076923	Z table –B
10	12021	4	-0.14285	Z table	0.25641026	Z table –B
11	12024	4	-0.14285	Z table	0.28205128	Z table –B
12	12025	4	-0.14285	Z table	0.30769231	Z table –B

No	Respondent Code	Data (X)	Z= (X - µ)/s	Z standard (A)	Probability (B)	Difference (D = A – B)
13	12039	4	-0.14285	Z table	0.33333333	Z table –B
14	12042	4	-0.14285	Z table	0.35897436	Z table –B
15	12043	4	-0.14285	Z table	0.38461538	Z table –B
16	12046	4	-0.14285	Z table	0.41025641	Z table –B
17	12060	4	-0.14285	Z table	0.43589744	Z table –B
18	12061	4	-0.14285	Z table	0.46153846	Z table –B
19	12062	4	-0.14285	Z table	0.48717949	Z table –B
20	12075	4	-0.14285	2.800	0.51282051	2.287
21	12086	4	-0.14285	Z table	0.53846154	Z table –B
22	12087	4	-0.14285	Z table	0.56410256	Z table –B
23	12100	4	-0.14285	Z table	0.58974359	Z table –B
24	12105	4	-0.14285	Z table	0.61538462	Z table –B
25	12106	4	-0.14285	Z table	0.64102564	Z table –B
26	12109	4	-0.14285	Z table	0.66666667	Z table –B
27	12117	4	-0.14285	Z table	0.69230769	Z table –B
28	12120	4	-0.14285	Z table	0.71794872	Z table –B
29	12122	4	-0.14285	Z table	0.74358974	Z table –B
30	12130	4	-0.14285	Z table	0.76923077	Z table –B
31	12003	5	1.249916	Z table	0.79487179	Z table –B
32	12017	5	1.249916	Z table	0.82051282	Z table –B
33	12031	5	1.249916	Z table	0.84615385	Z table –B
34	12034	5	1.249916	Z table	0.87179487	Z table –B
35	12048	5	1.249916	Z table	0.8974359	Z table –B
36	12069	5	1.249916	Z table	0.92307692	Z table –B
37	12070	5	1.249916	Z table	0.94871795	Z table –B
38	12107	5	1.249916	Z table	0.97435897	Z table –B
39	12129	5	1.249916	Z table	1	Z table –B
	Sum	160				
	Average (µ)	4.1				
	Standard deviation (s)	0.72				

Source: Output of calculation using Microsoft Excel

2. Kolmogorov-Smirnov Z of the data that is the maximum value of the difference i.e. 2.287 (See Table 3- 25)
3. Based on the Z, probability that the data have normal distribution is 0.0 %
4. The conclusion is that the distribution of the data is not normal because the probability less than 0.5%

The result of this calculation are also presented in section 4.3.2.

3.9. Analysis of data

As mentioned in the theory of this study (section 2.4), to achieve the objectives, analyses of the analyses of comparisons and correlations must be conducted. The methods of analyses are established based on the type of data and samples (Santoso 2001; Sugiyono 1999).

In the data analyses in chapter 5. statistical methods were used to obtain the findings and probability was used for validation of the findings. As stated in section 3.9, statistics were employed for comparison and correlation. Comparison produced differences and correlation produced degrees of relationships. The differences and relationships were tested and validated by standard probability of Chi-square (χ^2) or Normal (Z) with an error margin 0.05. Hence, if the error probability in tests is more than 0.05, hypotheses of comparisons and correlations were rejected.

3.9.1. Comparison

In data analyses of this study, the comparisons were categorized into three groups. The category is based on the number and type of samples.

3.9.1.1 Two independent samples

For comparing two independent sample groups, the Mann-Whitney U test was used (Sugiyono 1999) the formulae of which are shown in Equation 3- 4. The formulae were used to analyse the differences between stakeholders in their expectations with graduates i.e. the outcome of the third objective. The analyses are presented in sections 5.3.1.1 to 5.3.1.18.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$ ***Equation 3- 4 (a)***

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$ ***Equation 3- 4 (b)***

$$z = \frac{U - (\frac{1}{2} n_1 . n_2)}{\sqrt{\frac{1}{12} n_1 . n_2 .(n_1 + n_2 + 1)}}$$ ***Equation 3- 4 (c)***

Note: n_1 = *number of sample 1*
n_2 = *number of sample 2*
R_1 = *Sum of rank values in sample 1*
R_2 = *Sum of rank values in sample 2*
U_1 = *Mann-Whitney U in sample 1*
U_2 = *Mann-Whitney U in sample 2*

To understand how the formula work, an example needs to be presented. In this example, the data is an expectation of respondents (graduates and academicians) with competences of graduates in variable K1 is presented in Table 3-26. The Purpose of this test is to examine if the two respondent have similar level of expectation of the variable or not. The calculation of the test is as follow:

1. Data are combined and ordered as presented in Table 3-26.

Table 3-26 Calculation of Mann-Whitney U

No	Respondent Code	Expectation of K1	Rankings	No	Respondent Code	Expectation of K1	Rankings
1	G 048	1	1.5	35	A 045	7	34
2	A 065	1	1.5	36	A 069	7	34
3	G 061	2	5.5	37	A 090	7	34
4	G 066	2	5.5	38	A 095	7	34
5	A 035	2	5.5	39	A 122	7	34
6	A 059	2	5.5	40	G 007	8	46
7	A 089	2	5.5	41	G 016	8	46
8	A 136	2	5.5	42	G 021	8	46
9	G 034	3	7	43	G 060	8	46
10	G 106	3	7	44	G 086	8	46
11	A 024	3	7	45	A 000	8	46
12	A 126	3	7	46	A 014	8	46
13	G 019	4	16	47	A 018	8	46
14	G 025	4	16	48	A 027	8	46
15	G 043	4	16	49	A 028	8	46
16	G 062	4	16	50	A 056	8	46
17	G 107	4	16	51	A 098	8	46
18	A 079	4	16	52	A 120	8	46
19	A 087	4	16	53	G 000	9	60
20	G 017	5	21	54	G 003	9	60
21	G 046	5	21	55	G 005	9	60
22	G 109	5	21	56	G 013	9	60
23	G 006	6	25.5	57	G 070	9	60
24	G 010	6	25.5	58	G 100	9	60
25	G 039	6	25.5	59	G 130	9	60
26	G 087	6	25.5	60	A 002	9	60
27	A 009	6	25.5	61	A 006	9	60
28	A 125	6	25.5	62	A 051	9	60
29	G 031	7	34	63	A 084	9	60
30	G 042	7	34	64	A 085	9	60
31	G 129	7	34	65	A 088	9	60
32	A 012	7	34	66	A 091	9	60
33	A 030	7	34	67	A 134	9	60
34	A 043	7	34				

Note: G = Graduate, A = Academician
Source: Output of calculation using Microsoft Excel

2. n_1 = number of samples of graduate = 32
3. n_2 = number of samples of academician = 35

4. R_1 = number of ranks of graduate = 1.5 + 5.5 + 5.5 + …..+ 60 = R_1 (Table 3-26)
5. R_2 = number of ranks of academician = 1.5 + 5.5 + 5.5 + …..+ 60 = R_2 (Table 3-26)
6. U_1 = U of graduates calculated by Equation 3-4 (a) = 822
7. U_2 = U of academicians calculated by Equation 3-4 (b) = U_2
8. Z in the data calculated by Equation 3-4 (c) = -0.3324533
9. Based on Z, the probability of similarity in Z table is 0.739
10. Conclusion is that the variable is expected similarly by stakeholders because the probability of similarity less than 5 %.

The result of this calculation is also presented in section 5.3.1.10.

3.9.1.2 Three or more related samples

For comparing three or more related samples, the Kendall-W test was used (Santoso 2001) the formulae of which are shown in Equation 3-5. The formulae were used to validate: The 9-rankings of graduates competence and stakeholders' expectation i.e. the first and second objectives. The analyses are presented in sections 5.1 and 5.2.

$$W = \frac{12\sum Ri^2 - 3n^2k(k+1)^2}{n^2k(k^2-1)}$$ ***Equation 3-5 (a)***

$$\chi^2 = n(k-1)W$$ ***Equation 3-5 (b)***

Note: *W =Kendall W*
k = number of variable
n = number of respondent sample
Ri =Sum of each variable value
X^2 =Chi Square

To understand how the formula works, an example needs to be presented. In this example, the data is the expectation of respondents with competence should be mastered by graduates is presented in Table 4-62. The purpose of this test is to examine if the respondents have preference to the rankings or not. In other words, the purpose of this test is to examine if the ranking is valid or not. The calculation of the test is as follow:

1. Values of total (Ri), average, mean rank and rakings of each variable are presented

in Table 3- 27

Table 3- 27 Calculation of Kendall W

	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
Total (Ri)	194	183	157	229	141	114	143	161	118
Mean (Ri/n)	6.06	5.72	4.91	7.16	4.41	3.56	4.47	5.03	3.69
Ranking	2	3	5	1	7	9	6	4	8

Source: Output of calculation using Microsoft Excel

2. k = number of variable = 9
3. n = number of respondent = 32
4. Ri =Sum of each variable value = (see Table 3- 27)
5. Kendall W calculated by Equation 3- 5 (a) = 0.179
6. Chi-square calculated by Equation 3- 5 (b) = 45.775
7. Based on the Chi-square, the probability of similarity between ranking = 0.0 %
8. Conclusion is that the rankings are valid because the probability of similarity between ranking less than 5 %

The result of this calculation is also presented in section 5.2.1.2.

3.9.1.3 Three or more independent samples

For comparing three or more independent samples, the Kruskal-Wallis-H test was used (Santoso 2001) the formulae of which are shown in Equation 3- 6. The formulae were used to analyse the differences among stakeholders in their expectations with graduates i.e. the third objective of this study. The results of the analyses are presented in sections 5.3.2.1 to 5.3.2.3.

$$H = \frac{12}{n(n+1)} \sum \frac{R_j^2}{n_j} - 3(n+1)$$ ***Equation 3- 6 (a)***

$$\chi^{2} = H$$ ***Equation 3- 6 (b)***

Note: *H = coefficient of Kruskal-Wallis*
Rj = Sum of ranking per category
nj = number of sample per category
n = number of sample
χ^2 =Chi Square

To understand how the formula works, an example needs to be presented. In this example, the data is the expectation of respondents (employers, graduates, academicians and professional) with competences of graduates in variable K1 is presented in Table 4- 59, Table 4- 62, Table 4- 66 and Table 4- 70. The purpose of this test is to examine if the four respondents have similar level of expectation on the variable or not. The calculation of the test is as follow:

1. Data were combined and ordered as presented in Table 3- 28.

Table 3- 28 Calculation of Kruskal-Wallis H

No	Respondent Code	Expectation of K1	Ranking	No	Respondent Code	Expectation of K1	Ranking	No	Respondent Code	Expectation of K1	Ranking	No	Respondent Code	Expectation of K1	Ranking
1	G 048	1	1.5	25	G 006	6	27.5	49	E 330	8	56	73	E 276	9	80.5
2	A 065	1	1.5	26	G 010	6	27.5	50	G 007	8	56	74	E 284	9	80.5
3	G 061	2	5.5	27	G 039	6	27.5	51	G 016	8	56	75	E 293	9	80.5
4	G 066	2	5.5	28	G 087	6	27.5	52	G 021	8	56	76	G 000	9	80.5
5	A 035	2	5.5	29	A 009	6	27.5	53	G 060	8	56	77	G 003	9	80.5
6	A 059	2	5.5	30	A 125	6	27.5	54	G 086	8	56	78	G 005	9	80.5
7	A 089	2	5.5	31	P 159	6	27.5	55	A 000	8	56	79	G 013	9	80.5
8	A 136	2	5.5	32	G 031	7	38	56	A 014	8	56	80	G 070	9	80.5
9	G 034	3	11	33	G 042	7	38	57	A 018	8	56	81	G 100	9	80.5
10	G 106	3	11	34	G 129	7	38	58	A 027	8	56	82	G 130	9	80.5
11	A 024	3	11	35	A 012	7	38	59	A 028	8	56	83	A 002	9	80.5
12	A 126	3	11	36	A 030	7	38	60	A 056	8	56	84	A 006	9	80.5
13	P 030	3	11	37	A 043	7	38	61	A 098	8	56	85	A 051	9	80.5
14	G 019	4	17	38	A 045	7	38	62	A 120	8	56	86	A 084	9	80.5
15	G 025	4	17	39	A 069	7	38	63	P 025	8	56	87	A 085	9	80.5
16	G 043	4	17	40	A 090	7	38	64	P 027	8	56	88	A 088	9	80.5
17	G 062	4	17	41	A 095	7	38	65	P 154	8	56	89	A 091	9	80.5
18	G 107	4	17	42	A 122	7	38	66	P 197	8	56	90	A 134	9	80.5
19	A 079	4	17	43	P 033	7	38	67	P 204	8	56	91	P 043	9	80.5
20	A 087	4	17	44	P 060	7	38	68	E 000	9	80.5	92	P 171	9	80.5
21	G 017	5	22	45	E 043	8	56	69	E 145	9	80.5	93	P 287	9	80.5
22	G 046	5	22	46	E 152	8	56	70	E 156	9	80.5				
23	G 109	5	22	47	E 177	8	56	71	E 167	9	80.5				
24	E 175	6	27.5	48	E 180	8	56	72	E 170	9	80.5				

Note: E = Employer, G = Graduate, A = Academician, P = Professional
Source: Output of calculation using Microsoft Excel

2. Rj = sum of ranking of employers = 6 + 8 + …..+ 9 = Rj_1
3. Rj = sum of ranking of graduates = 1 + 2 +…..+ 9 = Rj_2
4. Rj = sum of ranking of academicians = 1 + 2 + …. + 9 = Rj_3
5. Rj = sum of ranking of professionals = 3+ 6 +….+ 9 = Rj_4
6. nj = number of sample of employers = 14
7. nj = number of sample per category = 32
8. nj = number of sample per category = 35
9. nj = number of sample per category = 12
10. n = number of sample = 93
11. H and Chi-square calculated by Equation 3- 6 (a) and (b) is 12.33
12. Based on the Chi-square, the probability of similarity among the respondents is 0.01 (1 %)
13. The conclusion is that the variable is expected differently by stakeholders because the probability of similarity less than 5 %

The calculation also is presented in section 5.3.2.1.

3.9.2. Correlation

All correlation tests in this analysis were calculated by the Spearman-r test (Santoso 2001; Sugiyono 1999) the formulae of which are shown in Equation 3- 7. The correlation degree was stated by number between zero (0) and one (1). Zero means that no correlation exists between two variables; One means that two variables fully relate. The formulae were used to analyse the correlation between:

1. graduates' performance and stakeholders' satisfaction i.e. the fifth objective; and
2. graduates' competence and stakeholders' satisfaction. i.e. the sixth objective.

The results of the analyses are presented in sections 5.5 and 7. .

$$r_s = 1 - \frac{6\sum di^2}{n(n^2 - 1)}$$ ***Equation 3- 7 (a)***

$$z = r_s \sqrt{n - 1}$$ ***Equation 3- 7 (b)***

Note: r_s *= coefficient of Spearman correlation*
di = difference of rank
n = number of sample

To understand how the formula works, an example needs to be presented. In this example, the data is the perception of respondents about the satisfaction with graduates and data of graduates' performance as presented in Table 4- 51 and Table 4- 55. The purpose of this test is to examine if the two variables have correlation significantly or not. The calculation of the test is as follow:

1. Data were combined and ordered as presented in Table 3- 29.

Table 3- 29 Calculation of correlation

No	Respondent Code	Time Performance of graduates	Satisfaction with graduates	Time Performance	Ranking of Satisfaction (D)	Difference (C = A – B)	C^2
1	11000	3	4	32	7	25	625
2	11101	1	2	1	1	0	0
3	11122	3	4	32	7	25	625
4	11145	3	4	32	7	25	625
5	11152	2	5	5	44	-39	1521
6	11156	3	4	32	7	25	625
7	11167	2	4	5	7	-2	4
8	11170	2	4	5	7	-2	4
9	11175	2	4	5	7	-2	4
10	11177	3	5	32	44	-12	144
11	11180	2	4	5	7	-2	4
12	11276	3	5	32	44	-12	144
13	11284	3	5	32	44	-12	144
14	11293	3	4	32	7	25	625
15	11330	3	3	32	2	30	900
16	12000	3	4	32	7	25	625
17	12003	2	4	5	7	-2	4
18	12005	3	4	32	7	25	625
19	12006	1	4	1	7	-6	36
20	12007	3	4	32	7	25	625
21	12010	2	3	5	2	3	9
22	12013	3	4	32	7	25	625

No	Respondent Code	Time Performance of graduates	Satisfaction with graduates	Time Performance	Ranking of Satisfaction (B)	Difference (C = A – B)	C^2
23	12016	2	4	5	7	-2	4
24	12017	2	3	5	2	3	9
25	12019	2	3	5	2	3	9
26	12021	2	4	5	7	-2	4
27	12024	2	4	5	7	-2	4
28	12025	3	5	32	44	-12	144
29	12031	2	4	5	7	-2	4
30	12034	2	5	5	44	-39	1521
31	12039	2	4	5	7	-2	4
32	12042	3	5	32	44	-12	144
33	12043	2	4	5	7	-2	4
34	12046	2	4	5	7	-2	4
35	12048	2	3	5	2	3	9
36	12060	2	4	5	7	-2	4
37	12061	2	4	5	7	-2	4
38	12062	2	4	5	7	-2	4
39	12066	2	4	5	7	-2	4
40	12069	3	4	32	7	25	625
41	12070	5	4	53	7	46	2116
42	12075	5	4	53	7	46	2116
43	12086	3	4	32	7	25	625
44	12087	2	4	5	7	-2	4
45	12100	2	4	5	7	-2	4
46	12105	1	5	1	44	-43	1849
47	12106	4	5	52	44	8	64
48	12107	1	5	1	44	-43	1849
49	12109	3	4	32	7	25	625
50	12117	3	4	32	7	25	625
51	12120	2	5	5	44	-39	1521
52	12122	2	4	5	7	-2	4
53	12129	3	4	32	7	25	625
54	12130	2	4	5	7	-2	4
							23079

Source: Output of calculation using Microsoft Excel

2. di = difference of rank (see Table 3- 29)
3. n = number of sample = 54
4. Spearman Rank coefficient calculated by Equation 3- 7 (a) is 0.153
5. Z coefficient calculated by Equation 3- 7 (b) is Z
6. Based on the Z value, the probability of independence between the two variables is 27.5%

7. The conclusion is that: the correlation between the two variables is weak because the value of Spearman Rank coefficient is less than 0.4 and not significant because the probability of independence less than 5%

The calculation is also presented in section 5.5.1.1.

3.9.3. Linear regression

In developing models linking graduates' competence and stakeholders' satisfaction i.e. the outcome of the sixth objective, the linear regression method was used. The samples for this study are (S_i, C_i) where S = Stakeholders' Satisfaction, C = Graduates' Competence and $i = 1, 2, 3, \ldots n$. The regression model is given by Equation 3-8.

$$S = a + bC$$ ***Equation 3-8***

Note: *S = Stakeholders' Satisfaction as the dependent variable,*
a = the y intercept,
b = the gradient or slope of the line,
C= Graduates' Competence as the independent variable.

The parameters of the linear regression model are estimated using the method of ordinary least squares, so that the regression parameters are formulated in Equation 3-9 (*Simple linear regression* 2008). The formulae are presented from Equation 3-4 to Equation 3-7. The developed models are presented in sections 7. .

$$b = \frac{\sum_{i=1}^{n}\left(C_i - \overline{C}\right)\left(S_i - \overline{S}\right)}{\sum_{i=1}^{n}\left(C_i - \overline{C}\right)^2}$$ ***Equation 3-9 (a)***

$$a = \overline{S} - b\overline{C}$$ ***Equation 3-9 (b)***

Note: *a = the y intercept*
b = the gradient or slope of the line
S = Stakeholders' Satisfaction as the dependent variable
C= Graduates' Competence as the independent variable
i = 1, 2, 3, … n
$\overline{S}$ *= Average of Satisfaction*
$\overline{C}$ *= Average of Competence*

To understand how the formula works, an example needs to be presented. In this example, the data is the perception of respondents about the satisfaction with graduates and data of graduates' competence K4 as presented in Table 3- 30. The purpose of this calculation is to develop a linear model linking the two variables. The calculation of the test is as follow:

1. The calculation is presented in Table 3- 30.

Table 3- 30 Calculation to develop a linear model

Respondent Code	C_i	S_i	$C_i - \overline{C}$ (X)	$S_i - \overline{S}$ (Y)	XY	X²
11000	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
11101	2	2	-1.94444444	-2.07407407	4.032921811	3.7808642
11122	5	4	1.05555556	-0.07407407	-0.0781893	1.1141975
11145	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
11152	5	5	1.05555556	0.925925926	0.977366255	1.1141975
11156	3	4	-0.94444444	-0.07407407	0.069958848	0.8919753
11167	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
11170	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
11175	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
11177	5	5	1.05555556	0.925925926	0.977366255	1.1141975
11180	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
11276	4	5	0.05555556	0.925925926	0.051440329	0.0030864
11284	4	5	0.05555556	0.925925926	0.051440329	0.0030864
11293	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
11330	3	3	-0.94444444	-1.07407407	1.014403292	0.8919753
12000	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12003	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12005	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12006	1	4	-2.94444444	-0.07407407	0.218106996	8.6697531
12007	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12010	4	3	0.05555556	-1.07407407	-0.05967078	0.0030864
12013	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12016	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12017	5	3	1.05555556	-1.07407407	-1.13374486	1.1141975
12019	4	3	0.05555556	-1.07407407	-0.05967078	0.0030864
12021	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12024	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12025	4	5	0.05555556	0.925925926	0.051440329	0.0030864
12031	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12034	5	5	1.05555556	0.925925926	0.977366255	1.1141975
12039	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864

Respondent Code	C_i	S_i	$C_i - \overline{C}$ **(X)**	$S_i - \overline{S}$ **(Y)**	**XY**	**X²**
12042	3	5	-0.94444444	0.925925926	-0.8744856	0.8919753
12043	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12046	3	4	-0.94444444	-0.07407407	0.069958848	0.8919753
12048	4	3	0.05555556	-1.07407407	-0.05967078	0.0030864
12060	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12061	3	4	-0.94444444	-0.07407407	0.069958848	0.8919753
12062	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12066	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12069	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12070	5	4	1.05555556	-0.07407407	-0.0781893	1.1141975
12075	2	4	-1.94444444	-0.07407407	0.144032922	3.7808642
12086	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12087	5	4	1.05555556	-0.07407407	-0.0781893	1.1141975
12100	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12105	4	5	0.05555556	0.925925926	0.051440329	0.0030864
12106	5	5	1.05555556	0.925925926	0.977366255	1.1141975
12107	5	5	1.05555556	0.925925926	0.977366255	1.1141975
12109	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12117	4	4	0.05555556	-0.07407407	-0.00411523	0.0030864
12120	4	5	0.05555556	0.925925926	0.051440329	0.0030864
12122	5	4	1.05555556	-0.07407407	-0.0781893	1.1141975
12129	5	4	1.05555556	-0.07407407	-0.0781893	1.1141975
12130	2	4	-1.94444444	-0.07407407	0.144032922	3.7808642
Average	$\overline{C}$ =3.9444444	$\overline{S}$ =4.0740741				
n	54	54				
Sum	213	220	-1.0658E-14	-1.7764E-14	8.222222222	36.833333

Source: Output of calculation using Microsoft Excel

2. $\overline{S}$ = Average of Satisfaction = 4.0740741
3. $\overline{C}$ = Average of Competence = 3.9444444
4. n = number of samples = 54
5. b calculated by Equation 3- 9 (a) = 0.223227753
6. a calculated by Equation 3- 9 (b)= 3.193564605
7. Based on values of a, b and Equation 3- 8, the model is: S = 3.194 +0.223 (K4)

The result of this calculation is also presented in section 7.2.1.

3.10. Summary of methodology

In this chapter, the prediction of findings, measurement methods, research instruments, data sources, data collecting methods, data analysing method have been established so that new data could be obtained. The collected data will be described in chapter 4. while the data analysis will be presented in chapter 5.

4. THE DATA COLLECTED

4.1. Introduction

The aim of this chapter is to analyse the quantity and quality of data obtained from respondents. The results will support an assumption that the data are fit as samples in this study so that the survey can be stopped. The sequence from the survey of data collection to obtain fit samples is shown in Figure 4- 1.

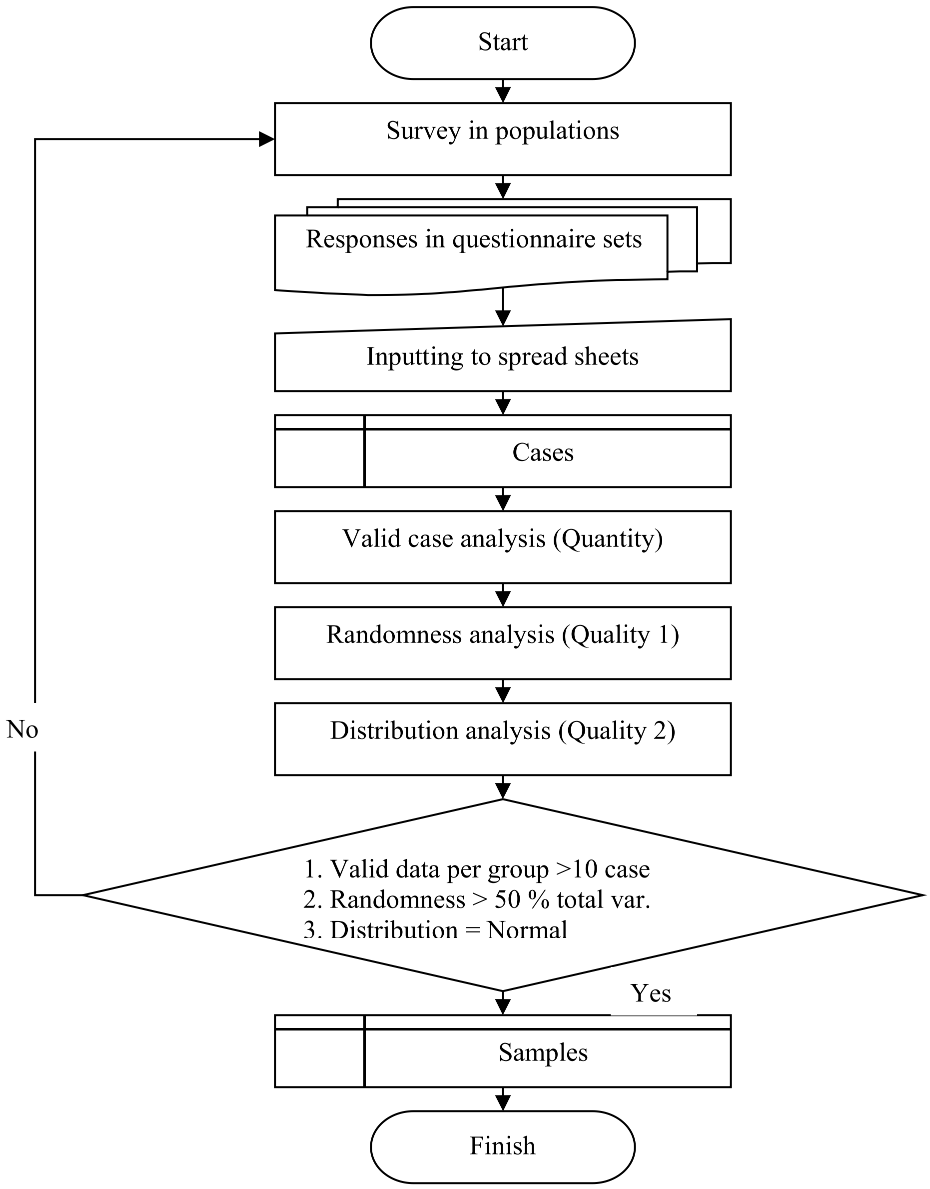

Figure 4- 1 Flowchart of analysis data quantity and quality

The figure shows the analyses that should be conducted to decide if the survey can be stopped or not. The analyses consist of valid cases, randomness and distribution analyses.

4.1.1. Valid case analysis

Valid case analysis is an analysis indicating if a case supplies data properly, completely or not. Ten valid cases per group in a group will be used as the minimum requirement for the analysis. As there are four groups, this study needs at least forty samples (Roscoe 1992). This analysis was conducted together the data presentation such as in Table 4- 4, Table 4- 8, Table 4- 12 etc. The results are shown at the bottom of those tables.

4.1.2. Randomness analysis

Randomness analysis is an analysis indicating if data are collected randomly or not. This is a condition that must be fulfilled in order that data can be used as samples for generalization (Section 3.8.1). However, in multivariate data such as the data of this study, at least 50 % of the total variables must have random data.

The randomness of data was tested using the Run Test, the formula of which is shown in Equation 3- 2 (Sugiyono 1999). This test was conducted after the data presentation. The results are shown in tables such as Table 4- 5, Table 4- 9, Table 4- 13 etc.

4.1.3. Distribution analysis

Distribution analysis is an analysis indicating that data have a certain distribution. In a adequate sample, the distribution of data in the sample should follow distribution in its population (Section 3.8.2). By nature, the data in this study, especially competence, are expected to have normal distribution. Therefore, the normal distribution examinations will indicate the quality of data. However, in ordinal (non-parametric) data such as the data of this study, normal distribution is not an absolute condition.

In this study, the normality of data was examined by conducted either statistical tests or normal curve plots (Santoso 2001). The normal distribution test would be tested by the One-Sample Kolmogorov-Smirnov method which its formula is shown in Equation 3- 3 (Santoso 2001). This test was conducted after the randomness analysis. The results are shown in tables such as Table 4- 6, Table 4- 10, Table 4- 14 etc.

4.2. Data overview

The data are divided into concepts, factors and variables. The four concepts are expectations, competence, performance and satisfaction (Section 2.4.1). The expectations and competence data are further divided into three factors i.e. knowledge, skills, and attitude which have nine variables (Section 2.5.1). Performance is further divided into three factors each of which has a variable (Section 2.5.2). Satisfaction is based on perception with only one variable (Section 2.4.2.4). The breakdown of the data is shown in Table 4- 1.

Table 4- 1 Breakdown of data

Concept	Factor	Number of variable
Expectations	Knowledge	9
	Skills	9
	Attitude	9
Competence	Knowledge	9
	Skills	9
	Attitude	9
Performance	Time	1
	Cost	1
	Quality	1
Satisfaction	Perception	1

Source: Theory and variables presented in sections 2.4 and 2.5

The data obtained from selected personnel who voluntarily supplied it were divided into four groups i.e. employers, graduates, academicians and professionals (Section 3.6.1). They are representative of their groups, however, performance and satisfaction data were not supplied by academicians and professionals. Details of the relationship between the data groups and their suppliers are shown in Table 4- 2.

Table 4- 2 Data and their suppliers

Data / Source	Expectations	Competence	Performance	Satisfaction
Employers	Supplied	Supplied	Supplied	Supplied
Graduates	Supplied	Supplied	Supplied	Supplied
Academicians	Supplied	Supplied	Not Supplied	Not Supplied
Professionals	Supplied	Supplied	Not Supplied	Not Supplied

Source: Suppliers of data presented in section 3.6.2

Data suppliers were voluntary participants, however, as so many targeted personnel did not take part in providing data. Therefore, suppliers and data were randomly obtained so that they could be seen as representations of each population. The numbers of targeted personnel and participants are shown in Table 4- 3. As shown in the table, the participation rates of employers and professionals are lower than the others. This may be due to the difficulty in the identification of both personnel and addresses. Based on the number of participants, however, these data generally are still reasonable for analysis.

Table 4- 3 Number of targeted personnel and participants providing data

Group of respondents	Number of targeted Personnel	Number of Participants
Employers	339 (100 %)	17 (5 %)
Graduates	130 (100 %)	39 (30 %)
Academicians	139 (100 %)	48 (35 %)
Professionals	288 (100 %)	16 (5.6%)

Source: Documentation of the survey

4.3. Data related to competence

As described in 3.4.1, the 27 variables of competence were measured to know the actual competence level of graduates. The competence data are categorized into three factors and four respondent groups. The factor groups are knowledge, skills and attitude, while the respondent groups are employers, graduates, academicians and professionals. Knowledge variables are shown in Table 2- 2, skills in Table 2- 3, and attitude variables are shown in Table 2- 4. Competence was measured in five levels as shown in Table 3- 7. The data values are ordinal numbers.

4.3.1. Knowledge competence assessed by employers

The data of graduates' knowledge competence obtained from employers are shown in Table 4- 4. The headings, **K1** to **K9** are the codes of measured variables as described in Table 2- 2. In the left column, the numbers **11000** to **11330** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means

Somewhat, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3-7. The data contained in the table were compiled directly from questionnaire sets. The table shows 17 cases of assessments on 9 variables of knowledge competence with no missing values.

Table 4-4 Employers' assessments on knowledge

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
11000	4	4	4	4	3	2	2	2	3
11043	5	5	5	4	4	5	4	4	4
11101	4	4	3	2	2	3	4	2	3
11122	5	5	5	5	4	4	4	3	3
11145	4	4	4	4	4	4	4	4	4
11152	5	5	5	5	5	4	4	4	3
11156	3	3	4	3	4	4	2	2	3
11167	3	4	3	4	4	4	4	3	3
11170	5	5	5	4	5	4	5	4	4
11175	4	4	4	4	4	4	4	1	2
11177	4	5	5	5	4	3	4	4	3
11180	4	4	4	4	3	3	2	2	2
11276	4	4	4	4	4	3	3	4	4
11284	4	4	4	4	4	4	4	4	3
11292	2	2	3	2	2	2	2	2	2
11293	4	4	5	4	4	4	3	3	2
11330	4	4	3	3	4	3	2	2	3
Missing	0	0	0	0	0	0	0	0	0
Total Cases	17	17	17	17	17	17	17	17	17

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4-5. The tests indicate that all variables i.e. K1, K2, K3, K4, K5, K6, K7, K8 and K9 have random data.

Table 4- 5 Randomness tests of employers' assessments on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Test Value (median)	4	4	4	4	4	4	4	3	3
Cases < Test Value	3	2	4	4	4	7	7	7	4
Cases >= Test Value	14	15	13	13	13	10	10	10	13
Number of Runs	5	5	8	8	8	9	7	13	7
Z	-.400	.000	.273	.273	.273	.000	-.899	1.692	.000
Prob. of random	.689	1.000	.785	.785	.785	1.000	.369	.091	1.000
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 6. The tests indicate that variables i.e. K1, K2, K3, K6, K8 and K9 have normal distributions.

Table 4- 6 Normal distribution tests of employers' assessments on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Kolmogorov-Smirnov Z	1.334	1.330	.922	1.418	1.551	1.279	1.361	1.072	1.091
Prob. of normal	.057	.058	.363	.036	.016	.076	.049	.201	.185
Inference	Normal	Normal	Normal	-	-	Normal	-	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables K4, K5, and K7 need to be described in a frequency table as shown in Table 4- 7 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that variables have normal distribution tendencies. Because of the adequate in valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 7 Frequency of employers' assessments on knowledge

Variable Code / Competence Level	K1	K2	K3	K4	K5	K6	K7	K8	K9
(1) Very low								1	
(2) Low	1	1		2	2	2	5	6	4
(3) Somewhat	2	1	4	2	2	5	2	3	9
(4) High	10	10	7	10	11	9	9	7	4
(5) Very high	4	5	6	3	2	1	1		
Tendency of distribution	-	-	-	Normal	Normal	-	Normal	-	-

Source: Output of frequency analysis calculated by SPSS

4.3.2. Knowledge competence assessed by graduates

The data of graduates' knowledge competence obtained from graduates are shown in Table 4- 8. The headings, **K1** to **K9** are the codes of measured variables as described in Table 2- 2. In the left column, the numbers **12000** to **12130** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 39 cases of assessments on 9 variables of knowledge competence with no missing values.

Table 4- 8 Graduates' assessments on knowledge

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
12000	4	4	3	4	2	2	2	2	2
12003	5	5	5	4	3	3	4	2	3
12005	4	4	4	4	4	3	3	4	4
12006	1	1	1	1	2	2	1	2	2
12007	4	4	3	4	4	4	4	4	3

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
12010	3	4	3	4	4	3	3	3	4
12013	4	5	4	4	3	5	3	3	3
12016	4	4	2	4	3	3	3	2	4
12017	5	5	5	5	5	5	5	4	3
12019	4	4	3	4	4	4	4	3	4
12021	4	4	4	4	4	4	4	4	3
12024	4	4	4	4	4	3	4	4	2
12025	4	4	4	4	3	3	4	5	5
12031	5	5	3	4	2	4	4	4	4
12034	5	5	4	5	4	4	5	5	4
12039	4	4	3	4	4	2	3	4	4
12042	4	4	3	3	5	4	4	3	3
12043	4	4	4	4	3	3	3	4	4
12046	4	3	2	3	4	3	5	4	2
12048	5	4	4	4	4	4	3	3	3
12060	4	4	4	4	3	3	4	4	2
12061	4	4	4	3	2	2	4	2	3
12062	4	4	5	4	3	4	2	4	3
12066	3	4	2	4	4	3	4	4	4
12069	5	5	5	4	4	4	5	4	4
12070	5	4	4	5	4	4	5	5	4
12075	4	4	2	2	2	4	4	4	4
12086	4	4	2	4	4	4	2	2	4
12087	4	4	4	5	4	4	4	5	5
12100	4	4	4	4	4	4	3	3	2
12105	4	4	4	4	4	3	4	3	2
12106	4	4	4	5	4	4	4	5	4
12107	5	5	4	5	4	4	3	4	4
12109	4	4	5	4	4	5	4	5	2
12117	4	4	4	4	4	4	4	4	1
12120	4	4	2	4	4	4	4	4	4
12122	4	4	5	5	4	3	3	3	1
12129	5	5	5	5	5	4	4	4	4
12130	4	4	4	2	2	4	2	4	2
Missing	0	0	0	0	0	0	0	0	0
Total Cases	39	39	39	39	39	39	39	39	39

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 9. The tests indicate that all variables i.e. K1, K2, K3, K4, K5, K6, K7, K8 and K9 have random data.

Table 4- 9 Randomness tests of graduates' assessments on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Test Value (median)	4	4	4	4	4	4	4	4	3
Cases < Test Value	3	2	14	6	13	16	15	14	11
Cases >= Test Value	36	37	25	33	26	23	24	25	28
Number of Runs	7	5	20	12	15	20	23	20	17
Z	.000	.000	.195	.221	-1.038	.000	1.043	.195	.000
Prob. of random	1.000	1.000	.846	.825	.299	1.000	.297	.846	1.000
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 10. The tests indicate that no variable has a normal distribution.

Table 4- 10 Normal distribution tests of graduates' assessments on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Kolmogorov-Smirnov Z	2.287	2.428	1.780	2.311	2.199	1.872	1.776	1.818	1.667
Prob. of normal	.000	.000	.004	.000	.000	.002	.004	.003	.008
Inference	-	-	-	-	-	-	-	-	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables K1, K2, K3, K4, K5, K6, K7, K8 and K9 need to be described in a frequency table as shown in Table 4- 11 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of adequate in valid case numbers, randomness and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 11 Frequency of graduates' assessments on knowledge

Variable Code / Competence Level	K1	K2	K3	K4	K5	K6	K7	K8	K9
(1) Very low	1	1	1	1	0	0	1	0	2
(2) Low	0	0	6	2	6	4	4	6	9
(3) Somewhat	2	1	7	3	7	12	10	8	9
(4) High	27	29	18	25	23	20	19	19	17
(5) Very high	9	8	7	8	3	3	5	6	2
Tendency of distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.3.3. Knowledge competence assessed by academicians

The data of graduates' knowledge competence obtained from academicians are shown in Table 4- 12. The headings, **K1** to **K9** are the codes of measured variables as described in Table 2- 2. In the left column, the numbers **13000** to **13136** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 48 cases of assessments on 9 variables of knowledge competence with a missing value in the variable K8.

Table 4- 12 Academicians' assessments on knowledge

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
13000	4	4	4	3	3	3	3	2	1
13002	4	4	4	4	4	4	4	4	4
13006	5	5	5	5	5	4	4	4	4
13008	4	4	4	4	3	4	4	4	2
13009	5	4	3	3	2	2	4	2	3
13012	4	4	5	4	3	3	3	4	3
13014	4	4	4	5	4	4	4	4	4
13018	4	4	5	4	2	2	4	3	2
13019	4	4	3	4	3	2	2	2	3
13024	5	4	5	5	4	4	4	4	4
13027	5	5	4	5	5	4	4	4	4
13028	4	4	4	4	3	4	3	4	3
13030	5	5	5	5	5	5	5	5	3
13035	4	4	4	4	3	4	3	4	2
13041	1	1	1	1	1	1	1	1	1
13042	5	5	5	5	4	5	3	3	3
13043	4	4	5	4	3	3	4	4	3
13045	3	4	4	5	4	4	3	4	3
13050	4	4	3	3	2	2	2	1	1
13051	4	3	3	3	3	4	4	4	3
13056	3	3	4	3	2	2	3	2	2
13058	4	4	4	4	3	3	3	3	2
13059	5	4	3	3	2	3	3	4	2
13065	4	5	5	4	4	4	2	2	4
13069	3	3	3	2	2	2	2	3	2
13072	4	4	3	2	2	2	4	2	3
13079	4	4	4	3	4	3	3	2	2
13080	4	4	4	3	3	3	3	3	3
13084	4	4	3	4	3	4	3	3	3
13085	4	4	4	3	3	3	3	3	2
13087	5	4	4	4	4	4	5	5	3
13088	2	2	3	4	3	4	4	4	4
13089	4	4	3	3	3	4	3	3	3
13090	4	4	4	4	2	3	4	4	4
13091	5	4	4	4	3	3	3	2	3
13092	4	3	4	4	4	4	4	4	3

Respondent Code \ Variable Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
13095	4	3	2	4	2	3	4	2	2
13098	4	4	4	4	3	4	4	3	4
13099	3	4	5	4	4	4	4	4	3
13117	4	4	4	4	3	3	2	3	2
13120	5	5	4	4	4	4	4	4	3
13121	4	4	4	4	3	3	4	4	4
13122	5	5	5	5	5	5	4	4	4
13125	3	3	3	3	4	4	3	-	1
13126	4	5	3	4	4	4	4	5	3
13129	4	4	5	4	3	3	4	4	2
13134	5	5	5	5	5	4	4	4	4
13136	4	4	4	4	3	4	3	4	4
Missing	0	0	0	0	0	0	0	1	0
Total Cases	48	48	48	48	48	48	48	47	48

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 13. The tests indicate that all variables i.e. K1, K2, K3, K4, K5, K6, K7, K8 and K9 have random data.

Table 4- 13 Randomness tests of academicians' assessments on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Test Value (median)	4	4	4	4	3	4	4	4	3
Cases < Test Value	5	7	13	13	10	22	20	21	15
Cases >= Test Value	40	38	32	32	35	23	25	24	30
Number of Runs	11	11	21	16	19	26	22	22	24
Z	.484	-.775	.373	-.103	.857	.607	-.221	-.273	.851
Prob. of random	.628	.438	.709	.270	.391	.544	.825	.785	.395
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 14. The tests indicate that no variable has a normal distribution.

Table 4- 14 Normal distribution tests of academicians' assessments on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Kolmogorov-Smirnov Z	2.309	2.387	1.680	2.027	1.574	1.768	2.020	1.905	1.516
Prob. of normal	.000	.000	.007	.001	.014	.004	.001	.001	.020
Inference	-	-	-	-	-	-	-	-	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables K1, K2, K3, K4, K5, K6, K7, K8 and K9 need to be described in a frequency table as shown in Table 4- 15 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of the adequate in number of samples, randomness and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 15 Frequency of academicians' assessments on knowledge

Competence Level \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
(1) Very low	1	1	1	1	1	1	1	2	4
(2) Low	1	1	1	2	9	7	5	9	12
(3) Somewhat	5	6	12	11	20	14	17	10	19
(4) High	29	31	22	25	13	23	23	23	13
(5) Very high	12	9	12	9	5	3	2	3	0
Tendency of distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.3.4. Knowledge competence assessed by professionals

The data of graduates' knowledge competence obtained from professionals are shown in Table 4- 16. The headings, **K1** to **K9** are the codes of measured variables as described in Table 2- 2. In the left column, the numbers **14025** to **14287** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 16 cases of assessments on 9 variables of knowledge competence with a missing value in the variable K5.

Table 4- 16 Professionals' assessments on knowledge

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
14025	4	5	3	4	3	3	2	1	2
14027	5	4	5	4	4	4	5	4	3
14030	4	4	3	4	4	3	2	2	2
14033	5	4	5	5	4	4	4	5	4
14043	4	4	4	4	4	4	3	4	3
14060	5	5	5	5	5	5	5	4	4
14154	4	4	4	4	4	2	2	2	2
14159	4	4	4	3	3	3	2	2	3
14171	4	4	2	4	3	3	2	1	2
14177	5	5	4	4	-	1	3	2	3
14192	5	5	5	5	5	3	3	3	2
14197	4	5	2	4	3	2	2	2	4
14204	5	4	4	4	4	3	3	2	3
14210	4	4	3	3	3	2	2	2	2
14284	4	4	4	3	2	2	2	2	3
14287	5	5	5	4	5	3	4	3	4
Missing	0	0	0	0	1	0	0	0	0
Total Cases	16	16	16	16	15	16	16	16	16

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 17. The tests indicate that most variables i.e. K3, K4, K5, K6, K8 and K9 have random data.

Table 4- 17 Randomness tests of professionals' assessments on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Test Value (median)	4	4	4	4	4	3	2	2	3
Cases < Test Value	0	0	5	3	6	4	0	2	5
Cases >= Test Value	14	14	9	11	8	10	14	12	9
Number of Runs	1	1	8	5	6	7	1	4	10
Z			.044	-.185	-.772	.000		.000	1.264
Prob. of random			.965	.854	.440	1.000		1.000	.206
Inference	-	-	Random	Random	Random	Random	-	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 18. The tests indicate that variables K3, K4, K5, K6, K7, K8, and K9 have normal distributions.

Table 4- 18 Normal distribution tests of professionals' assessments on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Kolmogorov-Smirnov Z	1.521	1.658	.837	1.242	.882	.918	1.272	1.208	.845
Prob. of normal	.020	.008	.486	.092	.418	.368	.079	.108	.473
Inference	-	-	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The other variables K1 and K2 need to be described in a frequency table as shown in Table 4-19 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of adequate in valid case numbers, randomness distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4-19 Frequency of professionals' assessments on knowledge

Competence Level \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
(1) Very low	0	0	0	0	0	1	0	2	0
(2) Low	0	0	2	0	1	4	8	8	6
(3) Somewhat	0	0	3	3	5	7	4	2	6
(4) High	9	10	6	10	6	3	2	3	4
(5) Very high	7	6	5	3	3	1	2	1	0
Tendency of distribution	Normal	Normal	-	-	-	-	-	-	-

Source: Output of frequency analysis calculated by SPSS

4.3.5. Skills competence assessed by employers

The data of graduates' skills competence obtained from employers are shown in Table 4-20. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2-3. In the left column, the numbers **11000** to **11330** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3-7. The data contained in the table were compiled directly from questionnaire sets. The table shows 17 cases of assessments on 9 variables of skills competence with no missing values.

Table 4- 20 Employers' assessments on skills

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
11000	4	4	4	4	4	4	4	3	3
11043	4	4	4	5	5	4	4	2	4
11101	2	4	2	1	2	1	1	1	1
11122	5	4	4	4	4	4	5	4	5
11145	5	3	4	4	4	4	4	4	4
11152	5	5	5	5	5	5	5	5	4
11156	3	4	4	4	5	5	4	2	2
11167	2	3	4	4	3	4	4	3	3
11170	4	4	4	4	5	5	4	4	5
11175	4	4	4	3	2	3	1	1	1
11177	5	5	5	4	5	5	5	3	4
11180	4	4	4	3	4	4	4	3	2
11276	5	4	4	4	5	5	4	3	4
11284	4	5	5	5	5	4	5	4	4
11292	2	2	2	2	2	2	2	2	2
11293	5	4	4	3	4	4	4	3	3
11330	3	4	3	3	3	4	3	2	2
Missing	0	0	0	0	0	0	0	0	0
Total Cases	17	17	17	17	17	17	17	17	17

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 21. The tests indicate that all variables i.e. S1, S2, S3, S4, S5, S6, S7, S8 and S9 have random data.

Table 4- 21 Randomness tests of employers' assessments on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Test Value (median)	4	4	4	4	4	4	4	3	3
Cases < Test Value	5	3	3	6	5	3	4	6	6
Cases >= Test Value	12	14	14	11	12	14	13	11	11
Number of Runs	8	7	6	8	10	7	8	10	12
Z	.000	.507	.000	-.146	.881	.507	.273	.406	1.510
Prob. of random	1.000	.612	1.000	.884	.378	.612	.785	.685	.131
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 22. The tests indicate that variables i.e. S1, S4, S5, S8 and S9 have normal distributions.

Table 4- 22 Normal distribution tests of employers' assessments on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Kolmogorov-Smirnov Z	1.023	1.463	1.559	1.145	.967	1.423	1.471	.780	.937
Prob. of normal	.246	.028	.015	.145	.308	.035	.026	.577	.344
Inference	Normal	-	-	Normal	Normal	-	-	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables S2, S3, S6, and S7 need to be described in a frequency table as shown in Table 4- 23 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of adequate in valid case numbers, randomness distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 23 Frequency of employers' assessments on skills

Variable Code / Competence Level	S1	S2	S3	S4	S5	S6	S7	S8	S9
(1) Very low	0	0	0	1	0	1	2	2	2
(2) Low	3	1	2	1	3	1	1	4	4
(3) Somewhat	2	2	1	4	2	1	1	6	3
(4) High	6	11	11	8	5	9	9	4	6
(5) Very high	6	3	3	3	7	5	4	1	2
Tendency of distribution		Normal	Normal			Normal	Normal		

Source: Output of frequency analysis calculated by SPSS

4.3.6. Skills competence assessed by graduates

The data of graduates' skills competence obtained from graduates are shown in Table 4- 24. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2- 3. In the left column, the numbers **12000** to **12130** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 39 cases of assessments on 9 variables of skills competence with no missing values.

Table 4- 24 Graduates' assessments on skills

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
12000	2	4	4	4	4	4	4	3	3
12003	5	5	5	4	5	5	5	4	4
12005	4	4	4	4	5	4	4	4	4
12006	1	1	1	1	1	1	2	3	1
12007	3	3	4	5	5	5	5	4	4
12010	4	4	5	4	4	4	4	4	4
12013	4	4	4	4	4	4	4	3	4
12016	2	4	3	4	4	5	5	1	4
12017	4	4	5	3	4	4	4	3	3
12019	3	4	4	4	4	4	4	3	3
12021	4	4	4	4	4	4	4	4	4
12024	4	4	4	4	4	4	4	3	3
12025	5	5	3	5	5	5	5	5	5
12031	4	4	5	5	5	5	5	5	5
12034	4	5	5	5	5	5	5	5	5
12039	3	4	4	5	5	5	5	4	4
12042	2	4	4	3	4	3	4	2	3
12043	4	4	4	4	4	4	4	4	4
12046	2	3	3	5	4	3	4	3	4
12048	5	5	3	4	5	5	5	5	5
12060	4	4	4	4	4	4	4	3	4
12061	4	4	4	4	4	4	5	2	3
12062	4	3	3	5	4	4	4	4	4
12066	3	3	4	4	4	4	4	4	4
12069	5	5	5	5	5	5	5	5	5
12070	5	5	4	4	5	5	5	4	4
12075	4	4	4	4	5	4	4	3	4
12086	2	4	4	4	4	4	4	4	4
12087	4	4	4	4	4	5	4	4	4
12100	4	4	4	4	4	4	4	3	3
12105	4	4	4	5	5	4	5	4	5
12106	4	4	4	4	5	5	5	5	5
12107	2	4	5	5	5	5	5	5	5
12109	5	4	4	5	4	5	5	5	5
12117	4	5	3	4	4	4	4	4	4

Respondent Code \ Variable Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
12120	2	4	5	5	5	5	5	4	5
12122	5	4	4	4	4	4	4	3	3
12129	5	5	5	5	5	5	5	5	5
12130	4	2	2	4	2	4	5	2	5
Missing	0	0	0	0	0	0	0	0	0
Total Cases	39	39	39	39	39	39	39	39	39

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 25. The tests indicate that all variables S1, S2, S3, S4, S5, S6, S7, S8 and S9 have random data.

Table 4- 25 Randomness tests of graduates' assessments on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Test Value (median)	4	4	4	4	4	4	4	4	4
Cases < Test Value	12	6	8	3	2	3	1	15	9
Cases >= Test Value	27	33	31	36	37	36	38	24	30
Number of Runs	20	8	14	7	4	7	3	21	16
Z	.721	-1.697	.000	.000	-.558	.000	.000	.357	.302
Prob. of random	.471	.090	1.000	1.000	.577	1.000	1.000	.721	.762
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 26. The tests indicate that no variable has a normal distribution.

Table 4- 26 Normal distribution tests of graduates' assessments on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Kolmogorov-Smirnov Z	1.955	2.241	1.990	1.984	1.967	1.774	1.774	1.415	1.608
Prob. of normal	.001	.000	.001	.001	.001	.004	.004	.036	.011
Inference	-	-	-	-	-	-	-	-	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables S1, S2, S3, S4, S5, S6, S7, S8 and S9 need to be described in a frequency table as shown in Table 4- 27 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of adequate in valid case numbers, randomness and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 27 Frequency of graduates' assessments on skills

Competence Level \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
(1) Very low	1	1	1	1	1	1	0	1	1
(2) Low	7	1	1	0	1	0	1	3	0
(3) Somewhat	4	4	6	2	0	2	0	11	8
(4) High	19	25	22	23	21	20	20	15	18
(5) Very high	8	8	9	13	16	16	18	9	12
Tendency of distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.3.7. Skills competence assessed by academicians

The data of graduates' skills competence obtained from academicians are shown in Table 4- 28. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2- 3. In the left column, the numbers **13000** to **13136** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 48 cases of assessments on 9 variables of skills competence with a missing value in the variable S5.

Table 4- 28 Academicians' assessments on skills

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
13000	4	3	3	2	3	3	3	3	3
13002	4	4	4	4	4	4	4	4	4
13006	5	5	4	4	4	4	4	4	4
13008	4	4	4	3	4	4	4	3	4
13009	3	5	3	4	4	3	3	4	3
13012	4	4	4	4	4	4	4	4	3
13014	4	4	4	5	5	4	4	4	4
13018	4	4	4	4	3	4	4	2	3
13019	3	4	3	3	4	4	4	3	3
13024	4	5	4	4	4	4	4	4	4
13027	4	4	5	5	5	4	5	4	4
13028	4	4	4	4	4	5	5	4	4
13030	5	5	5	5	5	5	5	4	5
13035	4	4	4	4	3	4	4	3	3
13041	1	3	1	1	1	1	1	1	1
13042	5	5	5	5	5	5	5	4	4
13043	5	4	4	2	3	4	3	3	3
13045	4	4	5	4	4	4	4	4	4
13050	1	2	3	2	4	1	3	3	3
13051	4	4	3	5	3	4	3	4	4
13056	4	3	4	4	3	4	4	3	3
13058	4	4	4	3	4	3	3	3	3
13059	4	4	4	4	3	3	4	3	3
13065	4	4	3	4	4	4	3	3	3
13069	2	3	3	2	4	3	4	3	3
13072	4	4	4	3	4	3	2	2	2
13079	4	4	3	4	4	4	5	3	3
13080	4	4	4	4	4	3	3	2	2
13084	4	3	3	3	4	3	4	3	3
13085	4	4	4	4	4	3	4	3	3

Respondent Code \ Variable Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
13087	4	4	4	4	4	4	4	4	4
13088	2	4	4	4	4	4	4	4	4
13089	3	3	3	2	2	2	3	3	3
13090	4	4	4	3	4	4	4	3	3
13091	3	4	4	4	4	4	4	4	4
13092	3	4	4	5	4	5	5	4	4
13095	4	4	4	2	4	2	4	2	2
13098	4	4	4	4	4	5	4	4	4
13099	4	4	3	4	4	4	4	4	4
13117	4	4	3	3	4	4	4	3	3
13120	5	4	4	4	5	4	4	4	5
13121	4	4	4	2	3	4	4	4	3
13122	4	4	4	4	3	4	4	3	3
13125	3	3	3	4	4	3	4	3	2
13126	3	4	5	4	5	5	4	4	4
13129	5	4	4	4	4	4	4	4	4
13134	5	5	5	5	5	5	5	4	3
13136	4	4	4	4	-	3	4	2	2
Missing	0	0	0	0	1	0	0	0	0
Total Cases	48	48	48	48	47	48	48	48	48

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 29. The tests indicate that all variables S1, S2, S3, S4, S5, S6, S7, S8 and S9 have random data.

Table 4- 29 Randomness tests of academicians' assessments on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Test Value (median)	4	4	4	4	4	4	4	3	3
Cases < Test Value	10	7	13	15	11	13	11	5	4
Cases >= Test Value	35	38	32	30	34	32	34	40	41

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Number of Runs	17	14	20	24	16	18	18	11	9
Z	.000	.397	.004	.851	-.462	-.365	.000	.484	.207
Prob. of random	1.000	.691	.997	.395	.644	.715	1.000	.628	.836
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4-30. The tests indicate that no variable has a normal distribution.

Table 4-30 Normal distribution tests of academicians' assessments on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Kolmogorov-Smirnov Z	2.441	2.508	2.213	2.099	2.234	2.166	2.234	1.985	1.710
Prob. of normal	.000	.000	.000	.000	.000	.000	.000	.001	.006
Inference	-	-	-	-	-	-	-	-	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables S1, S2, S3, S4, S5, S6, S7, S8 and S9 need to be described in a frequency table as shown in Table 4-31 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of adequate in valid case numbers, randomness and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 31 Frequency of academicians' assessments on skills

Variable Code / Competence Level	S1	S2	S3	S4	S5	S6	S7	S8	S9
(1) Very low	2	0	1	1	1	2	1	1	1
(2) Low	2	1	0	7	1	2	1	5	5
(3) Somewhat	7	7	13	7	9	11	9	19	22
(4) High	30	34	28	26	29	26	30	23	18
(5) Very high	7	6	6	7	7	7	7	0	2
Tendency of distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.3.8. Skills competence assessed by professionals

The data of graduates' skills competence obtained from professionals are shown in Table 4- 32. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2- 3. In the left column, the numbers **14025** to **14287** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 16 cases of assessments on 9 variables of skills competence with a missing value in the variables S6, S7, S8 and S9.

Table 4- 32 Professionals' assessments on skills

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
14025	4	3	3	2	3	2	3	1	1
14027	5	4	4	4	5	5	5	4	4

Respondent Code \ Variable Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
14030	3	4	4	2	4	2	4	3	3
14033	5	4	5	5	5	5	5	5	5
14043	4	4	4	3	5	4	4	4	4
14060	5	4	5	5	3	5	5	4	3
14154	4	3	4	4	4	4	4	4	4
14159	4	4	4	4	4	4	4	3	3
14171	2	2	4	3	3	2	4	2	2
14177	3	3	4	2	4	4	4	2	2
14192	4	4	4	3	3	-	-	-	-
14197	2	4	4	2	4	5	5	2	2
14204	4	4	4	2	3	3	3	3	3
14210	4	3	4	3	3	3	3	2	3
14284	4	3	3	2	3	3	3	3	3
14287	5	5	4	4	5	4	4	3	3
Missing	0	0	0	0	0	1	1	1	1
Total Cases	16	16	16	16	16	15	15	15	15

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 33. The tests indicate that all variables S1, S2, S3, S4, S5, S6, S7, S8 and S9 have random data.

Table 4- 33 Randomness tests of professionals' assessments on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Test Value (median)	4	4	4	3	4	4	4	3	3
Cases < Test Value	3	5	2	5	6	6	4	4	3
Cases >= Test Value	11	9	12	9	8	8	10	10	11
Number of Runs	5	8	4	8	8	8	4	6	4
Z	-.185	.044	.000	.044	.000	.000	-1.538	-.149	-1.046

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Prob. of random	.854	.965	1.000	.965	1.000	1.000	.124	.882	.295
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 34. The tests indicate that all variables have normal distributions. Because of adequate in valid case numbers, randomness and distribution, these data are fit as samples in generalization analysis.

Table 4- 34 Normal distribution tests of professionals' assessments on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Kolmogorov-Smirnov Z	1.176	1.224	1.336	.814	1.002	.723	.802	.702	.962
Prob. of normal	.126	.100	.056	.521	.268	.672	.541	.707	.313
Inference	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

4.3.9. Attitude competence assessed by employers

The data of graduates' attitude competence obtained from employers are shown in Table 4- 35. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2- 4. In the left column, the numbers **11000** to **11330** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 17 cases of assessments on 9 variables of attitude competence with no missing values.

Table 4- 35 Employers' assessments on attitude

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
11000	4	3	3	3	3	4	4	4	4
11043	4	2	4	4	4	4	4	4	5
11101	3	2	4	4	3	4	1	1	1
11122	4	4	5	5	4	5	4	4	5
11145	4	4	4	4	3	4	3	4	4
11152	5	4	5	5	3	4	4	5	5
11156	4	4	4	4	4	3	3	4	4
11167	4	3	3	3	2	3	3	3	4
11170	4	5	4	4	5	5	4	5	5
11175	3	2	1	4	2	1	3	1	1
11177	4	5	5	4	3	5	5	5	5
11180	4	3	4	3	3	4	3	3	4
11276	4	5	5	4	3	4	3	4	4
11284	5	4	4	4	3	4	4	4	4
11292	2	2	4	4	2	2	4	2	2
11293	4	4	4	4	3	4	3	4	4
11330	3	3	3	3	3	3	3	3	3
Missing	0	0	0	0	0	0	0	0	0
Total Cases	17	17	17	17	17	17	17	17	17

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 36. The tests indicate that all variables A1, A2, A3, A4, A5, A6, A7, A8 and A9 have random data.

Table 4- 36 Randomness tests of employers' assessments on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Test Value (median)	4	4	4	4	3	4	3	4	4
Cases < Test Value	4	8	4	4	3	5	1	6	4
Cases >= Test Value	13	9	13	13	14	12	16	11	13
Number of Runs	8	11	7	7	7	8	3	12	8
Z	.273	.518	.000	.000	.507	.000	.000	1.510	.273
Prob. of random	.785	.605	1.000	1.000	.612	1.000	1.000	.131	.785
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 37. The tests indicate that variables i.e. A2, A3, A5, A6, A7 and S8 have normal distributions.

Table 4- 37 Normal distribution tests of employers' assessments on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Kolmogorov-Smirnov Z	1.486	.905	1.286	1.412	1.338	1.305	1.069	1.220	1.387
Prob. of normal	.024	.386	.073	.037	.056	.066	.203	.102	.043
Inference	-	Normal	Normal	-	Normal	Normal	Normal	Normal	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables A1, A4, and A9 need to be described in a frequency table as shown in Table 4- 38 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of adequate in valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 38 Frequency of employers' assessments on attitude

Variable Code / Competence Level	A1	A2	A3	A4	A5	A6	A7	A8	A9
(1) Very low	0	0	1	0	0	1	1	2	2
(2) Low	1	4	0	0	3	1	0	1	1
(3) Somewhat	3	4	3	4	10	3	8	3	1
(4) High	11	6	9	11	3	9	7	8	8
(5) Very high	2	3	4	2	1	3	1	3	5
Tendency of distribution	Normal			Normal					Normal

Source: Output of frequency analysis calculated by SPSS

4.3.10. Attitude competence assessed by graduates

The data of graduates' attitude competence obtained from graduates are shown in Table 4- 39. The headings, **A1** to **A9** are the codes of measured variables as described in Table 2- 4. In the left column, the numbers **12000** to **12130** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, **2** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 39 cases of assessments on 9 variables of attitude competence with no missing values.

Table 4- 39 Graduates' assessments on attitude

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
12000	4	5	5	4	4	4	4	3	4
12003	5	4	4	4	4	4	4	4	4

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
12005	4	5	5	4	5	4	5	5	4
12006	1	1	1	2	3	2	2	1	2
12007	4	4	5	5	3	4	4	5	4
12010	3	3	4	3	4	4	4	5	4
12013	4	3	3	4	4	5	5	4	4
12016	4	4	5	5	3	4	5	5	5
12017	4	4	4	4	4	4	4	4	4
12019	4	3	5	5	3	4	5	4	3
12021	4	4	4	4	4	4	4	4	4
12024	4	4	4	4	4	4	4	4	4
12025	5	3	4	4	4	5	5	5	5
12031	5	5	5	5	5	5	5	5	5
12034	5	4	5	5	4	5	4	4	4
12039	4	4	4	3	3	5	4	4	4
12042	3	2	3	2	2	3	4	4	4
12043	4	2	4	4	4	3	4	4	4
12046	4	2	4	4	4	4	3	4	4
12048	5	4	5	4	3	5	5	5	5
12060	4	4	4	4	4	4	4	4	4
12061	4	4	4	4	3	5	4	4	4
12062	4	5	4	3	3	5	4	4	5
12066	4	4	3	4	3	4	4	4	4
12069	5	4	5	5	4	4	3	4	4
12070	5	4	5	5	3	5	5	4	4
12075	4	4	5	5	5	5	5	5	5
12086	4	4	4	4	4	4	4	4	4
12087	5	4	4	5	5	4	5	5	5
12100	4	4	4	4	3	4	4	4	4
12105	4	5	4	3	4	5	5	5	4
12106	4	4	5	4	4	4	4	4	4
12107	5	4	5	5	5	5	5	5	5
12109	4	4	5	5	5	4	5	5	5
12117	5	4	4	4	4	4	4	4	4
12120	4	5	5	5	5	5	4	4	5
12122	4	4	4	4	4	4	3	4	4
12129	5	5	5	5	5	5	5	5	5
12130	2	4	4	4	5	5	5	4	4
Missing	0	0	0	0	0	0	0	0	0
Total Cases	39	39	39	39	39	39	39	39	39

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4-40. The tests indicate that all variables A1, A2, A3, A4, A5, A6, A7, A8 and A9 have random data.

Table 4-40 Randomness tests of graduates' assessments on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Test Value (median)	4	4	4	4	4	4	4	4	4
Cases < Test Value	4	8	4	6	12	3	4	2	2
Cases >= Test Value	35	31	35	33	27	36	35	37	37
Number of Runs	8	11	9	11	17	5	9	4	5
Z	.000	-1.120	.297	.000	-.044	-1.277	.297	-.558	.000
Prob. of Random	1.000	.263	.767	1.000	.965	.202	.767	.577	1.000
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4-41. The tests indicate that no variable has a normal distribution.

Table 4-41 Normal distribution tests of graduates' assessments on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Kolmogorov-Smirnov Z	2.171	2.263	1.714	1.764	1.524	1.716	1.608	2.040	2.177
Prob. of normal	.000	.000	.006	.004	.019	.006	.011	.000	.000
Inference	-	-	-	-	-	-	-	-	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables A1, A2, A3, A4, A5, A6, A7, A8 and A9 need to be described in a frequency table as shown in Table 4- 42 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of adequate in valid case numbers, randomness and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 42 Frequency of graduates' assessments on attitude

Variable Code / Competence Level	A1	A2	A3	A4	A5	A6	A7	A8	A9
(1) Very low	1	1	1	0	0	0	0	1	0
(2) Low	1	3	0	2	1	1	1	0	1
(3) Somewhat	2	4	3	4	11	2	3	1	1
(4) High	24	24	19	20	18	21	20	24	26
(5) Very high	11	7	16	13	9	15	15	13	11
Tendency of distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.3.11. Attitude competence assessed by academicians

The data of graduates' attitude competence obtained from academicians are shown in Table 4- 43. The headings, **A1** to **A9** are the codes of measured variables as described in Table 2- 4. In the left column, the numbers **13000** to **13136** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 48 cases of assessments on 9 variables of attitude competence with a missing value in the variable A9.

Table 4- 43 Academicians' assessments on attitude

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
13000	3	4	4	3	3	3	4	4	4
13002	4	4	4	4	4	4	4	4	4
13006	4	4	4	4	4	4	4	4	4
13008	5	5	4	4	4	4	4	4	4
13009	2	2	4	3	3	4	3	3	4
13012	5	4	4	4	3	4	3	4	4
13014	5	4	4	4	4	5	4	4	4
13018	3	3	4	3	4	3	4	5	4
13019	4	2	3	3	3	3	3	3	3
13024	3	4	3	4	4	4	3	4	4
13027	5	5	4	4	4	5	4	4	4
13028	4	4	4	4	3	4	4	4	4
13030	5	5	5	5	5	5	5	5	5
13035	3	3	3	4	3	3	3	4	4
13041	1	1	3	3	1	1	3	3	3
13042	5	5	5	5	5	5	3	4	5
13043	4	4	4	4	2	4	2	2	2
13045	4	3	3	4	4	4	5	5	-
13050	3	3	3	2	1	3	1	3	3
13051	3	4	4	4	4	4	4	4	4
13056	3	4	4	4	3	4	3	3	3
13058	4	3	3	3	3	3	2	3	3
13059	4	3	3	4	2	3	2	4	4
13065	5	5	4	4	5	5	4	4	4
13069	2	2	4	3	3	3	4	2	4
13072	4	2	3	4	4	3	2	2	2
13079	4	4	5	5	5	5	5	5	5
13080	4	3	4	4	3	3	3	3	3
13084	4	3	3	3	3	4	3	3	3
13085	4	3	3	3	3	4	4	4	4
13087	4	3	4	3	3	3	3	4	4
13088	2	3	4	4	4	4	4	4	4
13089	3	3	2	2	2	2	2	3	2
13090	3	4	3	4	3	4	3	3	4
13091	3	3	3	3	4	4	4	4	4
13092	4	3	4	4	4	4	4	4	4
13095	2	4	4	4	3	4	3	4	3

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
13098	4	2	4	4	4	3	4	4	3
13099	4	4	4	4	4	4	4	4	4
13117	4	4	4	4	3	4	4	4	3
13120	5	4	4	4	5	4	3	4	4
13121	4	3	4	4	4	4	4	3	3
13122	4	3	4	4	4	3	4	4	4
13125	3	2	4	4	4	3	3	3	4
13126	5	4	4	5	5	4	4	5	4
13129	4	3	4	3	4	3	3	4	4
13134	4	4	4	4	4	4	4	4	4
13136	4	3	3	4	3	3	3	3	3
Missing	0	0	0	0	0	0	0	0	1
Total Cases	48	48	48	48	48	48	48	48	47

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4-44. The tests indicate that all variables A1, A2, A3, A4, A5, A6, A7, A8 and A9 have random data.

Table 4- 44 Randomness tests of academicians' assessments on attitude

Variable Code / Items	A1	A2	A3	A4	A5	A6	A7	A8	A9
Test Value (median)	4	4	4	4	4	4	4	4	4
Cases < Test Value	15	22	13	14	21	16	21	14	14
Cases >= Test Value	30	23	32	31	24	29	24	31	31
Number of Runs	18	23	15	22	24	24	23	19	21
Z	-.851	.000	-1.471	.428	.030	.619	.000	-.279	.075
Prob. of random	.395	1.000	.141	.669	.976	.536	1.000	.781	.941

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 45. The tests indicate that no variable has a normal distribution.

Table 4- 45 Normal distribution tests of academicians' assessments on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Kolmogorov-Smirnov Z	1.850	1.544	2.462	2.280	1.520	1.898	1.931	2.303	2.416
Prob. of normal	.002	.017	.000	.000	.020	.001	.001	.000	.000
Inference	-	-	-	-	-	-	-	-	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variables A1, A2, A3, A4, A5, A6, A7, A8 and A9 need to be described in a frequency table as shown in Table 4- 46 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of adequate in valid case numbers, randomness and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 46 Frequency of academicians' assessments on attitude

Competence Level \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
(1) Very low	1	1	0	0	2	1	1	0	0
(2) Low	4	6	1	2	3	1	5	3	3
(3) Somewhat	11	18	14	12	17	16	17	13	12
(4) High	23	18	30	30	20	24	22	27	29

Variable Code / Competence Level	A1	A2	A3	A4	A5	A6	A7	A8	A9
(5) Very high	9	5	3	4	6	6	3	5	3
Tendency of distribution	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.3.12. Attitude competence assessed by professionals

The data of graduates' attitude competence obtained from professionals are shown in Table 4- 47. The headings, **A1** to **A9** are the codes of measured variables as described in Table 2- 4. In the left column, the numbers **14025** to **14287** are the codes of respondents. The values **1** to **5** are data of competence levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high*** as described in Table 3- 7. The data contained in the table were compiled directly from questionnaire sets. The table shows 16 cases of assessments on 9 variables of attitude competence with no missing values.

Table 4- 47 Professionals' assessments on attitude

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
14025	4	4	3	3	2	3	2	2	2
14027	4	5	5	4	4	4	4	4	4
14030	4	4	4	3	2	4	3	3	3
14033	5	5	5	5	5	5	5	4	4
14043	4	4	4	4	4	5	4	4	4
14060	5	5	5	5	4	5	4	5	5
14154	4	3	3	4	2	4	4	4	4
14159	4	2	4	4	4	4	3	4	4
14171	3	3	4	4	2	3	3	4	4

Respondent Code \ Variable Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
14177	4	2	2	2	2	2	2	2	2
14192	3	3	3	3	2	3	3	4	4
14197	4	4	4	4	2	4	4	4	4
14204	4	4	4	4	4	4	3	3	4
14210	3	3	3	3	2	4	3	3	3
14284	4	3	2	3	3	3	3	3	2
14287	5	4	4	4	3	5	3	4	4
Missing	0	0	0	0	0	0	0	0	0
Total Cases	16	16	16	16	16	16	16	16	16

Source: Respondents

These assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 48. The tests indicate that all variables A1, A2, A3, A4, A5, A6, A7, A8 and A9 have random data.

Table 4- 48 Randomness tests of professionals' assessments on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Test Value (median)	4	4	4	4	3	4	3	4	4
Cases < Test Value	2	5	4	4	6	3	1	5	4
Cases >= Test Value	12	9	10	10	8	11	13	9	10
Number of Runs	5	5	6	6	10	6	2	6	6
Z	.089	-1.177	-.149	-.149	.935	.000	-1.021	-.567	-.149
Prob. of random	.929	.239	.882	.882	.350	1.000	.307	.571	.882
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 49. The tests indicate that all variables have normal distributions. Because of adequate in valid case numbers, randomness and distribution, these data are fit as samples in generalization analysis.

Table 4- 49 Normal distribution tests of professionals' assessments on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Kolmogorov-Smirnov Z	1.242	.889	1.047	1.121	1.010	.948	1.070	1.224	1.417
Prob. of normal	.092	.407	.223	.162	.260	.330	.202	.100	.036
Inference	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The other variable of A9 needs to be described in a frequency table as shown in Table 4- 50 to judge its distribution. The table shows the frequency of competence levels in each variable and indicates that the variable has tendency of normal distribution. Because of adequate in valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 50 Frequency of professionals' assessments on attitude

Competence \ Attribute Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
(1) Very Low	0	0	0	0	0	0	0	0	0
(2) Low	0	2	2	1	8	1	2	2	3
(3) Somewhat	3	5	4	5	2	4	8	4	2
(4) High	10	6	7	8	5	7	5	9	10
(5) Very High	3	3	3	2	1	4	1	1	1
Tendency of distribution	-	-	-	-	-	-	-	-	Normal

Source: Output of frequency analysis calculated by SPSS

4.4. Data related to performance and satisfaction

As shown in sections 3.4.2 and 3.4.3, the three variables of performance and one variable of satisfaction were measured to know performance of graduates and satisfaction of stakeholders. The performance data are categorized into three factors i.e. time, cost and quality and each factor has a variable. Satisfaction data are perceptions of respondents, i.e. employers and graduates. Measurements of time performance are shown in Table 3- 8, cost in Table 3- 9, quality in Table 3- 10, and satisfaction in Table 3- 11. The data values are ordinal numbers.

4.4.1. Performance and satisfaction assessments by employers

The data of performance and satisfaction obtained from employers are shown in Table 4- 51. The headings are the measured factors. In the left column, the numbers **11000** to **11330** are the codes of respondents. The values **1** to **5** are data of performance and satisfaction levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high***. The data contained in the table were compiled directly from questionnaire sets. The table shows 17 cases of assessments on performance and satisfaction with 2 missing values in each variable.

Table 4- 51 Employers' assessments on performance and satisfaction

Item / Respondent Code	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
11000	3	2	3	4
11043	-	-	-	-
11101	1	2	2	2
11122	3	2	3	4
11145	3	3	4	4
11152	2	2	4	5
11156	3	3	4	4
11167	2	2	3	4
11170	2	2	4	4
11175	2	4	4	4
11177	3	3	4	5
11180	2	2	2	4
11276	3	2	3	5

Item / Respondent Code	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
11284	3	3	4	5
11292	-	-	-	-
11293	3	3	3	4
11330	3	3	4	3
Missing	2	2	2	2
Total Cases	15	15	15	15

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 52. The tests indicate that most variables have random data.

Table 4- 52 Randomness tests of employers' assessments on performance and satisfaction

Variable / Items	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
Test Value (median)	3	2	4	4
Cases < Test Value	6	0	7	2
Cases >= Test Value	9	15	8	13
Number of Runs	9	1	8	4
Z	.168	-	.000	.000
Prob. of random	.867	-	1.000	1.000
Inference	Random	-	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 53. The tests indicate that data in variables of cost performance, quality performance, and satisfaction have normal distributions.

Table 4- 53 Normal distribution tests of graduates' assessments on performance and satisfaction

Variable / Items	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
Kolmogorov-Smirnov Z	1.422	1.282	1.261	1.291
Prob. of normal	.035	.075	.083	.071

Variable / Items	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
Inference	-	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variable of time performance needs to be described in a frequency table as shown in Table 4- 54 to judge its distribution. The table shows the frequency of performance levels in each variable and indicates that the variable has a tendency of normal distribution. Because of the adequate of valid case numbers, randomness and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 54 Frequency of graduates' assessments on performance and satisfaction

Variable / Level	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
(1) Very low	1	0	0	0
(2) Low	5	8	2	1
(3) Somewhat	9	6	5	1
(4) High	0	1	8	9
(5) Very high	0	0	0	4
Tendency of distribution	Normal	-	-	-

Source: Output of frequency analysis calculated by SPSS

4.4.2. Performance and satisfaction assessments by graduates

The data of performance and satisfaction obtained from graduates are shown in Table 4- 55. The headings are the measured factors. In the left column, the numbers **12000** to **12130** are the codes of respondents. The values **1** to **5** are data of performance and satisfaction levels; number ***1*** means ***Very low***, ***2*** means ***Low***, ***3*** means ***Somewhat***, ***4*** means ***High***, and ***5*** means ***Very high as*** described in Table 3- 8 and Table 3- 11. The data contained in the table were compiled directly from questionnaire sets. The table shows 39 cases of assessments on performance and satisfaction with no missing values.

Table 4- 55 Graduates' assessments on performance and satisfaction

Item / Respondent Code	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
12000	3	3	5	4
12003	2	1	3	4
12005	3	3	3	4
12006	1	2	4	4
12007	3	3	3	4
12010	2	2	3	3
12013	3	2	3	4
12016	2	3	4	4
12017	2	3	3	3
12019	2	2	3	3
12021	2	3	3	4
12024	2	2	4	4
12025	3	2	4	5
12031	2	3	3	4
12034	2	1	4	5
12039	2	2	3	4
12042	3	2	4	5
12043	2	2	3	4
12046	2	2	3	4
12048	2	3	4	3
12060	2	3	3	4
12061	2	2	3	4
12062	2	4	3	4
12066	2	4	3	4
12069	3	2	3	4
12070	5	5	5	4
12075	5	2	3	4
12086	3	3	3	4
12087	2	2	4	4
12100	2	3	4	4
12105	1	1	4	5
12106	4	2	3	5
12107	1	1	3	5
12109	3	3	2	4
12117	3	3	5	4
12120	2	4	3	5
12122	2	2	3	4
12129	3	2	3	4
12130	2	3	4	4
Missing	0	0	0	0
Total Cases	39	39	39	39

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4-56. The tests indicate that all variables i.e. time performance, cost performance, quality performance, and satisfaction have random data.

Table 4-56 Randomness tests of graduates' assessments on performance and satisfaction

Variable / Items	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
Test Value (median)	2	2	3	4
Cases < Test Value	3	4	1	4
Cases >= Test Value	36	35	38	35
Number of Runs	7	9	3	7
Z	.000	.297	.000	-.629
Prob. of random	1.000	.767	1.000	.529
Inference	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4-57. The tests indicate that no data in the variables have normal distributions.

Table 4-57 Normal distribution tests of graduates' assessments on performance and satisfaction

Variable / Items	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
Kolmogorov-Smirnov Z	2.001	1.546	2.302	2.360
Prob. of normal	.001	.017	.000	.000
Inference	'	'	'	'

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

All the variables need to be described in a frequency table as shown in Table 4-58 to judge their distribution. The table shows the frequency of performance levels in each variable and indicates that the variables have tendencies of normal distribution. Because of the adequate of valid case numbers, randomness and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 58 Frequency of graduates' assessments on performance and satisfaction

Variable / Level	Time Perf.	Cost Perf.	Quality Perf.	Satisfaction
(1) Very low	3	4	0	0
(2) Low	22	17	1	0
(3) Somewhat	11	14	24	4
(4) High	1	3	11	28
(5) Very high	2	1	3	7
Tendency of distribution	Normal	Normal	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.5. Data related to expectations

As shown in section 3.4.4, the 27 variables were to be measured to obtain data on expectations about graduates' competence. The expectations data are categorized into three factors and four respondent groups. The factor groups are knowledge, skills and attitude, while the respondent groups are employers, graduates, academicians and professionals. Knowledge variables are shown in Table 2- 2, skills in Table 2- 3, and attitude variables are shown in Table 2- 4. Expectations was measured in nine levels as shown in Table 3- 12. The data values are ordinal numbers.

4.5.1. Knowledge expected by employers

The data of expectations obtained from employers are shown in Table 4- 59. The headings, **K1** to **K9** are the codes of measured variables as described in Table 2- 2. In the left column, the numbers **11000** to **11330** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 17 cases of assessments on 9 variables of knowledge competence with no missing values and 3 cases of improper data.

Table 4- 59 Employers' expectations on knowledge

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
11000	9	5	6	8	7	1	4	3	2
11043	8	5	4	3	1	2	9	7	6
11101*	7	7	6	6	8	8	6	7	6
11122*	2	2	1	2	2	2	2	3	3
11145	9	2	4	8	7	1	6	5	3
11152	8	7	5	9	6	3	1	4	2
11156	9	5	8	4	1	7	6	3	2
11167	9	8	5	7	6	3	4	2	1
11170	9	7	4	6	5	8	3	1	2
11175	6	5	3	7	8	2	4	9	1
11177	8	9	3	7	4	2	6	5	1
11180	8	9	7	6	5	1	3	2	4
11276	9	6	7	8	5	4	3	2	1
11284	9	5	6	8	7	4	2	3	1
11292*	1	6	6	1	1	6	2	1	1
11293	9	6	5	8	3	7	4	2	1
11330	8	3	9	7	6	4	5	2	1
Total Cases	17	17	17	17	17	17	17	17	17
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	3	3	3	3	3	3	3	3	3

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 60. The tests indicate that all variables i.e. K1, K2, K3, K4, K5, K6, K7, K8 and K9 have random data.

Table 4- 60 Randomness tests of employers' expectations on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Test Value (median)	9	6	5	7	6	3	4	3	2
Cases < Test Value	6	7	5	4	7	6	5	6	7
Cases >= Test Value	8	7	9	10	7	8	9	8	7
Number of Runs	8	9	5	9	11	4	7	6	6
Z	.000	.278	-1.177	1.240	1.391	-1.910	.000	-.772	-.835
Prob. of random	1.000	.781	.239	.215	.164	.056	1.000	.440	.404
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 61. The tests indicate that all variables i.e. K1, K2, K3, K4, K5, K6, K7, K8 and K9 have normal distributions. Because of the adequate of valid case numbers, randomness and distribution, these data are fit as samples in generalization analysis.

Table 4- 61 Normal distribution tests of employers' expectations on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Kolmogorov-Smirnov Z	1.198	.725	.614	.930	.753	.753	.745	.911	1.069
Prob. of normal	.113	.669	.845	.352	.623	.622	.635	.378	.203
Inference	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

4.5.2. Knowledge expected by graduates

The data of expectations obtained from graduates are shown in Table 4- 62. The headings, **K1** to **K9** are the codes of measured variables as described in Table 2- 2. In the left column, the numbers **12000** to **12130** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 39 cases of assessments on 9 variables of knowledge competence with no missing values and 7 cases of improper data.

Table 4- 62 Graduates' expectations on knowledge

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
12000	9	8	6	7	1	3	4	2	5
12003	9	8	7	6	2	4	5	1	3
12005	9	5	8	7	6	2	3	4	1
12006	6	9	7	8	1	2	5	4	3
12007	8	5	3	9	1	6	7	4	2
12010	6	8	7	9	2	5	1	4	3
12013	9	6	2	5	1	3	4	7	8
12016	8	9	5	7	4	3	2	1	6
12017	5	8	7	9	1	4	6	3	2
12019	4	1	5	3	9	6	2	7	8
12021	8	7	5	9	4	2	3	6	1
12024*	7	7	7	7	6	6	8	6	5
12025	4	6	5	8	1	3	9	7	2
12031	7	9	6	8	3	1	5	2	4
12034	3	1	2	7	4	8	5	9	6
12039	6	7	3	8	5	1	2	9	4
12042	7	1	6	9	8	2	3	4	5
12043	4	5	8	7	3	2	6	9	1
12046	5	6	3	7	4	2	9	8	1
12048	1	2	3	7	5	6	8	4	9
12060	8	7	9	6	5	2	3	4	1
12061	2	1	3	4	8	9	5	6	7
12062	4	5	6	7	3	2	8	9	1
12066	2	4	6	9	3	5	7	8	1
12069*	7	6	8	5	3	2	9	1	4
12070	9	8	3	7	6	5	4	2	1
12075*	7	8	4	4	3	6	7	7	6
12086	8	6	4	7	9	5	1	3	2
12087	6	5	1	8	4	3	2	7	9

Respondent Code \ Variable Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
12100	9	8	7	6	4	5	3	1	2
12105*	7	8	7	8	6	7	8	6	3
12106	3	5	4	9	6	2	7	8	1
12107	4	5	3	9	8	2	1	7	6
12109	5	4	6	1	8	2	7	3	9
12117*	7	7	6	9	8	7	7	7	1
12120*	2	2	4	2	1	3	3	2	4
12122*	8	9	8	9	6	6	5	5	2
12129	7	6	5	9	8	4	1	2	3
12130	9	8	2	7	4	3	5	6	1
Total Cases	39	39	39	39	39	39	39	39	39
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	7	7	7	7	7	7	7	7	7

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 63. The tests indicate that all variables i.e. K1, K2, K3, K4, K5, K6, K7, K8 and K9 have random data.

Table 4- 63 Randomness tests of graduates' expectations on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Test Value (median)	6	6	5	7	4	3	5	4	3
Cases < Test Value	13	14	13	7	12	13	16	10	15
Cases >= Test Value	19	18	19	25	20	19	16	22	17
Number of Runs	13	19	16	13	12	15	18	12	18
Z	-1.096	.639	.000	.300	-1.345	-.350	.180	-.946	.203
Prob. of random	.273	.523	1.000	.764	.179	.727	.857	.344	.839
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 64. The tests indicate that most variables i.e. K1, K2, K3, K5, K6, K7, K8 and K9 have normal distributions.

Table 4- 64 Normal distribution tests of graduates' expectations on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Kolmogorov-Smirnov Z	.916	.939	.935	1.402	.885	1.167	.758	1.035	1.110
Prob. of normal	.372	.341	.346	.039	.414	.131	.613	.235	.170
Inference	Normal	Normal	Normal	-	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The variable K4 needs to be described in a frequency table as shown in Table 4- 65 to judge its distribution. The table shows the frequency of competence levels in each variable and indicates that the variable has a tendency of normal distribution. Because of the adequate of valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 65 Frequency of graduates' expectations on knowledge

Expectations \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
(1) Extremely Very Low	1	4	1	1	6	2	4	3	10
(2) Very Low	2	1	3	0	2	11	4	4	5
(3) Low	2	0	7	1	4	6	5	3	4
(4) Rather Low	5	2	2	1	7	3	3	7	2
(5) Somewhat	3	7	5	1	3	5	6	0	2
(6) Rather High	4	5	6	3	3	3	2	3	3
(7) High	3	3	5	11	0	0	4	5	1
(8) Very High	5	7	2	5	5	1	2	3	2
(9)Extremely Very High	7	3	1	9	2	1	2	4	3

Variable Code / Expectations	K1	K2	K3	K4	K5	K6	K7	K8	K9
Tendency of distribution	-	-	-	Normal	-	-	-	-	-

Source: Output of frequency analysis calculated by SPSS

4.5.3. Knowledge expected by academicians

The data of expectations obtained from academicians are shown in Table 4- 66. The headings, **K1** to **K9** are the codes of measured variables as described in Table 2- 2. In the left column, the numbers **13000** to **13136** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 48 cases of assessments on 9 variables of knowledge competence with 2 cases of missing and 11 cases of improper data.

Table 4- 66 Academicians' expectations on knowledge

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
13000	8	7	6	5	9	4	1	2	3
13002	9	7	5	8	6	2	4	3	1
13006	9	8	7	6	5	4	3	2	1
13008*	1	1	1	3	4	5	4	4	5
13009	6	8	7	9	1	3	4	5	2
13012	7	6	9	8	5	4	3	2	1
13014	8	2	5	9	6	3	4	7	1
13018	8	9	4	7	3	1	6	5	2
13019*	3	3	4	5	5	5	6	6	6
13024	3	4	5	9	6	2	8	7	1
13027	8	7	3	6	9	1	2	5	4
13028	8	9	1	7	3	6	2	4	5
13030	7	8	5	9	4	6	2	3	1

Respondent Code \ Variable Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
13035	2	1	5	3	6	4	8	7	9
13041*	1	1	1	1	1	1	1	1	1
13042*	5	9	4	8	6	7	2	3	1
13043	7	8	9	6	4	5	3	2	1
13045	7	8	6	9	5	3	4	2	1
13050	-	-	-	-	-	-	-	-	-
13051	9	4	8	7	6	5	3	2	1
13056	8	9	7	6	1	3	4	5	2
13058*	9	8	7	6	4	5	2	3	1
13059	2	1	3	4	7	6	8	5	9
13065	1	4	2	3	6	5	8	9	7
13069	7	9	5	8	6	4	3	2	1
13072*	8	7	6	8	5	7	4	2	5
13079	4	5	6	7	8	9	2	1	3
13080*	9	9	9	8	8	7	8	7	6
13084	9	8	6	7	2	4	5	3	1
13085	9	8	4	7	5	6	2	3	1
13087	4	9	8	7	1	3	5	6	2
13088	9	7	6	8	4	3	5	2	1
13089	2	9	1	8	6	7	5	3	4
13090	7	6	8	9	1	4	5	3	2
13091	9	8	5	7	4	6	2	3	1
13092*	4	4	3	4	5	4	4	4	6
13095	7	8	6	9	4	1	5	3	2
13098	8	7	6	9	2	5	4	3	1
13099*	8	8	8	8	8	8	8	8	7
13117*	1	1	3	1	1	3	4	2	3
13120	8	9	4	6	5	7	3	2	1
13121	-	-	-	-	-	-	-	-	-
13122	7	8	9	6	5	4	3	2	1
13125	6	8	2	9	1	7	5	3	4
13126	3	2	8	1	7	6	5	4	9
13129*	1	1	3	1	1	1	4	4	2
13134	9	8	5	7	6	4	3	2	1
13136	2	1	7	3	6	5	9	4	8
Total Cases	48	48	48	48	48	48	48	48	48
Missing data	2	2	2	2	2	2	2	2	2
***Improper data**	11	11	11	11	11	11	11	11	11

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 67. The tests indicate that most variables i.e. K1, K2, K3, K4, K5, K6, K7, and K8 have random data.

Table 4- 67 Randomness tests of academicians' expectations on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Test Value (median)	7	8	6	7	5	4	4	3	1
Cases < Test Value	10	15	16	12	15	11	16	12	0
Cases >= Test Value	25	20	19	23	20	24	19	23	35
Number of Runs	18	23	19	15	19	15	24	16	1
Z	.937	1.527	.044	-.486	.125	-.234	1.773	-.104	-
Prob. of random	.349	.127	.965	.627	.900	.815	.076	.917	-
Inference	Random	Random	Random	Random	Random	Random	Random	Random	-

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 68. The tests indicate that all variables i.e. K3, K4, K5, K6, and K7 have normal distributions.

Table 4- 68 Normal distribution tests of academicians' expectations on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Kolmogorov-Smirnov Z	1.570	1.585	.919	1.099	.892	.823	1.017	1.612	1.746
Prob. of normal	.014	.013	.367	.178	.404	.507	.252	.011	.005
Inference	-	-	Normal	Normal	Normal	Normal	Normal	-	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The other variables K1, K2, K8 and K9 need to be described in a frequency table as shown in Table 4- 69 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of the adequate of valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 69 Frequency of academicians' expectations on knowledge

Variable Code / Expectations	K1	K2	K3	K4	K5	K6	K7	K8	K9
(1) Extremely Very Low	0	0	0	0	2	3	1	1	7
(2) Very Low	0	1	0	0	0	3	1	5	4
(3) Low	0	1	2	1	1	2	3	3	1
(4) Rather Low	0	0	3	1	1	3	4	1	1
(5) Somewhat	0	5	3	0	3	0	1	2	0
(6) Rather High	1	2	2	2	3	0	3	0	1
(7) High	0	2	2	4	3	2	0	1	0
(8) Very High	5	1	1	5	1	1	0	0	0
(9)Extremely Very High	8	2	1	1	0	0	1	1	0
Tendency of distribution	Normal	Normal	-	-	-	-	-	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.5.4. Knowledge expected by professionals

The data of expectations obtained from professionals are shown in Table 4- 70. The headings, **K1** to **K9** are the codes of measured variables as described in Table 2- 2. In the left column, the numbers **14025** to **14287** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 16 cases of assessments on 9 variables of knowledge competence with no missing values and 4 cases of improper data.

Table 4- 70 Professionals' expectations on knowledge

Variable Code / Respondent Code	K1 Principles and concepts	K2 Basic science and engineering	K3 In-depth technical knowledge	K4 Problem solution	K5 Systems approach	K6 Sustainable design	K7 Laws, regulations and standards	K8 Management and business	K9 Other disciplines
14025	8	9	5	7	3	2	1	6	4
14027	8	7	6	9	5	2	4	3	1
14030	3	7	4	9	5	2	6	8	1
14033	7	5	3	9	8	6	1	2	4
14043	9	6	8	7	4	5	3	1	2
14060	7	6	2	9	8	3	5	4	1
14154	8	7	5	9	6	3	4	1	2
14159	6	9	5	8	7	2	3	4	1
14171	9	7	6	5	3	4	8	2	1
14177*	7	8	3	9	6	1	5	2	4
14192*	1	1	1	1	2	3	4	3	5
14197	8	9	1	7	6	3	4	2	5
14204	8	7	2	9	1	5	6	4	3
14210*	9	9	7	7	7	7	6	5	5
14284*	8	8	8	9	6	5	4	4	6
14287	9	8	4	7	6	3	5	2	1
Total Cases	16	16	16	16	16	16	16	16	16
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	4	4	4	4	4	4	4	4	4

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 71. The tests indicate that all variables i.e. K1, K2, K3, K4, K5, K6, K7, K8 and K9 have random data.

Table 4- 71 Randomness tests of professionals' expectations on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Test Value (median)	8	7	5	9	6	3	4	3	2
Cases < Test Value	4	3	6	6	6	4	4	6	6
Cases >= Test Value	8	9	6	6	6	8	8	6	6
Number of Runs	7	3	6	7	8	4	6	8	8
Z	.115	-1.671	-.303	.000	.303	-1.265	.000	.303	.303
Prob. of random	.908	.095	.762	1.000	.762	.206	1.000	.762	.762
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 72. The tests indicate that all variables i.e. K1, K2, K3, K4, K5, K6, K7, K8 and K9 have normal distributions. Because of the adequate of valid case numbers, randomness and distribution, these data are fit as samples in generalization analysis.

Table 4- 72 Normal distribution tests of professionals' expectations on knowledge

Items \ Variable Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Kolmogorov-Smirnov Z	.983	.844	.505	1.024	.528	.910	.464	.778	.994
Prob. of normal	.289	.475	.961	.245	.943	.379	.982	.580	.277
Inference	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

4.5.5. Skills expected by employers

The data of expectations obtained from employers are shown in Table 4- 73. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2- 3. In the left column, the numbers **11000** to **11330** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 17 cases of assessments on 9 variables of skills competence with no missing values and 3 cases of improper data.

Table 4- 73 Employers' expectations on skills

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
11000	9	7	8	6	4	5	3	2	1
11043	3	2	5	9	6	7	8	1	4
11101*	7	7	7	6	6	7	7	6	5
11122*	2	3	3	3	3	3	2	3	2
11145	5	4	3	9	8	2	1	4	7
11152	5	4	7	9	6	3	8	2	1
11156	8	6	9	5	7	4	3	1	2
11167	7	9	8	6	5	4	3	2	1
11170	1	6	7	9	8	5	4	3	2
11175	6	1	4	9	5	3	8	2	7
11177	4	5	9	7	8	3	6	1	2
11180	8	7	6	9	4	5	3	2	1
11276	9	7	3	8	4	6	5	1	2
11284	9	6	8	7	5	1	4	2	3
11292*	1	8	5	9	9	9	9	1	1
11293	6	9	8	7	5	4	3	2	1
11330	7	8	9	6	4	3	5	2	1
Total Cases	17	17	17	17	17	17	17	17	17
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	3	3	3	3	3	3	3	3	3

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 74. The tests indicate that all variables i.e. S1, S2, S3, S4, S5, S6, S7, S8 and S9 have random data.

Table 4- 74 Randomness tests of employers' expectations on skills

Variable Code / Items	S1	S2	S3	S4	S5	S6	S7	S8	S9
Test Value (median)	7	6	8	8	5	4	4	2	2
Cases < Test Value	7	5	7	7	4	6	6	4	6
Cases >= Test Value	7	9	7	7	10	8	8	10	8
Number of Runs	7	5	7	7	5	8	10	9	9
Z	-.278	-1.177	-.278	-.278	-.844	.000	.935	1.240	.366
Prob. of random	.781	.239	.781	.781	.399	1.000	.350	.215	.715
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 75. The tests indicate that all variables i.e. S1, S2, S3, S4, S5, S6, S7, S8 and S9 have normal distributions. Because of the adequate of valid case numbers, randomness and distribution, these data are fit as samples in generalization analysis.

Table 4- 75 Normal distribution tests of employers' expectations on skills

Variable Code / Items	S1	S2	S3	S4	S5	S6	S7	S8	S9
Kolmogorov-Smirnov Z	.476	.668	.837	.995	.869	.557	.712	1.208	1.153
Prob. of normal	.977	.763	.485	.276	.437	.916	.692	.108	.140
Inference	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

4.5.6. Skills expected by graduates

The data of expectations obtained from graduates are shown in Table 4- 76. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2- 3. In the left column, the numbers **12000** to **12130** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 39 cases of assessments on 9 variables of skills competence with no missing values and 7 cases of improper data.

Table 4- 76 Graduates' expectations on skills

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
12000	9	5	1	8	4	7	6	3	2
12003	4	9	7	6	8	3	5	2	1
12005	3	4	1	9	5	2	8	7	6
12006	9	6	3	4	5	1	2	7	8
12007	3	1	6	9	8	4	5	2	7
12010	6	5	7	8	2	4	9	1	3
12013	8	7	6	4	2	3	9	1	5
12016	2	5	4	9	7	8	6	1	3
12017	5	3	4	6	7	8	9	1	2
12019	5	1	2	3	7	4	6	8	9
12021	5	9	7	6	8	4	3	2	1
12024*	7	7	7	8	8	8	8	5	5
12025	9	8	1	7	6	4	5	3	2
12031	9	6	7	8	4	3	5	2	1
12034	1	2	8	7	9	6	5	4	3
12039	2	7	1	4	8	6	9	3	5
12042	4	5	9	8	3	2	6	1	7
12043	7	6	8	9	1	5	4	2	3
12046	3	2	6	9	8	1	7	4	5
12048	1	9	2	8	7	6	5	4	3
12060	8	6	7	5	1	9	2	3	4
12061	3	6	1	4	7	2	5	9	8
12062	9	7	6	8	1	5	2	4	3
12066*	7	1	2	3	5	6	4	9	8
12069	8	7	9	6	4	1	4	3	5
12070	1	2	3	9	4	5	8	7	6
12075*	7	6	7	7	9	7	7	5	7
12086	3	7	8	9	6	4	5	2	1
12087	3	1	2	6	7	8	9	5	4

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
12100	8	7	6	9	5	4	3	2	1
12105*	8	8	7	9	8	7	9	6	8
12106	3	5	6	7	1	2	4	9	8
12107	1	2	5	4	9	3	6	7	8
12109	7	8	6	4	9	5	2	3	1
12117*	9	9	9	6	9	8	9	8	9
12120*	7	2	1	1	1	2	1	2	1
12122*	8	7	7	8	8	8	9	7	7
12129	6	4	7	8	9	3	5	2	1
12130	5	8	9	7	6	4	3	2	1
Total Cases	39	39	39	39	39	39	39	39	39
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	7	7	7	7	7	7	7	7	7

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 77. The tests indicate that all variables i.e. S1, S2, S3, S4, S5, S6, S7, S8 and S9 have random data.

Table 4- 77 Randomness tests of graduates' expectations on skills

Variable Code / Items	S1	S2	S3	S4	S5	S6	S7	S8	S9
Test Value (median)	5	6	6	7	6	4	5	3	3
Cases < Test Value	15	16	14	13	14	11	10	14	11
Cases >= Test Value	17	16	18	19	18	21	22	18	21
Number of Runs	17	22	20	19	16	17	16	16	11
Z	.000	1.617	1.005	.769	-.091	.425	.315	-.091	-1.574
Prob. of random	1.000	.106	.315	.442	.927	.671	.752	.927	.115
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 78. The tests indicate that all variables i.e. S1, S2, S3, S5, S6, S7, S8 and S9 have normal distributions. Because of the adequate of valid case numbers, randomness and distribution, these data are fit as samples in generalization analysis.

Table 4- 78 Normal distribution tests of graduates' expectations on skills

Items \ Variable Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Kolmogorov-Smirnov Z	.961	.778	1.238	1.146	.977	.966	.909	1.219	1.046
Prob. of normal	.314	.580	.093	.144	.296	.309	.381	.102	.224
Inference	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

4.5.7. Skills expected by academicians

The data of expectations obtained from academicians are shown in Table 4- 79. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2- 3. In the left column, the numbers **14025** to **14287** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 48 cases of assessments on 9 variables of skills competence with 2 cases of missing and 11 cases of improper data.

Table 4- 79 Academicians' expectations on skills

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
13000	8	7	9	6	1	2	5	4	3
13002	7	8	6	9	3	4	5	2	1
13006	9	4	5	8	7	6	3	2	1
13008*	1	5	2	3	5	6	5	8	9
13009	5	4	9	6	7	3	8	2	1
13012	9	8	6	5	3	4	7	1	2
13014	6	5	8	9	7	4	3	1	2
13018*	3	8	9	4	7	5	6	2	1
13019	5	3	5	5	3	4	4	6	6
13024	7	6	5	9	2	1	3	4	8
13027	2	7	9	8	6	4	5	3	1
13028	3	7	9	8	6	4	5	2	1
13030	8	6	9	4	7	3	5	1	2
13035	2	3	1	4	5	6	7	8	9
13041*	1	3	1	1	3	2	2	1	1
13042*	3	5	9	4	8	7	4	2	1
13043	9	7	8	2	3	6	4	5	1
13045	6	5	8	7	4	9	3	2	1
13050	-	-	-	-	-	-	-	-	-
13051	9	7	8	4	6	5	3	2	1
13056	9	8	7	6	1	4	5	3	2
13058	9	6	8	5	7	3	4	2	1
13059*	4	2	1	3	5	7	6	9	8
13065	1	2	5	3	9	4	6	7	8
13069	3	6	9	4	8	5	7	2	1
13072*	5	5	8	8	6	8	8	6	8
13079	9	3	8	1	7	6	5	4	2
13080*	9	9	8	7	7	7	7	6	6
13084	9	8	7	6	5	3	4	1	2
13085	3	9	8	7	6	5	4	2	1
13087	8	9	5	7	4	1	3	2	6
13088	9	6	8	7	4	3	5	1	2
13089	2	4	7	8	9	5	6	3	1
13090	7	3	8	5	9	6	4	1	2
13091	6	9	8	5	7	3	4	1	2

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
13092*	3	4	4	2	2	2	1	2	3
13095	6	7	8	2	5	4	9	3	1
13098	8	4	6	9	7	5	3	2	1
13099*	8	8	7	7	7	7	7	7	7
13117*	3	3	2	2	1	2	2	3	5
13120	3	8	7	9	6	5	4	2	1
13121	-	-	-	-	-	-	-	-	-
13122	9	6	8	5	7	4	3	2	1
13125	8	2	6	4	9	7	5	1	3
13126	9	3	1	2	4	7	5	8	6
13129*	4	3	1	1	2	4	2	4	7
13134	3	6	9	8	7	5	4	2	1
13136	7	2	1	3	6	5	4	8	9
Total Cases	48	48	48	48	48	48	48	48	48
Missing data	2	2	2	2	2	2	2	2	2
***Improper data**	11	11	11	11	11	11	11	11	11

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 80. The tests indicate that the variables S1, S2, S3, S4, S5, S6, S7 and S8 have random data.

Table 4- 80 Randomness tests of academicians' expectations on skills

Variable Code / Items	S1	S2	S3	S4	S5	S6	S7	S8	S9
Test Value (median)	7	6	8	6	6	4	5	2	1
Cases < Test Value	15	13	15	17	13	9	17	8	0
Cases >= Test Value	20	22	20	18	22	26	18	27	35
Number of Runs	23	20	24	16	18	16	18	13	1
Z	1.527	.794	1.878	-.682	.058	.512	.000	.000	-

Variable Code / Items	S1	S2	S3	S4	S5	S6	S7	S8	S9
Prob. of random	.127	.427	.060	.495	.954	.609	1.000	1.000	-
Inference	Random	Random	Random	Random	Random	Random	Random	Random	-

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 81. The tests indicate that most variables i.e. S1, S2, S4, S5, S6, and S7 have normal distributions.

Table 4- 81 Normal distribution tests of academicians' expectations on skills

Variable Code / Items	S1	S2	S3	S4	S5	S6	S7	S8	S9
Kolmogorov-Smirnov Z	1.130	.980	1.493	.738	1.039	.844	1.209	1.826	2.088
Prob. of normal	.155	.293	.023	.647	.230	.475	.108	.003	.000
Inference	Normal	Normal	-	Normal	Normal	Normal	Normal	-	-

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The other variables S3, S8 and S9 need to be described in a frequency table as shown in Table 4- 82 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of the adequate of valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 82 Frequency of academicians' expectations on skills

Variable Code / Expectations	S1	S2	S3	S4	S5	S6	S7	S8	S9
(1) Extremely Very Low	1	0	3	1	2	2	0	8	18
(2) Very Low	3	3	0	3	1	1	0	15	9
(3) Low	6	4	0	2	3	6	8	4	2
(4) Rather Low	0	4	0	6	4	9	9	3	0
(5) Somewhat	1	2	4	5	3	9	10	1	0
(6) Rather High	4	7	4	4	6	5	3	0	2
(7) High	4	6	4	4	11	2	3	1	0
(8) Very High	5	6	12	5	1	0	1	3	2
(9)Extremely Very High	11	3	8	5	4	1	1	0	2
Tendency of distribution	'	'	Normal	'	'	'	'	Normal	Normal

Source: Output of frequency analysis calculated by SPSS

4.5.8. Skills expected by professionals

The data of expectations obtained from professionals are shown in Table 4- 83. The headings, **S1** to **S9** are the codes of measured variables as described in Table 2- 3. In the left column, the numbers **11000** to **11330** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 16 cases of assessments on 9 variables of skills competence with no missing values and 4 cases of improper data.

Table 4- 83 Professionals' expectations on skills

Variable Code / Respondent Code	S1 Apply in-depth technical skills	S2 Use technologies	S3 Synthesise information	S4 Communicate effectively	S5 Function as an individual	S6 Function in multi-disciplinary teams	S7 Function to be a member	S8 Function to be a manager	S9 Function to be a leader
14025	6	8	7	9	5	4	3	2	1
14027	9	1	8	7	6	2	3	4	5
14030	4	7	8	9	1	5	6	3	2
14033	2	8	7	9	6	3	5	4	1
14043	7	9	6	8	3	4	5	2	1
14060	4	5	9	8	2	6	7	3	1
14154	6	7	9	8	5	4	3	1	2
14159	9	5	4	8	3	7	6	1	2
14171	9	8	6	7	4	3	5	2	1
14177*	3	6	9	7	8	5	4	2	1
14192*	1	1	1	1	2	2	2	4	4
14197	1	4	5	9	8	7	6	3	2
14204	1	6	8	9	4	7	5	3	2
14210*	7	8	8	7	7	7	7	5	6
14284*	8	7	6	8	8	8	8	6	4
14287	5	7	8	9	6	4	3	2	1
Total Cases	16	16	16	16	16	16	16	16	16
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	4	4	4	4	4	4	4	4	4

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 84. The tests indicate that all variables i.e. S1, S2, S3, S4, S5, S6, S7, S8 and S9 have random data.

Table 4- 84 Randomness tests of professionals' expectations on skills

Variable Code / Items	S1	S2	S3	S4	S5	S6	S7	S8	S9
Test Value (median)	6	7	8	9	5	4	5	3	2
Cases < Test Value	6	5	6	6	6	3	4	6	6
Cases >= Test Value	6	7	6	6	6	9	8	6	6
Number of Runs	6	9	6	5	9	7	5	7	7
Z	-.303	1.041	-.303	-.908	.908	.836	-.575	.000	.000
Prob. of random	.762	.298	.762	.364	.364	.403	.565	1.000	1.000
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 85. The tests indicate that all variables i.e. S1, S2, S3, S4, S5, S6, S7, S8 and S9 have normal distributions. Because of the adequate of valid case numbers, randomness and distribution, these data are fit as samples in generalization analysis.

Table 4- 85 Normal distribution tests of professionals' expectations on skills

Variable Code / Items	S1	S2	S3	S4	S5	S6	S7	S8	S9
Kolmogorov-Smirnov Z	.511	.747	.766	1.053	.444	.810	.819	.663	1.142
Prob. of normal	.956	.633	.601	.217	.989	.528	.514	.771	.147
Inference	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

4.5.9. Attitude expected by employers

The data of expectations obtained from employers are shown in Table 4- 86. The headings, **A1** to **A9** are the codes of measured variables as described in Table 2- 4. In the left column, the numbers **11000** to **11330** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 17 cases of assessments on 9 variables of attitude competence with no missing values and 3 cases of improper data.

Table 4- 86 Employers' expectations on attitude

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
11000	9	5	7	6	1	4	3	8	2
11043	3	1	5	4	2	6	7	8	9
11101*	7	7	7	6	6	6	5	7	7
11122*	3	3	2	2	3	2	3	3	2
11145	3	2	6	7	8	7	4	1	9
11152	9	6	5	3	2	4	1	7	8
11156	8	6	9	2	5	4	3	7	1
11167	9	7	8	6	5	4	3	2	1
11170	2	9	8	7	1	6	5	3	4
11175	6	5	4	2	1	7	3	8	9
11177	7	4	5	2	1	6	3	8	9
11180	8	4	7	3	2	6	1	5	9
11276	9	3	6	4	2	5	1	7	8
11284	9	3	8	5	1	4	2	6	7
11292*	9	9	9	9	9	9	9	9	9
11293	9	7	5	4	1	8	2	3	6
11330	9	4	8	3	1	7	2	5	6
Total Cases	17	17	17	17	17	17	17	17	17
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	3	3	3	3	3	3	3	3	3

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 87. The tests indicate that all variables A1, A2, A3, A4, A5, A6, A7, A8 and A9 have random data.

Table 4- 87 Randomness tests of employers' expectations on attitude

Variable Code / Items	A1	A2	A3	A4	A5	A6	A7	A8	A9
Test Value (median)	9	5	7	4	2	6	3	7	8
Cases < Test Value	7	7	7	6	7	6	6	7	7
Cases >= Test Value	7	7	7	8	7	8	8	7	7
Number of Runs	7	6	9	6	5	6	4	8	5
Z	-.278	-.835	.278	-.772	-1.391	-.772	-1.910	.000	-1.391
Prob. of random	.781	.404	.781	.440	.164	.440	.056	1.000	.164
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 88. The tests indicate that all variables i.e. A1, A2, A3, A4, A5, A6, A7, A8 and A9 have normal distributions. Because of the adequate of valid case numbers, randomness and distribution, these data are fit as samples in generalization analysis.

Table 4- 88 Normal distribution tests of employers' expectations on attitude

Variable Code / Items	A1	A2	A3	A4	A5	A6	A7	A8	A9
Kolmogorov-Smirnov Z	1.018	.484	.709	.653	1.318	.848	.941	.826	.791
Prob. of normal	.251	.973	.696	.787	.062	.469	.339	.502	.559
Inference	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

4.5.10. Attitude expected by graduates

The data of expectations obtained from graduates are shown in Table 4- 89. The headings, **A1** to **A9** are the codes of measured variables as described in Table 2- 4. In the left column, the numbers **12000** to **12130** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very***

high, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 39 cases of assessments on 9 variables of attitude competence with no missing values and 7 cases of improper data.

Table 4- 89 Graduates' expectations on attitude

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
12000	9	4	8	5	1	3	2	7	6
12003	9	5	6	7	2	3	1	4	8
12005	8	9	6	1	7	5	4	3	2
12006	8	9	6	4	3	7	5	1	2
12007	9	7	6	5	3	8	4	2	1
12010	8	3	4	2	1	7	5	6	9
12013	5	4	7	6	3	8	2	9	1
12016	5	4	9	3	2	1	7	8	6
12017	9	2	8	7	1	3	6	5	4
12019	1	5	2	3	9	6	4	7	8
12021	5	6	2	3	1	9	4	7	8
12024*	7	7	7	7	7	7	7	7	7
12025	8	7	9	1	2	6	5	3	4
12031	9	2	3	1	6	5	4	8	7
12034	9	1	5	3	2	6	4	7	8
12039	9	6	5	3	1	7	2	8	4
12042	9	4	5	2	1	8	3	7	6
12043	9	2	7	6	1	3	4	5	8
12046	3	2	7	6	4	5	1	8	9
12048	2	5	6	8	9	4	7	1	3
12060	4	7	3	1	2	8	9	6	5
12061	1	6	2	7	9	4	8	3	5
12062	9	7	2	3	1	8	4	5	6
12066	9	1	2	5	4	7	6	3	8
12069*	9	4	3	7	1	5	2	6	8
12070	9	1	2	7	8	4	3	6	5
12075*	7	6	9	9	8	9	9	8	8
12086	9	4	6	3	2	5	1	7	8
12087	6	4	8	7	1	2	5	9	3
12100	9	8	7	6	2	5	1	4	3
12105*	8	7	9	8	6	5	7	8	8
12106	9	2	6	4	3	5	1	7	8

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
12107	9	1	6	4	3	2	5	7	8
12109	1	7	2	3	4	9	6	8	5
12117*	9	9	9	9	9	9	9	9	9
12120*	2	2	1	2	3	2	2	1	1
12122*	8	9	7	8	8	9	7	8	8
12129	9	6	5	8	7	3	1	2	4
12130	9	6	5	2	3	1	4	7	8
Total Cases	39	39	39	39	39	39	39	39	39
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	7	7	7	7	7	7	7	7	7

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 90. The tests indicate that all variables A1, A2, A4, A5, A6, A7, A8 and A9 have random data.

Table 4- 90 Randomness tests of graduates' expectations on attitude

Variable Code / Items	A1	A2	A3	A4	A5	A6	A7	A8	A9
Test Value (median)	9	5	6	4	3	5	4	7	6
Cases < Test Value	14	16	15	15	16	12	11	16	15
Cases >= Test Value	18	16	17	17	16	20	21	16	17
Number of Runs	13	12	10	18	16	17	14	15	19
Z	-1.187	-1.617	-2.323	.203	-.180	.192	-.375	-.539	.564
Prob. of random	.235	.106	.020	.839	.857	.848	.708	.590	.573
Inference	Random	Random	-	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 91. The tests indicate that most variables i.e. A2, A3, A4, A6, A7, A8 and A9 have normal distributions.

Table 4- 91 Normal distribution tests of graduates' expectations on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Kolmogorov-Smirnov Z	1.773	.795	.953	1.040	1.381	.690	.884	1.248	1.191
Prob. of normal	.004	.552	.324	.230	.044	.727	.415	.089	.117
Inference	-	Normal	Normal	Normal	-	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The other variables A1 and A5 need to be described in a frequency table as shown in Table 4- 92 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variable has tendency of normal distribution. Because of the adequate of valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 92 Frequency of graduates' expectations on attitude

Expectations \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
(1) Extremely Very Low	4	4	5	0	4	2	0	5	8
(2) Very Low	2	4	4	0	2	4	4	9	3
(3) Low	7	1	2	2	1	5	3	5	6
(4) Rather Low	2	2	2	6	3	8	3	4	2
(5) Somewhat	4	5	1	1	4	4	9	1	3
(6) Rather High	2	5	7	4	3	4	5	0	2
(7) High	3	5	6	4	6	1	1	4	2
(8) Very High	3	3	3	7	5	3	2	1	5
(9)Extremely Very High	5	3	2	8	4	1	5	3	1

Expectations \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Tendency of distribution	Normal	-	-	-	Normal	-	-	-	-

4.5.11. Attitude expected by academicians

The data of expectations obtained from academicians are shown in Table 4- 93. The headings, **A1** to **A9** are the codes of measured variables as described in Table 2- 4. In the left column, the numbers **13000** to **13136** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 48 cases of assessments on 9 variables of attitude competence with 2 cases of missing and 11 cases of improper data.

Table 4- 93 Academicians' expectations on attitude

Respondent Code \ Variable Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
13000	9	7	6	8	4	5	3	2	1
13002	9	5	6	4	3	8	1	2	7
13006	6	9	8	5	4	3	2	1	7
13008*	1	4	5	4	7	4	6	2	3
13009	9	8	4	3	2	7	1	6	5
13012	9	8	6	7	4	5	3	2	1
13014	9	8	7	2	1	6	3	5	4
13018	9	6	8	7	1	5	4	3	2
13019*	5	6	5	5	5	6	5	5	5
13024	6	7	2	5	4	3	1	9	8
13027	9	8	5	6	4	7	1	3	2
13028	9	5	8	7	1	6	2	3	4
13030	9	5	8	7	1	4	2	3	6

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
13035	1	2	4	5	6	8	9	7	3
13041*	1	1	1	1	1	1	1	1	1
13042*	9	2	3	6	1	4	5	8	7
13043	9	7	4	3	2	8	1	6	5
13045	9	6	7	5	1	4	8	3	2
13050	-	-	-	-	-	-	-	-	-
13051	9	8	7	6	5	4	3	2	1
13056	9	8	4	3	2	7	1	6	5
13058	9	8	6	3	2	7	1	5	4
13059*	1	2	2	2	2	2	2	2	2
13065	1	2	9	3	4	5	6	7	8
13069	9	3	4	5	1	8	2	6	7
13072*	9	6	7	8	7	6	6	8	8
13079	3	9	1	7	2	6	5	4	8
13080*	9	7	8	8	7	7	7	7	7
13084	9	6	8	5	1	7	2	3	4
13085	6	5	3	4	2	9	1	8	7
13087	9	5	8	7	2	4	1	3	6
13088	9	5	8	6	2	4	1	7	3
13089	7	3	8	5	1	6	2	4	9
13090	9	4	8	3	1	7	2	5	6
13091	9	6	8	5	3	7	2	4	1
13092*	4	4	4	4	5	4	4	4	4
13095	9	7	8	3	1	5	2	4	6
13098	9	1	8	7	2	3	6	5	4
13099*	7	7	7	7	7	7	7	7	7
13117*	1	2	1	2	4	3	3	3	4
13120	9	5	8	7	6	3	4	1	2
13121	-	-	-	-	-	-	-	-	-
13122	9	6	8	7	4	5	1	3	2
13125	8	7	9	6	5	2	1	3	4
13126	1	7	5	4	8	6	9	3	2
13129*	1	3	1	1	3	2	2	1	1
13134	9	8	4	5	3	7	1	6	2
13136	1	2	4	3	5	8	9	7	6
Total Cases	48	48	48	48	48	48	48	48	48
Missing data	2	2	2	2	2	2	2	2	2
***Improper data**	11	11	11	11	11	11	11	11	11

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4-94. The tests indicate that all variables i.e. A1, A2, A3, A4, A5, A6, A7, A8 and A9 have random data.

Table 4-94 Randomness tests of academicians' expectations on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Test Value (median)	9	6	7	5	2	6	2	4	4
Cases < Test Value	10	14	16	12	10	16	13	16	13
Cases >= Test Value	25	21	19	23	25	19	22	19	22
Number of Runs	18	12	15	20	15	18	17	16	20
Z	.937	-1.897	-.993	1.042	.000	.000	.000	-.647	.794
Prob. of random	.349	.058	.321	.297	1.000	1.000	1.000	.518	.427
Inference	Random	Random	Random	Random	Random	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4-95. The tests indicate that all variables i.e. A2, A4, A5, A6, A8 and A9 have normal distributions.

Table 4-95 Normal distribution tests of academicians' expectations on attitude

Items \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Kolmogorov-Smirnov Z	2.450	.916	1.480	.961	1.336	.982	1.620	1.168	.933
Prob. of normal	.000	.371	.025	.314	.056	.290	.011	.131	.348
Inference	-	Normal	-	Normal	Normal	Normal	-	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The other variables A1, A3 and A7 need to be described in a frequency table as shown in Table 4- 96 to judge their distribution. The table shows the frequency of competence levels in each variable and indicates that the variables have tendencies of normal distribution. Because of the adequate of valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 96 Frequency of academicians' expectations on attitude

Variable Code / Expectations	A1	A2	A3	A4	A5	A6	A7	A8	A9
(1) Extremely Very Low	4	1	1	0	10	0	13	2	4
(2) Very Low	0	3	1	1	9	1	9	4	7
(3) Low	1	2	1	8	3	4	4	10	2
(4) Rather Low	0	1	7	3	7	5	2	4	6
(5) Somewhat	0	7	2	9	3	6	1	4	3
(6) Rather High	3	5	4	4	2	5	2	5	5
(7) High	1	6	3	9	0	8	0	4	4
(8) Very High	1	8	14	1	1	5	1	1	3
(9)Extremely Very High	25	2	2	0	0	1	3	1	1
Tendency of distribution	Normal	-	Normal	-	-	-	Normal	-	-

Source: Output of frequency analysis calculated by SPSS

4.5.12. Attitude expected by professionals

The data of expectations obtained from professionals are shown in Table 4- 97. The headings, **A1** to **A9** are the codes of measured variables as described in Table 2- 4. In the left column, the numbers **14025** to **14287** are the codes of respondents. The values **1** to **9** are data of importance levels; number ***1*** means ***Extremely very low***, ***2*** means ***Very low***, ***3*** means ***Low***, ***4*** means ***Rather low***, ***5*** means ***Somewhat***, ***6*** means ***Rather high***, ***7*** means ***High***, ***8*** means ***Very high***, and ***9*** means ***Extremely very high.*** The data contained in the table were compiled directly from questionnaire sets. The table shows 16 cases of assessments on 9 variables of attitude competence with no missing values and 4 cases of improper data.

Table 4- 97 Professionals' expectations on attitude

Variable Code / Respondent Code	A1 Think critically, creatively, reflectively	A2 Committed to lifelong learning	A3 Committed to ethic	A4 Committed to environment	A5 Work with global perspectives	A6 Committed to professional skills	A7 Committed to different cultural groups	A8 Committed to group skills	A9 Committed to interpersonal skills
14025	8	6	5	3	2	7	1	4	9
14027	9	7	8	2	4	5	1	3	6
14030	9	2	6	4	1	5	3	8	7
14033	9	6	8	7	1	5	2	4	3
14043	6	1	8	7	2	9	3	5	4
14060	9	8	6	5	1	2	4	3	7
14154	9	6	7	8	2	1	3	4	5
14159	9	5	4	3	2	8	1	6	7
14171	9	4	5	6	1	3	2	7	8
14177*	9	6	8	4	1	3	5	2	2
14192*	1	1	1	1	3	1	1	1	1
14197	6	5	9	4	1	3	2	8	7
14204	9	7	5	4	1	2	3	6	8
14210*	9	9	9	9	7	8	7	6	6
14284*	8	6	6	5	6	7	6	6	8
14287	9	8	6	5	1	7	2	3	4
Total Cases	16	16	16	16	16	16	16	16	16
Missing data	0	0	0	0	0	0	0	0	0
***Improper data**	4	4	4	4	4	4	4	4	4

Source: Respondents

The assessments, however, must be described to understand their characteristics especially randomness and distribution. The results of the randomness tests of these data are shown in Table 4- 98. The tests indicate that most variables i.e. A1, A2, A3, A4, A6, A7, A8 and A9 have random data.

Table 4- 98 Randomness tests of professionals' expectations on attitude

Variable Code / Items	A1	A2	A3	A4	A5	A6	A7	A8	A9
Test Value (median)	9	6	6	5	1	5	2	5	7
Cases < Test Value	3	5	4	6	0	5	3	6	5

Variable Code / Items	A1	A2	A3	A4	A5	A6	A7	A8	A9
Cases >= Test Value	9	7	8	6	12	7	9	6	7
Number of Runs	6	7	6	6	1	5	4	7	8
Z	.000	.000	.000	-.303	-	-.833	-.836	.000	.416
Prob. of random	1.000	1.000	1.000	.762	-	.405	.403	1.000	.677
Inference	Random	Random	Random	Random	-	Random	Random	Random	Random

Source: Output of Run test calculated by SPSS

The results of the normal distribution tests of these data are shown in Table 4- 99. The tests indicate that most variables i.e. A2, A3, A4, A5, A6, A7, A8 and A9 have normal distributions.

Table 4- 99 Normal distribution tests of professionals' expectations on attitude

Variable Code / Items	A1	A2	A3	A4	A5	A6	A7	A8	A9
Kolmogorov-Smirnov Z	1.530	.652	.652	.602	1.125	.576	.686	.754	.830
Prob. of normal	.018	.789	.788	.862	.159	.894	.734	.620	.496
Inference	-	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Source: Output of Kolmogorov-Smirnov test calculated by SPSS

The other variable of A1 needs to be described in a frequency table as shown in Table 4- 100 to judge its distribution. The table shows the frequency of competence levels in each variable and indicates that the variable has a tendency of normal distribution. Because of the adequate of valid case numbers, randomness, distribution and distribution tendency, these data are fit as samples in generalization analysis.

Table 4- 100 Frequency of professionals' expectations on attitude

Expectations \ Variable Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
(1) Extremely Very Low	0	1	0	0	7	1	3	0	0
(2) Very Low	0	1	0	1	4	2	4	0	0
(3) Low	0	0	0	2	0	2	4	3	1
(4) Rather Low	0	1	1	3	1	0	1	3	2
(5) Somewhat	0	2	3	2	0	3	0	1	1
(6) Rather High	2	3	3	1	0	0	0	2	1
(7) High	0	2	1	2	0	2	0	1	4
(8) Very High	1	2	3	1	0	1	0	2	2
(9) Extremely Very High	9	0	1	0	0	1	0	0	1
Tendency of distribution	Normal	-	-	-	-	-	-	-	-

Source: Output of frequency analysis calculated by SPSS

4.6. Summary of data collected

In this chapter, the quality and quantity of data have been analysed. Cases with proper data were selected as samples for the next analysis while other cases would be treated or excluded. Proper data are data accurately provided of the questionnaire set. Improper data may be the result of missing or incorrect values. Missing values are empty data because they were not provided by participants or respondents while incorrect values are data incorrectly supplied by respondents. The number of the missing values is shown in Table 4- 101 and incorrect values in Table 4- 102.

Table 4- 101 Number of missing values

Source \ Data	Expectations	Competence	Performance	Satisfaction
Employers	-	-	2 (11.7 %)	2 (11.7 %)
Graduates	-	-		
Academicians	1 (2.2 %)	3 (6.7 %)	-	-
Professionals	-	2 (12.5 %)	-	-

Source: Analyses presented in sections 4.3, 4.4 and 4.5

The percentages of missing values are between 0 and 12.5 possibly because respondents were not sure about the value of the investigated object. Before analysis, the missing values need to be treated or excluded. Based on percentages and numbers, cases with missing values probably could be excluded from samples without any significant impact. They would be excluded in the group of concept or factor basis.

Table 4- 102 Number of incorrect values

Source \ Data	Expectations	Competence	Performance	Satisfaction
Employers	3 (17.6 %)	-	-	-
Graduates	7 (18 %)	-	-	-
Academicians	13 (29 %)	-	-	-
Professionals	4 (25%)	-	-	-

Source: Analyses presented in sections 4.3, 4.4 and 4.5

The percentages of incorrect values are between 0 and 29 concentrated in the data of expectations possibly because there was some difficulties in selecting importance rankings in 9 levels. Many of the incorrect values have ranking numbers less than 9. In considering the amount of valid data, cases with incorrect values could also probably be excluded without serious impact on samples.

Based on data reliability i.e. the number and percentages of participants, missing values and incorrect values described in Table 4- 3, Table 4- 101 and Table 4- 102, the data can be further analysed.

Based on the number of valid cases, randomness, distribution and tendency, the data can be used as samples for generalisation. Randomness and distribution of the data or cases has been proved statistically and descriptively. Therefore the cases will be used as samples that represent populations of stakeholders. An analysis to obtain general information regarding the stakeholders' assessment, expectation and perception on graduates will be conducted in the next chapter.

5. DATA ANALYSIS

The aim of this chapter is to present new information that has been produced as the findings of this study. The data were samples that have been presented in chapter 4. This analyses were conducted based on the theory, methods, and samples. The scheme of the data analysis to get the new information is shown in Figure 5- 1.

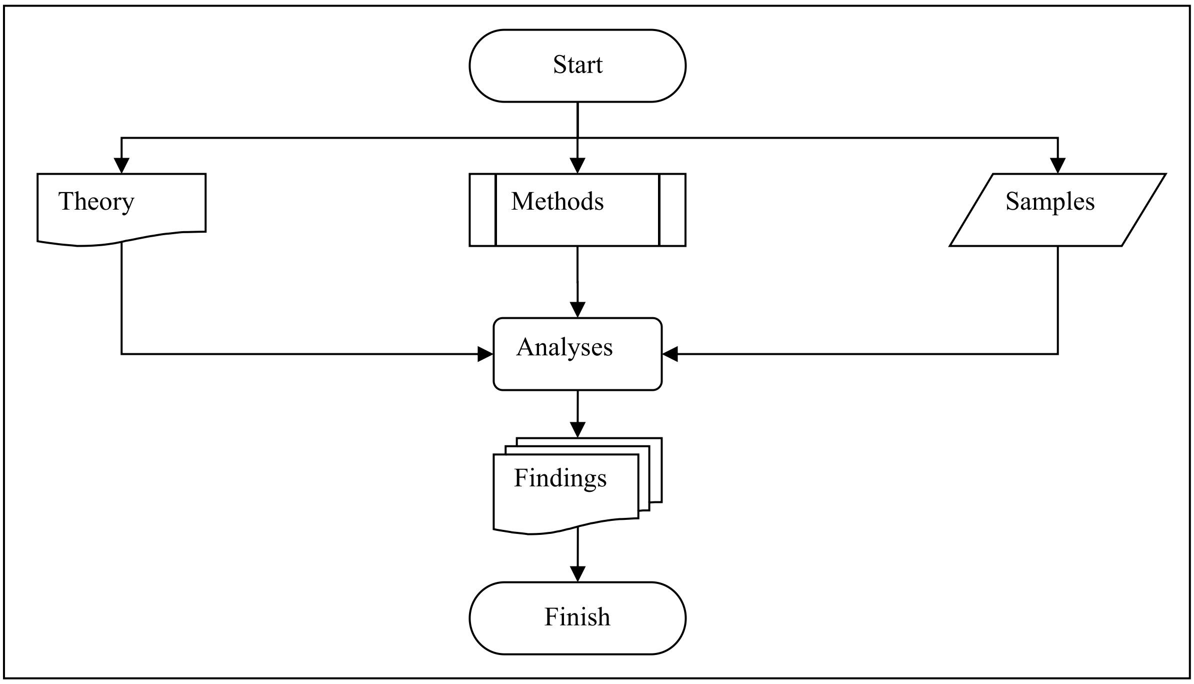

Figure 5- 1 Scheme of data analysis

The theory as the base of these analyses has been developed and described in section 2.4. The methods of analyses have been presented in section 3.9. The samples for each investigation were selected from cases that have been analysed in chapter 4.

The data analysis consist of: the rankings of graduates' actual competence; the rankings of expected competence; the differences among stakeholders in expectation; the priority of competence; the relationship between performance and satisfaction; and the models linking competence and satisfaction. The sequence of data analyses conducted in this chapter are shown in Table 5- 1.

Table 5- 1 Data analysis

Sections	Data analyses
5.1.	Investigation of graduates’ competence
5.1.1	Graduates’ knowledge ranked by stakeholders
5.1.1.1	Graduates’ knowledge ranked by employers
5.1.1.2	Graduates’ knowledge ranked by graduates
5.1.1.3	Graduates’ knowledge ranked by academicians
5.1.1.4	Graduates’ knowledge ranked by professionals
5.1.2	Graduates’ skills ranked by stakeholders
5.1.2.1	Graduates’ skills ranked by employers
5.1.2.2	Graduates’ skills ranked by graduates
5.1.2.3	Graduates’ skills ranked by academicians
5.1.2.4	Graduates’ skills ranked by professionals
5.1.3	Graduates’ attitude ranked by stakeholders
5.1.3.1	Graduates’ attitude ranked by employers
5.1.3.2	Graduates’ attitude ranked by graduates
5.1.3.3	Graduates’ attitude ranked by academicians
5.1.3.4	Graduates’ attitude ranked by professionals
5.2.	Investigation of stakeholders’ expectations
5.2.1	Expected knowledge ranked by stakeholders
5.2.1.1	Expected knowledge ranked by employers
5.2.1.2	Expected knowledge ranked by graduates
5.2.1.3	Expected knowledge ranked by academicians
5.2.1.4	Expected knowledge ranked by professionals
5.2.2	Expected skills ranked by stakeholders
5.2.2.1	Expected skills ranked by employers
5.2.2.2	Expected skills ranked by graduates
5.2.2.3	Expected skills ranked by academicians
5.2.2.4	Expected skills ranked by professionals
5.2.3	Expected attitude ranked by stakeholders
5.2.3.1	Expected attitude ranked by employers
5.2.3.2	Expected attitude ranked by graduates
5.2.3.3	Expected attitude ranked by academicians
5.2.3.4	Expected attitude ranked by professionals
5.3.	Comparisons between stakeholders’ expectations
5.3.1	Analyses using Mann-Whitney-U
5.3.2	Analyses using Kruskal-Wallis-H
5.4.	Investigation of the prioritised competencies
5.4.1	Knowledge prioritised by stakeholders
5.4.1.1	Knowledge prioritised by employers
5.4.1.2	Knowledge prioritised by graduates
5.4.1.3	Knowledge prioritised by academicians
5.4.1.4	Knowledge prioritised by professionals
5.4.2	Skills prioritised by stakeholders

Sections	Data analyses
5.4.2.1	Skills prioritised by employers
5.4.2.2	Skills prioritised by graduates
5.4.2.3	Skills prioritised by academicians
5.4.2.4	Skills prioritised by professionals
5.4.3	Attitude prioritised by stakeholders
5.4.3.1	Attitude prioritised by employers
5.4.3.2	Attitude prioritised by graduates
5.4.3.3	Attitude prioritised by academicians
5.4.3.4	Attitude prioritised by professionals
5.5.	Investigation of the stakeholders' satisfaction
5.5.1	The relationship between Time performance and Satisfaction
5.5.2	The relationship between Cost performance and Satisfaction
5.5.3	The relationship between Quality performance and Satisfaction

5.1. Investigation of graduates' competence

The aim of this analysis is to investigate graduates' competencies (attributes) based on stakeholders' assessments. The investigation is addressed to identify the rankings of graduates' competence. The validation used a statistical method.

In this investigation, competence attributes are categorized into three factors of competence i.e. knowledge, skills and attitude while stakeholders are categorized into employers, graduates, academicians and professionals. The steps in this ranking analysis can be categorized in three stages as shown in Figure 5-2. The first is establishment of samples from qualified cases. The second is calculation of the ranking of graduates' competence. The third is the validation of the ranking to confirm that the ranking is valid based on the Kendall-W.

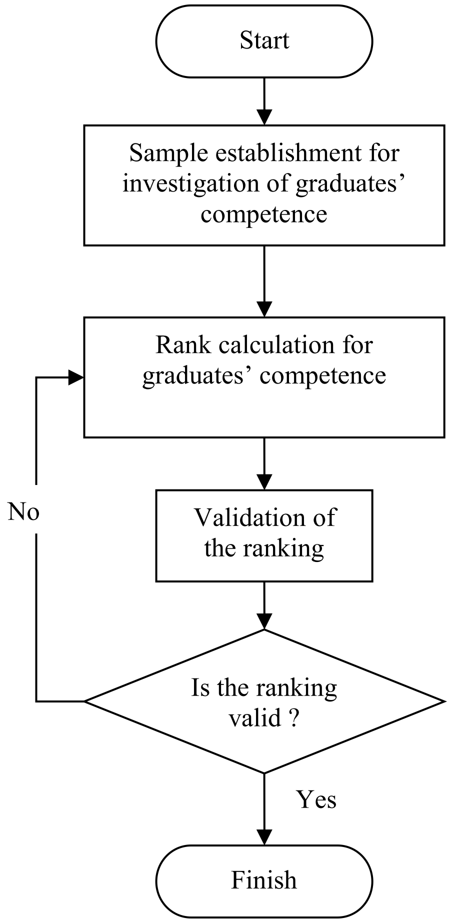

Figure 5- 2 Flowchart of competence instigation

a) Samples of graduates' competence

Samples used in the investigation of graduates' competence were selected from qualified cases that have been analysed in chapter 4. The qualified cases or the samples consist of 17 employers, 39 graduates, 45 academicians and 14 professionals as shown in Table 5- 2 to Table 5- 5.

Table 5- 2 Samples of employers for competence analysis

No	Sample Code	No	Sample Code	No	Sample Code
1	11000	7	11156	13	11276
2	11043	8	11167	14	11284
3	11101	9	11170	15	11292
4	11122	10	11175	16	11293
5	11145	11	11177	17	11330

No	Sample Code	No	Sample Code	No	Sample Code
6	11152	12	11180		

Source: Analyses in sections 4.3.1, 4.3.5 and 4.3.9

Table 5- 2 shows 17 employers used as the samples. No case of employers has been excluded. It means that the data of graduates' competence supplied by 17 employers can be used as samples in this investigation.

Table 5- 3 Samples of graduates for competence analysis

No	Sample Code	No	Sample Code	No	Sample Code
1	12000	14	12031	28	12075
2	12003	15	12034	29	12086
3	12005	16	12039	29	12087
4	12006	17	12042	30	12100
5	12007	18	12043	31	12105
6	12010	19	12046	32	12106
7	12013	20	12048	33	12107
8	12016	21	12060	34	12109
9	12017	22	12061	45	12117
10	12019	23	12062	36	12120
11	12021	24	12066	37	12122
12	12024	25	12069	38	12129
13	12025	26	12070	39	12130

Source: Analyses in sections 4.3.2, 4.3.6 and 4.3.10

Table 5- 3 shows 39 graduates used as the samples. No case of graduates has been excluded. It means that the data of graduates' competence supplied by 39 graduates can be used as samples in this investigation.

Table 5- 4 Samples of academician for competence analysis

No	Sample Code	No	Sample Code	No	Sample Code
1	13000	16	13042	31	13088
2	13002	17	13043	32	13089
3	13006	18	13050	33	13090
4	13008	19	13051	34	13091
5	13009	20	13056	45	13092
6	13012	21	13058	36	13095
7	13014	22	13059	37	13098
8	13018	23	13065	38	13099
9	13019	24	13069	39	13117
10	13024	25	13072	40	13120
11	13027	26	13079	41	13121
12	13028	27	13080	42	13122
13	13030	28	13084	43	13126

No	Sample Code	No	Sample Code	No	Sample Code
14	13035	29	13085	44	13129
15	13041	30	13087	45	13134

Source: Analyses in sections 4.3.3, 4.3.7 and 4.3.11

Table 5- 4 shows 45 academicians used as the samples. No case of academicians has been excluded. It means that the data of graduates' competence supplied by 45 academicians can be used as samples in this investigation.

Table 5- 5 Samples of professionals for competence analysis

No	Sample Code	No	Sample Code	No	Sample Code
1	14025	6	14060	11	14204
2	14027	7	14154	12	14210
3	14030	8	14159	13	14284
4	14033	9	14171	14	14287
5	14043	10	14197		

Source: Analyses in sections 4.3.4, 4.3.8 and 4.3.12

Table 5- 5 shows 14 professionals used as the samples. Two other cases have been excluded because of improper or missing values. It means that the data of graduates' competence supplied by 14 professionals can be used as samples in this investigation.

The samples have been established. As four samples contain three attribute groups, this analysis contained 12 sub-analyses.

b) Calculation of rankings

The calculation of rankings of graduates' competence was conducted based on means, mode, or median of the graduates' competence values. The ranking of one (1) is for the highest value or the highest of actual competence while nine (9) is for the lowest value or the lowest of actual competence. The calculation is presented in Table 5- 6, Table 5- 8, Table 5- 10 and so forth.

c) Validation of rankings

The validation or concordance of rankings was conducted with the Kendall-W the formulae of which have been shown in Equation 3- 5. Calculation of the validation was conducted with SPSS software. The validation is presented in Table 5- 7, Table 5- 9, Table 5- 11 and so forth.

5.1.1. Graduates' knowledge ranked by stakeholders

As the data presented in section 4.3, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.1.1.1 Graduates' knowledge ranked by employers

The description of employers' assessment on graduates' knowledge are presented in Table 5- 6 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the knowledge variables as shown in Table 2- 2. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 6 Graduates' knowledge ranked by employers

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Principles and concepts (K1)	17	.791	2	5	4.00	3	High
Basic science and engineering (K2)	17	.781	2	5	4.12	1	High
In-depth technical knowledge (K3)	17	.781	3	5	4.12	1	High
Problem solution (K4)	17	.883	2	5	3.82	4	Somewhat
Systems approach (K5)	17	.831	2	5	3.76	5	Somewhat
Sustainable design (K6)	17	.800	2	5	3.53	6	Somewhat
Laws, regulations and standards (K7)	17	.996	2	5	3.35	7	Low
Management and business (K8)	17	1.029	1	4	2.94	9	Low
Other disciplines (K9)	17	.707	2	4	3.00	8	Low

Source: Description of data presented in section 4.3.1

Based on employers' perception, abilities of civil engineering graduates in the following areas are high. The areas are understanding: the principles and concepts (K1); the basic science and engineering fundamentals (K2); and the in-depth technical knowledge in at least one discipline (K3). Meanwhile, abilities in the following area are low, i.e. understanding: the laws, regulations and standards (K7); the principles of management and business (K8); and the other disciplines (K9).

This ranking identifies a concern about civil engineering education because graduates' competence in "Management and business" (K8) was ranked as a low competence category.

Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.2.1) and the performance of graduates' job (section 7.2.2).

The ranking was calculated based on samples that were token form population of employers. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 7 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception. An example of the calculation can be seen in section 3.9.1.2.

Table 5- 7 Validation of graduates' knowledge ranked by employers

Item	Explanation
Number of Samples (N)	17
Kendall's W (Coefficient of Concordance)	.389
Chi-Square	52.845
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competencies that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.1.1 where this ranking will be compared with the ranking of expected competence presented in section 5.2.1.1.

5.1.1.2 Graduates' knowledge ranked by graduates

The description of graduates' assessment on graduates' knowledge are presented in Table 5- 8 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the knowledge variables as shown in Table 2- 2. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 8 Graduates' knowledge ranked by graduates

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Principles and concepts (K1)	39	.718	1	5	4.10	2	High
Basic science and engineering (K2)	39	.680	1	5	4.10	1	High
In-depth technical knowledge (K3)	39	1.042	1	5	3.62	5	Somewhat
Problem solution (K4)	39	.857	1	5	3.95	3	High
Systems approach (K5)	39	.850	2	5	3.59	6	Somewhat
Sustainable design (K6)	39	.788	2	5	3.56	8	Low
Laws, regulations and standards (K7)	39	.938	1	5	3.59	7	Low
Management and business (K8)	39	.932	2	5	3.64	4	Somewhat
Other disciplines (K9)	39	1.031	1	5	3.21	9	Low

Source: Description of data presented in section 4.3.2

Based on graduates' perception, abilities of civil engineering graduates in the following areas are high. The areas are understanding: the principles and concepts (K1); the basic science and engineering fundamentals (K2); and the problem identification, formulation and solution (K4). Meanwhile, abilities in the following area are low, i.e. understanding: the principles of sustainable design and development (K6); the laws, regulations and standards (K7); and the other disciplines (K9).

The ranking was calculated based on samples that were token form population of graduates. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 9 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 9 Validation of graduates' knowledge ranked by graduates

Item	Explanation
Number of Samples (N)	39

Item	Explanation
Kendall's W (Coefficient of Concordance)	.142
Chi-Square	44.236
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competencies that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.1.2 where this ranking will be compared with the ranking of expected competence presented in section 5.2.1.2.

5.1.1.3 Graduates' knowledge ranked by academicians

The description of academicians' assessment on graduates' knowledge are presented in Table 5- 10 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the knowledge variables as shown in Table 2- 2. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 10 Graduates' knowledge ranked by academicians

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Principles and concepts (K1)	45	.793	1	5	4.09	1	High
Basic science and engineering (K2)	45	.783	1	5	3.98	2	High
In-depth technical knowledge (K3)	45	.900	1	5	3.91	3	High
Problem solution (K4)	45	.869	1	5	3.80	4	Somewhat
Systems approach (K5)	45	.974	1	5	3.22	.8	Low
Sustainable design (K6)	45	.912	1	5	3.38	6	Somewhat
Laws, regulations and standards (K7)	45	.841	1	5	3.44	5	Somewhat
Management and business (K8)	45	1.019	1	5	3.31	7	Low
Other disciplines (K9)	45	.894	1	4	2.87	9	Low

Source: Description of data presented in section 4.3.3

Based on academicians' perception, abilities of civil engineering graduates in the following areas are high. The areas are understanding: the principles and concepts (K1); the basic science and engineering fundamentals (K2); and in-depth technical knowledge in at least one discipline (K3). Meanwhile, abilities in the following area are low , i.e. understanding: how to utilise a systems approach to design and operational performance (K5); the principles of management and business (K8); and the other disciplines (K9).

This ranking identifies a concern about civil engineering education because graduates' competence in "Management and business" (K8) was ranked as a low competence category. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.2.1) and the performance of graduates' job (section 7.2.2).

The ranking was calculated based on samples that were token form population of academicians. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 11 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 11 Validation of graduates' knowledge ranked by academicians

Item	Explanation
Number of Samples (N)	45
Kendall's W (Coefficient of Concordance)	.336
Chi-Square	120.879
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.1.3 where this ranking will be compared with the ranking of expected competence presented in section 5.2.1.3.

5.1.1.4 Graduates' knowledge ranked by professionals

The description of professionals' assessment on graduates' knowledge are presented in Table 5- 12 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the knowledge variables as shown in Table 2- 2. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 12 Graduates' knowledge ranked by professionals

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Principles and concepts (K1)	14	.497	4	5	4.36	1	High
Basic science and engineering (K2)	14	.469	4	5	4.29	2	High
In-depth technical knowledge (K3)	14	1.051	2	5	3.79	4	Somewhat
Problem solution (K4)	14	.616	3	5	3.93	3	High
Systems approach (K5)	14	.842	2	5	3.64	5	Somewhat
Sustainable design (K6)	14	.917	2	5	3.07	6	Somewhat
Laws, regulations and standards (K7)	14	1.167	2	5	2.86	7	Low
Management and business (K8)	14	1.222	1	5	2.57	9	Low
Other disciplines (K9)	14	.829	2	4	2.93	8	Low

Source: Description of data presented in section 4.3.4 in the cases presented in Table 5- 5

Based on professionals' perception, abilities of civil engineering graduates in the following areas are high. The areas are understanding: the principles and concepts (K1); the basic science and engineering fundamentals (K2); and the problem identification, formulation and solution (K4). Meanwhile, abilities in the following areas are low, i.e. understanding: the laws, regulations and standards (K7); the principles of management and business (K8); and the other disciplines (K9)

This ranking identifies a concern about civil engineering education because graduates' competence in "Management and business" (K8) was ranked as a low competence category. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.2.1) and the performance of graduates' job (section 7.2.2).

The ranking was calculated based on samples that were token form population of professionals. In order to know if this ranking can represent the population' perception,

statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 13 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 13 Validation of Graduates' knowledge ranked by professionals

Item	Explanation
Number of Samples (N)	14
Kendall's W (Coefficient of Concordance)	.559
Chi-Square	62.639
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section. 5.4.1.4 where this ranking will be compared with the ranking of expected competence presented in section 5.2.1.4.

Assessments of employers, graduates, academicians and professionals with rankings of graduates' knowledge have been presented in sections 5.1.1.1 to 5.1.1.4. The assessments were combined and discussed to achieve general information about stakeholders' assessment with ranking of graduates' knowledge. The combination and discussion of the assessment will be presented in section 6.1.1.

5.1.2. Graduates' skills ranked by stakeholders

As the data presented in section 4.3, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.1.2.1 Graduates' skills ranked by employers

The description of employers' assessment on graduates' skills are presented in Table 5- 14 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the skill variables as shown in Table 2- 3. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 14 Graduates' skills ranked by employers

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Apply in-depth technical skills (S1)	17	1.111	2	5	3.88	3	High
Use technologies (S2)	17	.748	2	5	3.94	5	Somewhat
Synthesise information (S3)	17	.857	2	5	3.88	4	Somewhat
Communicate effectively (S4)	17	1.057	1	5	3.65	7	Low
Function as an individual (S5)	17	1.144	2	5	3.94	1	High
Function in multi-disciplinary teams (S6)	17	1.088	1	5	3.94	2	High
Function to be a member (S7)	17	1.263	1	5	3.71	6	Somewhat
Function to be a manager (S8)	17	1.111	1	5	2.88	9	Low
Function to be a leader (S9)	17	1.269	1	5	3.12	8	Low

Source: Description of data presented in section 4.3.5

Based on employers' perception, abilities of civil engineering graduates in the following areas are high. The areas are: applying in-depth technical skills in at least one discipline (S1); functioning effectively as an individual (S5); and functioning effectively in multi-disciplinary or multi-cultural teams (S6). Meanwhile, the importance of the following abilities are low, i.e.: communication effectively not only with engineers but also with the community at large (S4); function effectively in teams with the capacity to be a manager (S8); and function effectively in teams with the capacity to be a leader (S9).

This ranking identifies a concern about civil engineering education because graduates' competence in "Communicate effectively" (S4), "Function to be a manager" (S8) and "Function to be a leader" (S9) was ranked as a low competence category. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.2.2).

The ranking was calculated based on samples that were token form population of employers. In order to know if this ranking can represent the population' perception,

statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 15 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 15 Validation of graduates' skills ranked by employers

Item	Explanation
Number of Samples (N)	17
Kendall's W (Coefficient of Concordance)	.287
Chi-Square	39.003
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.2.1 where this ranking will be compared with the ranking of expected competence presented in section 5.2.2.1.

5.1.2.2 Graduates' skills ranked by graduates

The description of graduates' assessment on graduates' skills are presented in Table 5- 16 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the skill variables as shown in Table 2- 3. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 16 Graduates' skills ranked by graduates

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Apply in-depth technical skills (S1)	39	3.67	1	5	3.67	8	Low

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Use technologies (S2)	39	3.97	1	5	3.97	7	Low
Synthesise information (S3)	39	3.95	1	5	3.95	5	Somewhat
Communicate effectively (S4)	39	4.21	1	5	4.21	4	Somewhat
Function as an individual (S5)	39	4.28	1	5	4.28	2	High
Function in multi-disciplinary teams (S6)	39	4.28	1	5	4.28	3	High
Function to be a member (S7)	39	4.41	2	5	4.41	1	High
Function to be a manager (S8)	39	3.72	1	5	3.72	9	Low
Function to be a leader (S9)	39	4.03	1	5	4.03	6	Somewhat

Source: Description of data presented in section 4.3.6

Based on graduates' perception, abilities of civil engineering graduates in the following areas are high. The areas are: function effectively as an individual (S5); function effectively in multi-disciplinary or multi-cultural teams (S6); and function effectively in teams with the capacity to be a member (S7). Meanwhile, abilities in the following areas are low, i.e.: applying in-depth technical skills in at least one discipline (S1); using technologies appropriately (S2); and functioning effectively in teams with the capacity to be a manager (S8)

This ranking identifies a concern about civil engineering education because graduates' competence in "Function to be a manager" (S8) was ranked as a low competence category. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.2.2).

The ranking was calculated based on samples that were token form population of graduates. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 17 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 17 Validation of graduates' skills ranked by graduates

Item	Explanation
Number of Samples (N)	39
Kendall's W (Coefficient of Concordance)	.174

Item	Explanation
Chi-Square	54.432
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.2.2 where this ranking will be compared with the ranking of expected competence presented in section 5.2.2.2.

5.1.2.3 Graduates' skills ranked by academicians

The description of academicians' assessment on graduates' skills are presented in Table 5- 18 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable and competence ranking. The attribute code is the skill variables as shown in Table 2- 3. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 18 Graduates' skills ranked by academicians

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Apply in-depth technical skills (S1)	45	.919	1	5	3.80	3	High
Use technologies (S2)	45	.601	2	5	3.96	1	High
Synthesise information (S3)	45	.735	1	5	3.78	6	Somewhat
Communicate effectively (S4)	45	1.007	1	5	3.62	7	Low
Function as an individual (S5)	45	.796	1	5	3.84	4	Somewhat
Function in multi-disciplinary teams (S6)	45	.939	1	5	3.73	5	Somewhat
Function to be a member (S7)	45	.796	1	5	3.84	2	High
Function to be a manager (S8)	45	.743	1	4	3.36	9	Low
Function to be a leader (S9)	45	.773	1	5	3.36	8	Low

Source: Description of data presented in section 4.3.7

Based on academicians' perception, abilities of civil engineering graduates in the following areas are high. The areas are: applying in-depth technical skills in at least one discipline (S1); using technologies appropriately (S2); and functioning effectively in teams with the capacity to be a member (S7). Meanwhile, abilities in the following areas are low, i.e.: communication effectively not only with engineers but also with the community at large (S4); function effectively in teams with the capacity to be a manager (S8); and function effectively in teams with the capacity to be a leader (S9).

This ranking identifies a concern about civil engineering education because graduates' competence in "Communicate effectively" (S4), "Function to be a manager" (S8) and "Function to be a leader" (S9) was ranked as a low competence category. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.2.2).

The ranking was calculated based on samples that were token form population of academicians. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 19 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 19 Validation of graduates' skills ranked by academicians

Item	Explanation
Number of Samples (N)	45
Kendall's W (Coefficient of Concordance)	.144
Chi-Square	51.944
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.2.3 where this ranking will be compared with the ranking of expected competence presented in section 5.2.2.3.

5.1.2.4 Graduates' skills ranked by professionals

The description of professionals' assessment on graduates' skills are presented in Table 5-20 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the skill variables as shown in Table 2-3. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5-20 Graduates' skills ranked by professionals

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Apply in-depth technical skills (S1)	14	.997	2	5	3.93	1	High
Use technologies (S2)	14	.745	2	5	3.64	6	Somewhat
Synthesise information (S3)	14	.555	3	5	4.00	2	High
Communicate effectively (S4)	14	1.122	2	5	3.21	7	Low
Function as an individual (S5)	14	.864	3	5	3.86	4	Somewhat
Function in multi-disciplinary teams (S6)	14	1.151	2	5	3.64	5	Somewhat
Function to be a member (S7)	14	.784	3	5	4.00	3	High
Function to be a manager (S8)	14	1.072	1	5	3.07	9	Low
Function to be a leader (S9)	14	.997	1	5	3.07	8	Low

Source: Description of data presented in section 4.3.8 in the cases presented in Table 5-5

Based on professionals' perception, abilities of civil engineering graduates in the following areas are high. The areas are: applying in-depth technical skills in at least one discipline (S1); accessing, evaluating and synthesising information (S3) and functioning effectively in teams with the capacity to be a member (S7). Meanwhile, abilities in the following areas are low, i.e.: communication effectively not only with engineers but also with the community at large (S4); function effectively in teams with the capacity to be a manager (S8); and function effectively in teams with the capacity to be a leader (S9).

This ranking identifies a concern about civil engineering education because graduates' competence in "Communicate effectively" (S4), "Function to be a manager" (S8) and "Function to be a leader" (S9) was ranked as a low competence category. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.2.2).

The ranking was calculated based on samples that were token form population of professionals. In order to know if this ranking can represent the population' perception,

statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 21 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 21 Validation of graduates' skills ranked by professionals

Item	Explanation
Number of Samples (N)	14
Kendall's W (Coefficient of Concordance)	.292
Chi-Square	32.694
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.2.4 where this ranking will be compared with the ranking of expected competence presented in section 5.2.2.4.

Assessments of employers, graduates, academicians and professionals with rankings of graduates' skills have been presented in sections 5.1.2.1 to 5.1.2.4. The assessments were combined and discussed to achieve general information about stakeholders' assessment with ranking of graduates' skills. The combination and discussion of the assessment will be presented in section 6.1.2.

5.1.3. Graduates' attitude ranked by stakeholders

As the data presented in section 4.3, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.1.3.1 Graduates' attitude ranked by employers

The description of employers' assessment on graduates' attitude are presented in Table 5-22 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the attitude variables as shown in Table 2-4. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5-22 Graduates' attitude ranked by employers

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Think critically, creatively, reflectively (A1)	17	.728	2	5	3.82	3	High
Committed to lifelong learning (A2)	17	1.068	2	5	3.47	7	Low
Committed to ethic (A3)	17	.993	1	5	3.88	2	High
Committed to environment (A4)	17	.600	3	5	3.88	4	Somewhat
Work with global perspectives (A5)	17	.781	2	5	3.12	9	Low
Committed to professional skills (A6)	17	1.047	1	5	3.71	5	Somewhat
Committed to different cultural groups (A7)	17	.870	1	5	3.41	8	Low
Committed to group skills (A8)	17	1.231	1	5	3.53	6	Somewhat
Committed to interpersonal skills (A9)	17	1.300	1	5	3.76	1	High

Source: Description of data presented in section 4.3.9

Based on employers' perception, abilities of civil engineering graduates in the following areas are high. The areas are: thinking critically, creatively, reflectively in their work (A1); committing to meet ethical responsibilities in their work (A3); and committing to develop effective interpersonal skills in his or her workplace (A9). Meanwhile, abilities in the following areas are low, i.e.: committing to undertake lifelong learning (A2); Working with international and global perspectives (A5); and committing to working effectively with different cultural groups (A7).

This ranking identifies a concern about civil engineering education because graduates' competence in "Committed to lifelong learning" (A2) was ranked as low. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.3.2).

The ranking was calculated based on samples that were token form population of employers. In order to know if this ranking can represent the population' perception,

statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 23 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 23 Validation of graduates' attitude ranked by employers

Item	Explanation
Number of Samples (N)	17
Kendall's W (Coefficient of Concordance)	.166
Chi-Square	22.572
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.004 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.3.1 where this ranking will be compared with the ranking of expected competence presented in section 5.2.3.1.

5.1.3.2 Graduates' attitude ranked by graduates

The description of graduates' assessment on graduates' attitude are presented in Table 5- 24 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the attitude variables as shown in Table 2- 4. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 24 Graduates' attitude ranked by graduates

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Think critically, creatively, reflectively (A1)	39	4.10	1	5	4.10	7	Low
Committed to lifelong learning (A2)	39	3.85	1	5	3.85	9	Low

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Committed to ethic (A3)	39	4.26	1	5	4.26	2	High
Committed to environment (A4)	39	4.13	2	5	4.13	6	Somewhat
Work with global perspectives (A5)	39	3.90	2	5	3.90	8	Low
Committed to professional skills (A6)	39	4.28	2	5	4.28	1	High
Committed to different cultural groups (A7)	39	4.26	2	5	4.26	3	High
Committed to group skills (A8)	39	4.23	1	5	4.23	4	Somewhat
Committed to interpersonal skills (A9)	39	4.21	2	5	4.21	5	Somewhat

Source: Description of data presented in section 4.3.10

Based on graduates' perception, abilities of civil engineering graduates in the following areas are high. The areas are understanding: committing to meet ethical responsibilities in their work (A3); committing to developing further his or her professional skills (A6); and committing to work effectively with different cultural groups (A7). Meanwhile, abilities in the following areas are low, i.e.: thinking critically, creatively, reflectively in their work (A1); committing to undertake lifelong learning (A2); and working with international and global perspectives (A5).

This ranking identifies a concern about civil engineering education because graduates' competence in "Committed to lifelong learning" (A2) was ranked as low. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.3.2).

The ranking was calculated based on samples that were token form population of graduates. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 25 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 25 Validation of graduates' attitude ranked by graduates

Item	Explanation
Number of Samples (N)	39
Kendall's W (Coefficient of Concordance)	.072
Chi-Square	22.374

Item	Explanation
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.004 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.3.2 where this ranking will be compared with the ranking of expected competence presented in section 5.2.3.2.

5.1.3.3 Graduates' attitude ranked by academicians

The description of academicians' assessment on graduates' attitude are presented in Table 5- 26 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the attitude variables as shown in Table 2- 4. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5- 26 Graduates' attitude ranked by academicians

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Think critically, creatively, reflectively (A1)	45	.963	1	5	3.73	1	High
Committed to lifelong learning (A2)	45	.919	1	5	3.47	8	Low
Committed to ethic (A3)	45	.609	2	5	3.76	2	High
Committed to environment (A4)	45	.688	2	5	3.73	5	Somewhat
Work with global perspectives (A5)	45	.968	1	5	3.51	7	Low
Committed to professional skills (A6)	45	.815	1	5	3.71	4	Somewhat
Committed to different cultural groups (A7)	45	.839	1	5	3.42	9	Low
Committed to group skills (A8)	45	.727	2	5	3.71	3	High
Committed to interpersonal skills (A9)	45	.701	2	5	3.69	6	Somewhat

Source: Description of data presented in section 4.3.11

Based on academicians' perception, abilities of civil engineering graduates in the following areas are high. The areas are: thinking critically, creatively, reflectively in their work (A1); committing to meet ethical responsibilities in their work (A3); and committing to use effective group skills in his or her workplace (A8). Meanwhile, abilities in the following areas are low, i.e.: Committing to undertake lifelong learning (A2); working with international and global perspectives (A5); and committing to working effectively with different cultural groups (A7).

This ranking identifies a concern about civil engineering education because graduates' competence in "Committed to lifelong learning" (A2) was ranked as low. Whereas, the competence significantly affects the stakeholders' satisfaction (section 7.3.2).

The ranking was calculated based on samples that were token form population of academicians. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 27 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 27 Validation of graduates' attitude ranked by academicians

Item	Explanation
Number of Samples (N)	45
Kendall's W (Coefficient of Concordance)	.048
Chi-Square	17.291
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.027 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.3.3 where this ranking will be compared with the ranking of expected competence presented in section 5.2.3.3.

5.1.3.4 Graduates' attitude ranked by professionals

The description of professionals' assessment on graduates' attitude are presented in Table 5- 28 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the attitude variables as shown in Table 2-4. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high competence, 4 to 6 are as moderate (somewhat) competence, and 7 to 9 are defined as low competence.

Table 5-28 Graduates' attitude ranked by professionals

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean	Ranking (Number)	Ranking (Term)
Think critically, creatively, reflectively (A1)	14	.616	3	5	4.07	2	High
Committed to lifelong learning (A2)	14	.893	2	5	3.79	5	Somewhat
Committed to ethic (A3)	14	.864	2	5	3.86	3	High
Committed to environment (A4)	14	.663	3	5	3.86	4	Somewhat
Work with global perspectives (A5)	14	1.072	2	5	3.07	9	Low
Committed to professional skills (A6)	14	.730	3	5	4.07	1	High
Committed to different cultural groups (A7)	14	.756	2	5	3.43	8	Low
Committed to group skills (A8)	14	.745	2	5	3.64	7	Low
Committed to interpersonal skills (A9)	14	.842	2	5	3.64	6	Somewhat

Source: Description of data presented in section 4.3.12 in the cases presented in Table 5-5

Based on professionals' perception, abilities of civil engineering graduates in the following areas are high. The areas: thinking critically, creatively, reflectively in their work (A1); committing to meet ethical responsibilities in their work (A3); and committing to develop further his or her professional skills (A6). Meanwhile, abilities in the following areas are low, i.e.: working with international and global perspectives (A5); committing to work effectively with different cultural groups (A7); and committing to use effective group skills in his or her workplace (A8).

The ranking was calculated based on samples that were token form population of professionals. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5-29 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 29 Validation of graduates' attitude ranked by professionals

Item	Explanation
Number of Samples (N)	14
Kendall's W (Coefficient of Concordance)	.260
Chi-Square	29.153
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.3.4 where this ranking will be compared with the ranking of expected competence presented in section 5.2.3.4.

Assessments of employers, graduates, academicians and professionals with rankings of graduates' attitude have been presented in sections 5.1.3.1 to 5.1.3.4. The assessments were combined and discussed to achieve general information about stakeholders' assessment with ranking of graduates' attitude. The combination and discussion of the assessment will be presented in section 6.1.3.

5.1.4. Summary of investigation in graduates' competence

This investigation found several rankings of graduates' competence based on perceptions of respondents i.e. employers, graduates, academicians and professional separately. The respondents can be combined to form a wider stakeholders of the civil engineering education. Perception of the wider stakeholders should produce more reliable rankings. If the rankings of graduates' competence have been known, they can be compared with rankings of stakeholders' expectation. Hence, all of stakeholders' perceptions in the ranking of graduates' competence will be combined and discussed in section 6.1.

5.2. Investigation of stakeholders' expectations

The aim of this analysis is to investigate the expectation of competencies (attributes) based on stakeholders' expectations. The investigation is addressed to identify valid rankings of expectations with competence that should be mastered by graduates. The validation was conducted by a statistical method.

In this investigation, the expected competence attributes are categorized into knowledge, skills and attitude; while stakeholders are categorized into employers, graduates, academicians and professionals. The steps in this ranking analysis are three stages as shown in Figure 5- 3. The first is the establishment of samples from qualified cases. The second is calculation of the ranking of stakeholders' expectation with competence that should be mastered by graduates. The third is the validation of the ranking to confirm that the ranking is valid based on the Kendall-W.

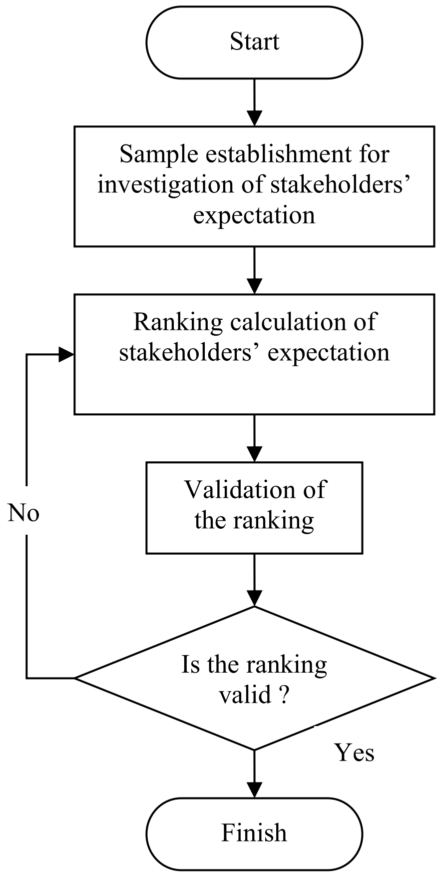

Figure 5- 3 Flowchart of expectations investigation

a) Samples of stakeholders' expectation

Samples used in the investigation of graduates' competence were selected from qualified cases that have been analysed in chapter 4. The qualified cases or the samples in this analysis consist of 14 employers, 32 graduates, 35 academicians and 12 professionals as shown in Table 5- 30 to Table 5- 33

Table 5- 30 Samples of employers' expectations analysis

No	Sample Code	No	Sample Code	No	Sample Code
1	11000	6	11167	11	11276
2	11043	7	11170	12	11284
3	11145	8	11175	13	11293
4	11152	9	11177	14	11330
5	11156	10	11180		

Source: Analyses in sections 4.5.1, 4.5.5 and 4.5.9

Table 5- 30 shows 14 employers used as samples in this analysis. Three others have been excluded because of improper or missing values. It means that the data of graduates' competence supplied by 14 employers can be used as samples in this investigation.

Table 5- 31 Samples of graduates' expectations analysis

No	Sample Code	No	Sample Code	No	Sample Code
1	12000	12	12025	23	12066
2	12003	13	12031	24	12070
3	12005	14	12034	25	12086
4	12006	15	12039	26	12087
5	12007	16	12042	27	12100
6	12010	17	12043	28	12106
7	12013	18	12046	29	12107
8	12016	19	12048	30	12109
9	12017	20	12060	31	12129
10	12019	21	12061	32	12130
11	12021	22	12062		

Source: Analyses in sections 4.5.2, 4.5.6 and 4.5.10

Table 5- 31 shows 32 graduates used as samples in this analysis. Seven others have been excluded because of improper or missing values. It means that the data of graduates' competence supplied by 32 graduates can be used as samples in this investigation.

Table 5- 32 Samples of academicians' expectations analyse

No	Sample Code	No	Sample Code	No	Sample Code
1	13000	13	13043	25	13089
2	13002	14	13045	26	13090
3	13006	15	13051	27	13091
4	13009	16	13056	28	13095
5	13012	17	13058	29	13098
6	13014	18	13065	30	13120

No	Sample Code	No	Sample Code	No	Sample Code
7	13018	19	13069	31	13122
8	13024	20	13079	32	13125
9	13027	21	13084	33	13126
10	13028	22	13085	34	13134
11	13030	23	13087	35	13136
12	13035	24	13088		

Source: Analyses in sections 4.5.3, 4.5.7 and 4.5.11

Table 5- 32 shows 35 academicians used as samples in this analysis. Thirteen others have been excluded because of improper or missing values. It means that the data of graduates' competence supplied by 35 academicians can be used as samples in this investigation.

Table 5- 33 Samples of professionals' expectations analysis

No	Sample	No	Sample	No	Sample
1	14025	5	14043	9	14171
2	14027	6	14060	10	14197
3	14030	7	14154	11	14204
4	14033	8	14159	12	14287

Source: Analyses in sections 4.5.4, 4.5.8 and 4.5.12

Table 5- 33 shows 12 professionals used as samples in this analysis. Four others have been excluded because of improper or missing values in the cases. It means that the data of graduates' competence supplied by 12 professionals can be used as samples in this investigation.

The samples for this analysis have been established. As four samples contain three attribute groups, this analysis contained 12 sub-analyses.

b) Calculation of rankings

The calculation of rankings of stakeholders' expectation was conducted based on means, mode, or median of the stakeholders' expectation values. Ranking of one (1) is for the highest value or the most expected competence; while a ranking of nine (9) is for the lowest value or the less expected competence. The calculation is presented in Table 5- 34, Table 5- 36, Table 5- 38 and so forth.

c) Validation of rankings

The validation or concordance of ranking was conducted using the Kendall-W the formulae of which have been shown in Equation 3- 5. Calculation of validation was conducted with SPSS software. The validation is presented in Table 5- 35, Table 5- 37, Table 5- 39 and so forth.

5.2.1. Expected knowledge ranked by stakeholders

As the data presented in section 4.5, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.2.1.1 Expected knowledge ranked by employers

The description of employers' expectation on graduates' knowledge are presented in Table 5- 34 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the knowledge variables as shown in Table 2- 2. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 34 Expected knowledge ranked by employers

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Principles and concepts (K1)	14	.852	6	9	8.43	1	High
Basic science and engineering (K2)	14	2.033	2	9	5.86	3	High
In-depth technical knowledge (K3)	14	1.828	3	9	5.43	4	Somewhat
Problem solution (K4)	14	1.657	3	9	6.86	2	High
Systems approach (K5)	14	2.165	1	8	5.07	5	Somewhat
Sustainable design (K6)	14	2.345	1	8	3.50	8	Low
Laws, regulations and standards (K7)	14	2.016	1	9	4.29	6	Somewhat
Management and business (K8)	14	2.243	1	9	3.57	7	Low
Other disciplines (K9)	14	1.468	1	6	2.00	9	Low

Source: Description of data presented in section 4.5.1 in the cases presented in Table 5- 30

Based on employers' perception, the importance of the following abilities for civil engineering graduates are high. The areas are understanding: the principles and concepts (K1); the basic science and engineering fundamentals (K2); and the problem identification, formulation and solution (K4). Meanwhile, the importance of abilities in the following areas are low, i.e. understanding: the principles of sustainable design and development (K6); the principles of management and business (K8); and the other disciplines (K9).

This ranking identifies a concern about civil engineering education because competence in “Problem solution” (K4) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates’ competence in the area is classified only as medium (section 5.1.1.1).

The ranking was calculated based on samples that were token form population of employers. In order to know if this ranking can represent the population’ perception, statisticians recommend that this ranking should be validated by Kendall’s W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 35 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population’ perception.

Table 5- 35 Validation of expected knowledge ranked by employers

Item	Explanation
Number of Samples (N)	14 Employers
Kendall's W (Coefficient of Concordance)	.499
Chi-Square	55.867
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.1.1 where this ranking will be compared with the ranking of graduates’ competence presented in section 5.1.1.1.

5.2.1.2 Expected knowledge ranked by graduates

The description of graduates’ expectation on graduates’ knowledge are presented in Table 5- 36 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the knowledge variables as shown in Table 2- 2. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 36 Expected knowledge ranked by graduates

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Principles and concepts (K1)	32	2.435	1	9	6.06	2	High
Basic science and engineering (K2)	32	2.453	1	9	5.72	3	High
In-depth technical knowledge (K3)	32	2.069	1	9	4.91	5	Somewhat
Problem solution (K4)	32	1.868	1	9	7.16	1	High
Systems approach (K5)	32	2.576	1	9	4.41	7	Low
Sustainable design (K6)	32	1.966	1	9	3.56	9	Low
Laws, regulations and standards (K7)	32	2.423	1	9	4.47	6	Somewhat
Management and business (K8)	32	2.646	1	9	5.03	4	Somewhat
Other disciplines (K9)	32	2.788	1	9	3.69	8	Low

Source: Description of data presented in section 4.5.2 in the cases presented in Table 5- 31

Based on graduates' perception, the importance of the following abilities for civil engineering graduates are high. The areas are understanding: the principles and concepts (K1); the basic science and engineering fundamentals (K2); and the problem identification, formulation and solution (K4). Meanwhile, the importance of abilities in the following areas are low, i.e. understanding: how to utilise a systems approach to design and operational performance (K5); the principles of sustainable design and development (K6); and the other disciplines (K9).

The ranking was calculated based on samples that were token form population of graduates. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 37 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 37 Validation of expected knowledge ranked by graduates

Item	Explanation
Number of Samples (N)	32 Graduates
Kendall's W (Coefficient of Concordance)	.179
Chi-Square	45.775
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 < (.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.1.2 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.1.2.

5.2.1.3 Expected knowledge ranked by academicians

The description of academicians' expectation on graduates' knowledge are presented in Table 5- 38 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the knowledge variables as shown in Table 2- 2. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 38 Expected knowledge ranked by academicians

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Principles and concepts (K1)	35	2.447	1	9	6.69	3	High
Basic science and engineering (K2)	35	2.390	1	9	6.77	2	High
In-depth technical knowledge (K3)	35	2.129	1	9	5.63	4	Somewhat
Problem solution (K4)	35	1.997	1	9	6.89	1	High
Systems approach (K5)	35	2.184	1	9	4.63	5	Somewhat
Sustainable design (K6)	35	1.843	1	9	4.31	6	Somewhat
Laws, regulations and standards (K7)	35	1.955	1	9	4.06	7	Low
Management and business (K8)	35	1.853	1	9	3.54	8	Low
Other disciplines (K9)	35	2.381	1	9	2.49	9	Low

Source: Description of data presented in section 4.5.3 in the cases presented in Table 5- 32

Based on academicians' perception, the importance of the following abilities for civil engineering graduates are high. The areas are understanding: the principles and concepts (K1); the basic science and engineering fundamentals (K2); and the problem identification, formulation and solution (K4). Meanwhile, the importance of abilities in the following areas are low, i.e. understanding: the laws, regulations and standards (K7); the principles of management and business (K8); and the other disciplines (K9).

This ranking identifies a concern about civil engineering education because competence in "Problem solution" (K4) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the area is classified only as medium (section 5.1.1.3).

The ranking was calculated based on samples that were token form population of academicians. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 39 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 39 Validation of expected knowledge ranked by academicians

Item	Explanation
Number of Samples (N)	35 academicians
Kendall's W (Coefficient of Concordance)	.331
Chi-Square	92.739
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.1.3 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.1.3.

5.2.1.4 Expected knowledge ranked by professionals

The description of professionals' expectation on graduates' knowledge are presented in Table 5- 40 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the knowledge variables as shown in Table 2- 2. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 40 Expected knowledge ranked by professionals

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Principles and concepts (K1)	12	1.679	3	9	7.50	2	High
Basic science and engineering (K2)	12	1.288	5	9	7.25	3	High
In-depth technical knowledge (K3)	12	2.006	1	8	4.25	5	Somewhat
Problem solution (K4)	12	1.311	5	9	7.92	1	High
Systems approach (K5)	12	2.125	1	8	5.17	4	Somewhat
Sustainable design (K6)	12	1.371	2	6	3.33	7	Low
Laws, regulations and standards (K7)	12	2.038	1	8	4.17	6	Somewhat
Management and business (K8)	12	2.094	1	8	3.25	8	Low
Other disciplines (K9)	12	1.467	1	5	2.17	9	Low

Source: Description of data presented in section 4.5.4 in the cases presented in Table 5- 33

Based on professionals' perception, the importance of the following abilities for civil engineering graduates are high. The areas are understanding: the principles and concepts (K1); the basic science and engineering fundamentals (K2); and the problem identification, formulation and solution (K4). Meanwhile, the importance of abilities in the following areas are low, i.e. understanding: the principles of sustainable design and development (K6); the principles of management and business (K8); and the other disciplines (K9).

The ranking was calculated based on samples that were token form population of professionals. In order to know if this ranking can represent the population' perception,

statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 41 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 41 Validation of expected knowledge ranked by professionals

Item	Explanation
Number of Samples (N)	12 academicians
Kendall's W (Coefficient of Concordance)	.583
Chi-Square	55.956
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section. 5.4.1.4 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.1.4.

Expectation of employers, graduates, academicians and professionals with rankings of graduates' knowledge have been presented in sections 5.2.1.1 to 5.2.1.4. The expectation were combined and discussed to achieve general information about stakeholders' expectation with ranking of graduates' knowledge. The combination and discussion of the expectation will be presented in section 6.2.1

5.2.2. Expected skills ranked by stakeholders

As the data presented in section 4.5, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.2.2.1 Expected skills ranked by employers

The description of employers' expectation on graduates' skills are presented in Table 5-42 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the skill variables as shown in Table 2-3. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5-42 Expected skills ranked by employers

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Apply in-depth technical skills (S1)	14	2.424	1	9	6.29	3	High
Use technologies (S2)	14	2.392	1	9	5.82	4	Somewhat
Synthesise information (S3)	14	2.164	3	9	6.71	2	High
Communicate effectively (S4)	14	1.453	5	9	7.57	1	High
Function as an individual (S5)	14	1.550	4	8	5.64	5	Somewhat
Function in multi-disciplinary teams (S6)	14	1.592	1	7	3.93	7	Low
Function to be a member (S7)	14	2.209	1	8	4.57	6	Somewhat
Function to be a manager (S8)	14	.829	1	4	1.96	9	Low
Function to be a leader (S9)	14	2.103	1	7	2.50	8	Low

Source: Description of data presented in section 4.5.5 in the cases presented in Table 5-30

Based on employers' perception, the importance of the following abilities for civil engineering graduates are high. The areas are: apply in-depth technical skills in at least one discipline (S1); accessing, evaluating and synthesising information (S3); and communicating effectively not only with engineers but also with the community at large (S4). Meanwhile, the importance of abilities in the following areas are low, i.e.: function effectively in multi-disciplinary or multi-cultural teams (S6); function effectively in teams with the capacity to be a manager (S8) and function effectively in teams with the capacity to be a leader (S9).

This ranking identifies a concern about civil engineering education because competence in "Synthesise information" (S3) and "Problem solution" (K4) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the areas is consecutively classified only as medium and low (section 5.1.2.1).

The ranking indicates that the importance of graduates' skills are high in the core of civil engineering and low in the fringe. The ranking was calculated based on samples that were token form population of employers. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 43 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 43 Validation of expected skills ranked by employers

Item	Explanation
Number of Samples (N)	14 employers
Kendall's W (Coefficient of Concordance)	.485
Chi-Square	54.332
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.2.1 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.2.1.

5.2.2.2 Expected skills ranked by graduates

The description of graduates' expectation on graduates' skills are presented in Table 5- 44 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the skill variables as shown in Table 2- 3. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 44 Expected skills ranked by graduates

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Apply in-depth technical skills (S1)	32	2.741	1	9	4.97	5	Somewhat
Use technologies (S2)	32	2.575	1	9	5.13	4	Somewhat
Synthesise information (S3)	32	2.639	1	9	4.94	6	Somewhat
Communicate effectively (S4)	32	2.052	3	9	6.72	1	High
Function as an individual (S5)	32	2.626	1	9	5.59	2	High
Function in multi-disciplinary teams (S6)	32	2.092	1	9	4.41	7	Low
Function to be a member (S7)	32	2.225	2	9	5.38	3	High
Function to be a manager (S8)	32	2.620	1	9	3.81	9	Low
Function to be a leader (S9)	32	2.687	1	9	4.06	8	Low

Source: Description of data presented in section 4.5.6 in the cases presented in Table 5- 31

Based on graduates' perception, the importance of the following abilities for civil engineering graduates are high. The areas are: communication effectively not only with engineers but also with the community at large (S4); function effectively as an individual (S5); and function effectively in teams with the capacity to be a member (S7). Meanwhile, the importance of abilities in the following areas are low, i.e.: function effectively in multi-disciplinary or multi-cultural teams (S6); function effectively in teams with the capacity to be a manager (S8); and function effectively in teams with the capacity to be a leader (S9).

This ranking identifies a concern about civil engineering education because competence in "Problem solution" (K4) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the areas is classified only as medium (section 5.1.2.2).

The ranking was calculated based on samples that were token form population of graduates. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 45 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 45 Validation of expected skills ranked by graduates

Item	Explanation
Number of Samples (N)	32 Graduates
Kendall's W (Coefficient of Concordance)	.102
Chi-Square	26.067
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.2.2 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.2.2.

5.2.2.3 Expected skills ranked by academicians

The description of academicians' expectation on graduates' skills are presented in Table 5- 46 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the skill variables as shown in Table 2- 3. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 46 Expected skills ranked by academicians

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Apply in-depth technical skills (S1)	35	2.698	1	9	6.31	2	High
Use technologies (S2)	35	2.153	2	9	5.80	3	High
Synthesise information (S3)	35	2.248	1	9	6.94	1	High
Communicate effectively (S4)	35	2.336	1	9	5.69	5	Somewhat
Function as an individual (S5)	35	2.174	1	9	5.74	4	Somewhat
Function in multi-disciplinary teams (S6)	35	1.651	1	9	4.46	7	Low
Function to be a member (S7)	35	1.521	3	9	4.74	6	Somewhat
Function to be a manager (S8)	35	2.055	1	8	2.80	8	Low
Function to be a leader (S9)	35	2.501	1	9	2.51	9	Low

Source: Description of data presented in section 4.5.7 in the cases presented in Table 5- 32

Based on academicians' perception, the importance of the following abilities for civil engineering graduates are high. The areas are: applying in-depth technical skills in at least one discipline (S1); using technologies appropriately (S2); and accessing, evaluating and synthesising information (S3). Meanwhile, the importance of abilities in the following areas are low, i.e.: functioning effectively in multi-disciplinary or multi-cultural teams (S6); functioning effectively in teams with the capacity to be a manager (S8); and functioning effectively in teams with the capacity to be a leader (S9)

This ranking identifies a concern about civil engineering education because competence in "Synthesise information" (S3) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the areas is classified only as medium (section 5.1.2.3).

The ranking was calculated based on samples that were token form population of academicians. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 45 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 47 Validation of expected skills ranked by academicians

Item	Explanation
Number of Samples (N)	35 Academicians
Kendall's W (Coefficient of Concordance)	.309
Chi-Square	86.537
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.2.3 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.2.3.

5.2.2.4 Expected skills ranked by professionals

The description of professionals' expectation on graduates' skills are presented in Table 5-48 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the skill variables as shown in Table 2-3. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5-48 Expected skills ranked by professionals

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Apply in-depth technical skills (S1)	12	2.958	1	9	5.25	4	Somewhat
Use technologies (S2)	12	2.221	1	9	6.25	3	High
Synthesise information (S3)	12	1.564	4	9	7.08	2	High
Communicate effectively (S4)	12	.778	7	9	8.33	1	High
Function as an individual (S5)	12	1.975	1	8	4.42	7	Low
Function in multi-disciplinary teams (S6)	12	1.723	2	7	4.67	6	Somewhat
Function to be a member (S7)	12	1.422	3	7	4.75	5	Somewhat
Function to be a manager (S8)	12	1.000	1	4	2.50	8	Low
Function to be a leader (S9)	12	1.138	1	5	1.75	9	Low

Source: Description of data presented in section 4.5.8 in the cases presented in Table 5-33

Based on professionals perception, the importance of the following abilities for civil engineering graduates are high. The areas are: using technologies appropriately (S2); accessing, evaluating and synthesising information (S3); and communicating effectively not only with engineers but also with the community at large (S4). Meanwhile, the importance of abilities in the following areas are low, i.e.: functioning effectively as an individual (S5); functioning effectively in teams with the capacity to be a manager (S8); and functioning effectively in teams with the capacity to be a leader (S9).

This ranking identifies a concern about civil engineering education because competence in "Use technologies" (S2) and "Problem solution" (K4) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the areas is consecutively classified only as medium and low (section 5.1.2.4).

The ranking was calculated based on samples that were token form population of professionals. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 49 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 49 Validation of expected skills ranked by professionals

Item	Explanation
Number of Samples (N)	12 Professionals
Kendall's W (Coefficient of Concordance)	.573
Chi-Square	55.044
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.2.4 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.2.4.

Expectation of employers, graduates, academicians and professionals with rankings of graduates' skills have been presented in sections 5.2.2.1 to 5.2.2.4. The expectation were combined and discussed to achieve general information about stakeholders' expectation with ranking of graduates' skills. The combination and discussion of the expectation will be presented in section 6.2.2.

5.2.3. Expected attitude ranked by stakeholders

As the data presented in section 4.5, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.2.3.1 Expected attitude ranked by employers

The description of employers' expectation on graduates' attitude are presented in Table 5- 50 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the attitude variables as shown in Table 2- 4. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 50 Expected attitude ranked by employers

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Think critically, creatively, reflectively (A1)	14	2.598	2	9	7.14	1	High
Committed to lifelong learning (A2)	14	2.164	1	9	4.71	6	Somewhat
Committed to ethic (A3)	14	1.557	4	9	6.43	2	High
Committed to environment (A4)	14	1.791	2	7	4.11	7	Low
Work with global perspectives (A5)	14	2.134	1	8	2.36	9	Low
Committed to professional skills (A6)	14	1.399	4	8	5.54	4	Somewhat
Committed to different cultural groups (A7)	14	1.657	1	7	2.86	8	Low
Committed to group skills (A8)	14	2.441	1	8	5.57	4	Somewhat
Committed to interpersonal skills (A9)	14	3.074	1	9	6.29	3	High

Source: Description of data presented in section 4.5.9 in the cases presented in Table 5- 30

Based on employers' perception, the importance of the following abilities for civil engineering graduates are high. The areas are: thinking critically, creatively, reflectively in their work (A1); committing to undertake lifelong learning (A2); and committing to develop effective interpersonal skills in his or her workplace (A9). Meanwhile, the importance of abilities in the following areas are low, i.e.: committing to meet environmental responsibilities in their work (A4); working with international and global perspectives (A5); and committing to use effective group skills in his or her workplace (A8).

The ranking indicates that the importance of graduates' attitude is high in the core of civil engineering and low in the fringe. The ranking was calculated based on samples that were token form population of employers. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 51 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 51 Validation of expected attitude ranked by employers

Item	Explanation
Number of Samples (N)	14 Employers
Kendall's W (Coefficient of Concordance)	.356
Chi-Square	39.886
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.3.1 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.3.1.

5.2.3.2 Expected attitude ranked by graduates

The description of graduates' expectation on graduates' attitude are presented in Table 5- 52 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the attitude variables as shown in Table 2- 4. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 52 Expected attitude ranked by graduates

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Think critically, creatively, reflectively (A1)	32	2.821	1	9	7.09	1	High
Committed to lifelong learning (A2)	32	2.408	1	9	4.59	6	Somewhat
Committed to ethic (A3)	32	2.225	2	9	5.22	4	Somewhat
Committed to environment (A4)	32	2.200	1	8	4.25	7	Low
Work with global perspectives (A5)	32	2.637	1	9	3.38	9	Low
Committed to professional skills (A6)	32	2.324	1	9	5.22	4	Somewhat
Committed to different cultural groups (A7)	32	2.155	1	9	4.00	8	Low
Committed to group skills (A8)	32	2.352	1	9	5.63	2	High
Committed to interpersonal skills (A9)	32	2.433	1	9	5.63	2	High

Source: Description of data presented in section 4.5.10 in the cases presented in Table 5- 31

Based on graduates' perception, the importance of the following abilities for civil engineering graduates are high. The areas are: thinking critically, creatively, reflectively in their work (A1); committing to use effective group skills in his or her workplace (A8); and committing to develop effective interpersonal skills in his or her workplace (A9). Meanwhile, the importance of abilities in the following areas are low, i.e.: committing to meet environmental responsibilities in their work (A4); working with international and global perspectives (A5); and committing to working effectively with different cultural groups (A7).

This ranking identifies a concern about civil engineering education because competence in "Think critically, creatively, reflectively" (A1), "Committed to group skills" (A8) and "Committed to interpersonal skills" (A9) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the areas is consecutively classified only as low, medium and medium (section 5.1.3.2).

The ranking was calculated based on samples that were token form population of graduates. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 53 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 53 Validation of expected attitude ranked by graduates

Item	Explanation
Number of Samples (N)	32 Graduates
Kendall's W (Coefficient of Concordance)	.160
Chi-Square	41.083
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.3.2 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.3.2.

5.2.3.3 Expected attitude ranked by academicians

The description of academicians' expectation on graduates' attitude are presented in Table 5- 54 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the attitude variables as shown in Table 2- 4. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 54 Expected attitude ranked by academicians

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Think critically, creatively, reflectively (A1)	35	2.726	1	9	7.57	1	High
Committed to lifelong learning (A2)	35	2.153	1	9	5.89	3	High
Committed to ethic (A3)	35	2.133	1	9	6.26	2	High

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Committed to environment (A4)	35	1.652	2	8	5.09	5	Somewhat
Work with global perspectives (A5)	35	1.801	1	8	2.86	9	Low
Committed to professional skills (A6)	35	1.811	2	9	5.69	4	Somewhat
Committed to different cultural groups (A7)	35	2.531	1	9	2.94	8	Low
Committed to group skills (A8)	35	2.040	1	9	4.31	7	Low
Committed to interpersonal skills (A9)	35	2.379	1	9	4.40	6	Somewhat

Source: Description of data presented in section 4.5.11 in the cases presented in Table 5- 32

Based on academicians' perception, the importance of the following abilities for civil engineering graduates are high. The areas are: thinking critically, creatively, reflectively in their work (A1); committing to undertake lifelong learning (A2); and committing to meet ethical responsibilities in their work (A3). Meanwhile, the importance of abilities in the following areas are low, i.e.: working with international and global perspectives (A5); committing to work effectively with different cultural groups (A7); and committing to use effective group skills in his or her workplace (A8).

This ranking identifies a concern about civil engineering education because competence in "Committed to lifelong learning" (A2) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the area is classified only as low (section 5.1.3.3).

The ranking was calculated based on samples that were token form population of academicians. In order to know if this ranking can represent the population' perception, statisticians recommend that this ranking should be validated by Kendall's W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 55 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population' perception.

Table 5- 55 Validation of expected attitude ranked by academicians

Item	Explanation
Number of Samples (N)	35 Academicians
Kendall's W (Coefficient of Concordance)	.318

Item	Explanation
Chi-Square	89.173
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.3.3 where this ranking will be compared with the ranking of graduates' competence presented in section 5.1.3.3.

5.2.3.4 Expected attitude ranked by professionals

The description of professionals' expectation on graduates' attitude are presented in Table 5- 56 which shows the number of samples, standard deviation, minimum, maximum, mean and ranking for each variable. The attribute code is the attitude variables as shown in Table 2- 4. The ranking is competence value in ordinal number i.e. one (1) is for the highest value and nine (9) is for the lowest. Ranking 1 to 3 are defined as high expected competence, 4 to 6 are as moderate (somewhat) expected competence, and 7 to 9 are defined as low expected competence.

Table 5- 56 Expected attitude ranked by professionals

Attribute Code	Number of Samples	Std. Dev.	Min	Max	Mean Rank	Ranking (Number)	Ranking (Term)
Think critically, creatively, reflectively (A1)	12	1.165	6	9	8.42	1	High
Committed to lifelong learning (A2)	12	2.193	1	8	5.42	4	Somewhat
Committed to ethic (A3)	12	1.564	4	9	6.42	2	High
Committed to environment (A4)	12	1.850	2	8	4.83	6	Somewhat
Work with global perspectives (A5)	12	.900	1	4	1.58	9	Low
Committed to professional skills (A6)	12	2.598	1	9	4.75	7	Low
Committed to different cultural groups (A7)	12	.965	1	4	2.25	8	Low
Committed to group skills (A8)	12	1.881	3	8	5.08	5	Somewhat
Committed to interpersonal skills (A9)	12	1.865	3	9	6.25	3	High

Source: Description of data presented in section 4.5.12 in the cases presented in Table 5- 33

Based on professionals' perception, the importance of the following abilities for civil engineering graduates are high. The areas are: thinking critically, creatively, reflectively in their work (A1); committing to meeting ethical responsibilities in their work (A3); and committing to develop effective interpersonal skills in his or her workplace (A9). Meanwhile, the importance of abilities in the following areas are low, i.e.: working with international and global perspectives (A5); committing to developing further his or her professional skills (A6); and committing to working effectively with different cultural groups (A7).

This ranking identifies a concern about civil engineering education because competence in “Committed to interpersonal skills” (A9) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates’ competence in the area is classified only as medium (section 5.1.3.4).

The ranking was calculated based on samples that were token form population of professionals. In order to know if this ranking can represent the population’ perception, statisticians recommend that this ranking should be validated by Kendall’s W. This test compares the Chi-square value in the data and a value in a standard of sampling.

Result of the validation is presented in Table 5- 57 which indicates that the ranking of each variable is different because the probability of similarity among them is less than 0.05. The difference means that the respondents have preference with the ranking, so that the ranking is valid to represent the population’ perception.

Table 5- 57 Validation of expected attitude ranked by professionals

Item	Explanation
Number of Samples (N)	12 Professionals
Kendall's W (Coefficient of Concordance)	.579
Chi-Square	55.600
Number of Ranking	9
Degree of Freedom	8
Probability of Similarity between Rankings	.000 (<.05)
Inference	The rankings are valid

Source: Output of Kendall's W calculated by the SPSS

Because of the validity, the ranking can be used as an input in an analysis to select competence that should be prioritised by providers of civil engineering education. The analysis will be presented in section 5.4.3.4 where this ranking will be compared with the ranking of graduates’ competence presented in section 5.1.3.4.

Expectation of employers, graduates, academicians and professionals with rankings of graduates' attitude have been presented in sections 5.2.3.1 to 5.2.3.4. The expectation were combined and discussed to achieve general information about stakeholders' expectation with ranking of graduates' attitude. The combination and discussion of the expectation will be presented in section 6.2.3.

5.2.4. Summary of investigation in stakeholders' expectation

This investigation found several rankings of the importance of competence that should be mastered by civil engineering graduates. The rankings were based on perceptions of respondents i.e. employers, graduates, academicians and professional separately. This investigation also indicates that the expectations between those stakeholders are likely different. The differences among them were investigated in section 5.3.

The respondents can be combined to form a wider stakeholders of the civil engineering education. Perception of the wider stakeholders should produce more reliable rankings. If the rankings of stakeholders' expectation have been known, they can be compared with rankings of graduates' competence. Hence, all of stakeholders' perceptions in the ranking of graduates' competence will be combined and discussed in section 6.2.

5.3. Comparisons between stakeholders' expectations

The aim of this analysis is to compare expectations of stakeholders. The comparison is addressed to identify the valid differences between them. The validation was conducted by a statistical method.

In this analysis, stakeholders' expectations are categorized into expectation of knowledge, skills and attitude; while stakeholders are categorized into employers, graduates, academicians and professionals. The steps in this analysis can be categorized into three stages as shown in Figure 5-4. The first is the establishment of the samples, the second is the establishment of attributes that differently are expected by stakeholders; and the third is an investigation of the differences.

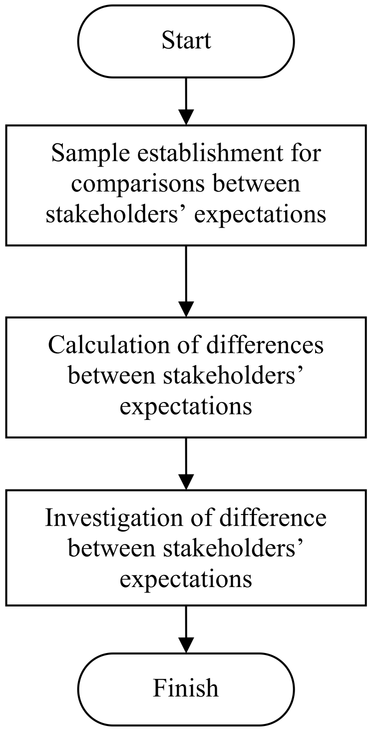

Figure 5- 4 Flowchart of comparison investigation

a) Samples of stakeholders' expectations

The samples used in this analysis consisted of 14 employers, 32 graduates, 35 academicians and 12 professionals. The samples are shown in Table 5- 30 to Table 5- 33. The samples for this analysis have been established.

b) Calculation of differences

The calculation of differences was conducted based on means or mode or median of the expectation values. A ranking of one (1) is for the highest value or the most expected competence; while a ranking of nine (9) is for the lowest value or the less expected competence.

The establishment of the differences between two stakeholders' expectations was conducted with the Mann-Whitney-U validated with the Normal-Z that the formulae have been presented in Equation 3- 4. Meanwhile, the establishment of the differences among all stakeholders was conducted with the Kruskal-Wallis-H validated with χ^2 that the formulae have been presented in Equation 3- 6.

c) Investigation of the differences

A further investigation of the differences was conducted by comparing values of expectations so that it can be known which competence is more expected by a stakeholder.

5.3.1. Analyses using Mann-Whitney-U

The Mann-Whitney-U was used to compare between two stakeholders. Because there were four stakeholders containing three attribute groups (knowledge, skills and attitude), the analysis will contain 18 sub-analyses presented from section 5.3.1.1 to section 5.3.1.18.

5.3.1.1 Comparison of employers and graduates on expected knowledge

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 58. The table shows several items including the probability of similarity between employers' and graduates' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to understand: the principles and concepts (K1); and the principles of management and business (K8). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 58 Comparison of employers and graduates on expected knowledge

No	Attribute Code	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Principles and concepts (K1)	186.5	-2.6252985	0.008 (<.05)	Different
2	Basic science and engineering (K2)	330.5	-0.0180496	0.985	Not different
3	In-depth technical knowledge (K3)	316	-0.2794254	0.779	Not different
4	Problem solution (K4)	253	-1.4278464	0.153	Not different
5	Systems approach (K5)	322	-0.1709084	0.864	Not different
6	Sustainable design (K6)	330	-0.027177	0.978	Not different
7	Laws, regulations and standards (K7)	272.5	-1.0590907	0.289	Not different
8	Management and business (K8)	214	-2.1141243	0.034 (<.05)	Different
9	Other disciplines (K9)	235	-1.7630527	0.077	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 59 which indicates that: "Principles and concepts" (K1) is more expected by employers than graduates; and "Management and business" (K8) is more expected by graduates than employers.

Table 5- 59 Differences between employers and graduates on expected knowledge

Stakeholder	Attribute Code	Mean	Median	Explanation
Employers	K1	8.43	9.00	Employers > Graduates
Graduates	K1	6.06	6.00	
Employers	K8	3.57	3.00	Employers < Graduates
Graduates	K8	5.03	4.00	

Source: Description presented in Table 5- 34 and Table 5- 36

5.3.1.2 Comparison of employers and graduates on expected skills

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 60. The table shows several items including the probability of similarity between employers' and graduates' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of graduates' ability to: function effectively in teams with the capacity to be a manager (S8); and function effectively in teams with the capacity to be a leader (S9). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 60 Comparison of employers and graduates on expected skills

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Apply in-depth technical skills (S1)	294.5	-0.6652261	0.505	Not different
2	Use technologies (S2)	303	-0.5135845	0.607	Not different
3	Synthesise information (S3)	266.5	-1.1713741	0.241	Not different
4	Communicate effectively (S4)	280	-0.934944	0.349	Not different
5	Function as an individual (S5)	285.5	-0.8270378	0.408	Not different
6	Function in multi-disciplinary teams (S6)	318.5	-0.2339113	0.815	Not different
7	Function to be a member (S7)	288	-0.7834815	0.433	Not different
8	Function to be a manager (S8)	173.5	-2.8785496	0.003 (<.05)	Different
9	Function to be a leader (S9)	176.5	-2.8076912	0.004 (<.05)	Different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 61 which indicates that "Function to be a manager" (S8) and "Function to be a leader" (S9) are more expected by graduates than employers.

Table 5- 61 Differences between employers and graduates on expected skills

Stakeholder	Attribute Code	Mean	Median	Explanation
Employers	S8	1.93	2.00	Employers < Graduates

Graduates	S8	3.81	3.00	
Employers	S9	2.50	2.00	Employers < Graduates
Graduates	S9	4.06	3.00	

Source: Description presented in Table 5- 42 and Table 5- 44

5.3.1.3 Comparison of employers and graduates on expected attitude

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 62. The table shows several items including the probability of similarity between employers' and graduates' expectations for each variable. The inference indicates that between the two stakeholders, there is no difference in the importance of those competencies. The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 62 Comparison of employers and graduates on expected attitude

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Think critically, creatively, reflectively (A1)	320.5	-0.2116823	0.832	Not different
2	Committed to lifelong learning (A2)	326.5	-0.0900082	0.928	Not different
3	Committed to ethic (A3)	242.5	-1.6026215	0.109	Not different
4	Committed to environment (A4)	288	-0.7821718	0.434	Not different
5	Work with global perspectives (A5)	224.5	-1.9457516	0.051	Not different
6	Committed to professional skills (A6)	313	-0.3324569	0.739	Not different
7	Committed to different cultural groups (A7)	229	-1.8438827	0.065	Not different
8	Committed to group skills (A8)	307.5	-0.4341112	0.664	Not different
9	Committed to interpersonal skills (A9)	295	-0.6605132	0.508	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

5.3.1.4 Comparison of employers and academicians on expected knowledge

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 63. The table shows several items including the probability of similarity between employers' and academicians' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to understand the principles and concepts (K1). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 63 Comparison of employers and academicians on expected knowledge

No	Tested Item	Mann-Whitney U	Z	Probability Of Similarity	Inference
1	Principles and concepts (K1)	242	-2.1699634	0.030 (<.05)	Different

2	Basic science and engineering (K2)	319	-0.897961	0.369	Not different
3	In-depth technical knowledge (K3)	357.5	-0.2680338	0.788	Not different
4	Problem solution (K4)	327	-0.768144	0.442	Not different
5	Systems approach (K5)	363.5	-0.171513	0.863	Not different
6	Sustainable design (K6)	312.5	-0.9992237	0.317	Not different
7	Laws, regulations and standards (K7)	350	-0.392662	0.694	Not different
8	Management and business (K8)	315.5	-0.9637933	0.335	Not different
9	Other disciplines (K9)	352	-0.3760485	0.706	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 64 which indicates that "Principles and concepts" (K1) is more expected by employers than academicians.

Table 5- 64 Differences between employers and academicians on expected knowledge

Stakeholder	Attribute Code	Mean	Median	Explanation
Employers	K1	8.43	9.00	Employers > Academicians
Academicians	K1	6.69	7.00	

Source: Description presented in Table 5- 34 and Table 5- 38

5.3.1.5 Comparison of employers and academicians on expected skills

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 65. The table shows several items including the probability of similarity between employers' and academicians' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to communicate effectively not only with engineers but also with the community at large (S4). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 65 Comparison of employers and academicians on expected skills

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Apply in-depth technical skills (S1)	358.5	-0.252406	0.800	Not different
2	Use technologies (S2)	335.5	-0.6245707	0.532	Not different
3	Synthesise information (S3)	354.5	-0.319589	0.749	Not different
4	Communicate effectively (S4)	205	-2.7412901	0.006 (<.05)	Different
5	Function as an individual (S5)	343	-0.5046616	0.613	Not different
6	Function in multi-disciplinary teams (S6)	366	-0.1306179	0.896	Not different
7	Function to be a member (S7)	339.5	-0.5628221	0.573	Not different

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
8	Function to be a manager (S8)	284.5	-1.5038377	0.132	Not different
9	Function to be a leader (S9)	345.5	-0.4838213	0.628	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 66 which indicates that "Communicate effectively" (S4) is more expected by employers than academicians.

Table 5- 66 Differences between employers and academicians on expected skills

Stakeholder	Attribute Code	Mean	Median	Explanation
Employers	S4	7.57	7.50	Employers > Academicians
Academicians	S4	5.69	6.00	

Source: Description presented in Table 5- 42and Table 5- 46

5.3.1.6 Comparison of employers and academicians on expected attitude

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 67. The table shows several items including the probability of similarity between employers' and academicians' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of committing to use effective group skills in his or her workplace (A8); and committing to develop effective interpersonal skills in his or her workplace (A9). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 67 Comparison of employers and academicians on expected attitude

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Think critically, creatively, reflectively (A1)	373	-0.0180798	0.985	Not different
2	Committed to lifelong learning (A2)	342.5	-0.5106623	0.609	Not different
3	Committed to ethic (A3)	308.5	-1.077015	0.281	Not different
4	Committed to environment (A4)	299.5	-1.2133089	0.225	Not different
5	Work with global perspectives (A5)	294	-1.3210342	0.186	Not different
6	Committed to professional skills (A6)	368.5	-0.0896485	0.928	Not different
7	Committed to different cultural groups (A7)	337	-0.6080375	0.543	Not different
8	Committed to group skills (A8)	220.5	-2.4956135	0.012 (<.05)	Different
9	Committed to interpersonal skills (A9)	248	-2.0426491	0.041 (<.05)	Different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 68 which indicates that: A8 is more expected by employers than academicians; and A9 is more expected by employers than academicians.

Table 5- 68 Differences between employers and academicians on expected attitude

Stakeholder	Attribute Code	Mean	Median	Explanation
Employers	A8	5.57	6.50	Employers > Academicians
Academicians	A8	4.31	4.00	
Employers	A9	6.29	7.50	Employers > Academicians
Academicians	A9	4.40	4.00	

Source: Description presented in Table 5- 50 and Table 5- 54

5.3.1.7 Comparison of employers and professionals on expected knowledge

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 69. The table shows several items including the probability of similarity between employers' and professionals' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to understand the problem identification, formulation and solution (K4). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 69 Comparison of employers and professionals on expected knowledge

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Principles and concepts (K1)	106	-0.5438769	0.586	Not different
2	Basic science and engineering (K2)	80	-1.5723541	0.115	Not different
3	In-depth technical knowledge (K3)	96.5	-0.903657	0.366	Not different
4	Problem solution (K4)	52.5	-2.7068033	0.006 (<.05)	Different
5	Systems approach (K5)	77.5	-1.6721031	0.094	Not different
6	Sustainable design (K6)	105	-0.5636733	0.572	Not different
7	Laws, regulations and standards (K7)	91.5	-1.1131187	0.265	Not different
8	Management and business (K8)	117.5	-0.0611986	0.951	Not different
9	Other disciplines (K9)	109.5	-0.397805	0.690	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 70 which indicates that "Problem solution" (K4) is more expected by professionals than employers.

Table 5- 70 Differences between employers and professionals on expected knowledge

Stakeholder	Attribute Code	Mean	Median	Explanation
Employers	K4	6.86	7.00	Employers < Professionals
Professionals	K4	7.92	8.50	

Source: Description presented in Table 5- 34 and Table 5- 40

5.3.1.8 Comparison of employers and professionals on expected skills

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 71. The table shows several items including the probability of similarity between employers' and professionals' expectations for each variable. The inference indicates that between the two stakeholders, there is no difference in the importance of those competencies. The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 71 Comparison of employers and professionals on expected skills

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Apply in-depth technical skills (S1)	110	-0.3608303	0.718	Not different
2	Use technologies (S2)	111	-0.3218988	0.747	Not different
3	Synthesise information (S3)	105	-0.5642002	0.572	Not different
4	Communicate effectively (S4)	88	-1.2752717	0.202	Not different
5	Function as an individual (S5)	117.5	-0.0603373	0.951	Not different
6	Function in multi-disciplinary teams (S6)	113.5	-0.2216501	0.824	Not different
7	Function to be a member (S7)	117	-0.0805498	0.935	Not different
8	Function to be a manager (S8)	73	-1.9005878	0.057	Not different
9	Function to be a leader (S9)	114.5	-0.18905	0.850	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

5.3.1.9 Comparison of employers and professionals on expected attitude

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 72. The table shows several items including the probability of similarity between employers' and professionals' expectations for each variable. The inference indicates that between the two stakeholders, there is no difference in the importance of those competencies. The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 72 Comparison of employers and professionals on expected attitude

No	Tested Item	Mann-	Z	Probability	Inference

		Whitney U		of Similarity	
1	Think critically, creatively, reflectively (A1)	97	-0.9967798	0.318	Not different
2	Committed to lifelong learning (A2)	108	-0.4404716	0.659	Not different
3	Committed to ethic (A3)	109.5	-0.384774	0.700	Not different
4	Committed to environment (A4)	79.5	-1.5849487	0.112	Not different
5	Work with global perspectives (A5)	118.5	-0.0212126	0.983	Not different
6	Committed to professional skills (A6)	117	-0.0800857	0.936	Not different
7	Committed to different cultural groups (A7)	114.5	-0.1829153	0.854	Not different
8	Committed to group skills (A8)	78	-1.6476844	0.099	Not different
9	Committed to interpersonal skills (A9)	106.5	-0.5017211	0.615	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

5.3.1.10 Comparison of graduates and academicians on expected knowledge

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 73. The table shows several items including the probability of similarity between graduates' and academicians' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to understand the principles of management and business (K8). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 73 Comparison of graduates and academicians on expected knowledge

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Principles and concepts (K1)	822	-0.3324533	0.739	Not different
2	Basic science and engineering (K2)	728.5	-1.1992136	0.230	Not different
3	In-depth technical knowledge (K3)	851.5	-0.0598288	0.952	Not different
4	Problem solution (K4)	767.5	-0.8410343	0.400	Not different
5	Systems approach (K5)	848.5	-0.0877147	0.930	Not different
6	Sustainable design (K6)	714	-1.3272402	0.184	Not different
7	Laws, regulations and standards (K7)	765.5	-0.8521386	0.394	Not different
8	Management and business (K8)	612.5	-2.2643248	0.023 (<.05)	Different
9	Other disciplines (K9)	682.5	-1.6548108	0.097	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 74 which indicates that K8 is more expected by graduates than academicians.

Table 5- 74 Differences between graduates and academicians on expected knowledge

Stakeholder	Attribute Code	Mean	Median	Explanation
Graduates	K8	5.03	4.00	Graduates > Academicians
Academicians	K8	3.54	3.00	

Source: Description presented in Table 5- 36 and Table 5- 38

5.3.1.11 Comparison of graduates and academicians on expected skills

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 75. The table shows several items including the probability of similarity between graduates' and academicians' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to: communicate effectively not only with engineers but also with the community at large (S4); and function effectively in teams with the capacity to be a leader (S9). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 75 Comparison of graduates and academicians on expected skills

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Apply in-depth technical skills (S1)	800.5	-0.5301987	0.595	Not different
2	Use technologies (S2)	854	-0.0367899	0.970	Not different
3	Synthesise information (S3)	663	-1.8001116	0.071	Not different
4	Communicate effectively (S4)	598.5	-2.3900191	0.016 (<.05)	Different
5	Function as an individual (S5)	781.5	-0.7051719	0.480	Not different
6	Function in multi-disciplinary teams (S6)	815.5	-0.3922098	0.694	Not different
7	Function to be a member (S7)	649.5	-1.9253242	0.054	Not different
8	Function to be a manager (S8)	665	-1.7999771	0.071	Not different
9	Function to be a leader (S9)	617.5	-2.2502674	0.024 (<.05)	Different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 76 which indicates that: S4 is more expected by graduates than academicians; and S9 is more expected by graduates than academicians.

Table 5- 76 Differences between graduates and academicians on expected skills

Stakeholder	Attribute Code	Mean	Median	Explanation
Graduates	S4	6.72	7.00	Graduates >Academicians

Academicians	S4	5.69	6.00	
Graduates	S9	4.06	3.00	Graduates >Academicians
Academicians	S9	2.51	1.00	

Source: Description presented in Table 5- 44 and Table 5- 46

5.3.1.12 Comparison of graduates and academicians on expected attitude

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 77. The table shows several items including the probability of similarity between graduates' and academicians' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to work effectively with different cultural groups (A7); to use effective group skills in his or her workplace (A8); and to develop effective interpersonal skills in his or her workplace (A9). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 77 Comparison of graduates and academicians on expected attitude

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Think critically, creatively, reflectively (A1)	829	-0.2930546	0.769	Not different
2	Committed to lifelong learning (A2)	776	-0.7545018	0.450	Not different
3	Committed to ethic (A3)	773	-0.7827407	0.433	Not different
4	Committed to environment (A4)	857	-0.0092267	0.992	Not different
5	Work with global perspectives (A5)	745	-1.0470634	0.295	Not different
6	Committed to professional skills (A6)	807	-0.4695742	0.638	Not different
7	Committed to different cultural groups (A7)	591.5	-2.4634495	0.013 (<.05)	Different
8	Committed to group skills (A8)	590.5	-2.4620549	0.013 (<.05)	Different
9	Committed to interpersonal skills (A9)	608.5	-2.2986311	0.021 (<.05)	Different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 78 which indicates that: "Committed to different cultural groups" (A7) is more expected by graduates than academicians; "Committed to group skills" (A8) is more expected by graduates than academicians; and "Committed to interpersonal skills" (A9) is more expected by graduates than academicians.

Table 5- 78 Differences between graduates and academicians on expected attitude

Stakeholder	Attribute Code	Mean	Median	Explanation

Graduates	A7	4.00	4.00	Graduates > Academicians
Academicians	A7	2.94	2.00	
Graduates	A8	5.63	6.50	Graduates > Academicians
Academicians	A8	4.31	4.00	
Graduates	A9	5.63	6.00	Graduates > Academicians
Academicians	A9	4.40	4.00	

Source: Description presented in Table 5- 52 and Table 5- 54

5.3.1.13 Comparison of graduates and professionals on expected knowledge

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 79. The table shows several items including the probability of similarity between graduates' and professionals' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to understand: the principles and concepts (K1); and the principles of management and business (K8). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 79 Comparison of graduates and professionals on expected knowledge

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Principles and concepts (K1)	161	-2.2926612	0.021 (<.05)	Different
2	Basic science and engineering (K2)	193.5	-1.624416	0.104	Not different
3	In-depth technical knowledge (K3)	241.5	-0.6417549	0.521	Not different
4	Problem solution (K4)	189	-1.753147	0.079	Not different
5	Systems approach (K5)	181.5	-1.8651424	0.062	Not different
6	Sustainable design (K6)	237	-0.7393707	0.459	Not different
7	Laws, regulations and standards (K7)	261	-0.244107	0.807	Not different
8	Management and business (K8)	166	-2.1796157	0.029 (<.05)	Different
9	Other disciplines (K9)	218	-1.1332698	0.257	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 80 which indicates that: "Principles and concepts" (K1) is more expected by professionals than graduates; and "Other disciplines" (K9) is more expected by graduates than professionals.

Table 5- 80 Differences between graduates and professionals on expected knowledge

Stakeholder	Attribute Code	Mean	Median	Explanation

Graduates	K1	6.06	6.00	Graduates < Professionals
Professionals	K1	7.50	8.00	
Graduates	K8	5.03	4.00	Graduates > Professionals
Professionals	K8	3.25	2.50	

Source: Description presented in Table 5- 36 and Table 5- 40

5.3.1.14 Comparison of graduates and professionals on expected skills

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 81. The table shows several items including the probability of similarity between graduates' and professionals' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to: communicate effectively not only with engineers but also with the community at large (S4); and function effectively in teams with the capacity to be a leader (S9). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 81 Comparison of graduates and professionals on expected skills

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Apply in-depth technical skills (S1)	259.5	-0.274626	0.783	Not different
2	Use technologies (S2)	233	-0.8165905	0.414	Not different
3	Synthesise information (S3)	192.5	-1.642812	0.100	Not different
4	Communicate effectively (S4)	165.5	-2.2152602	0.026 (<.05)	Different
5	Function as an individual (S5)	242	-0.6318802	0.527	Not different
6	Function in multi-disciplinary teams (S6)	253	-0.4075724	0.683	Not different
7	Function to be a member (S7)	236.5	-0.7452773	0.456	Not different
8	Function to be a manager (S8)	220	-1.0849876	0.277	Not different
9	Function to be a leader (S9)	163.5	-2.2432555	0.024 (<.05)	Different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 82 which indicates that: "Communicate effectively" (S4) is more expected by professionals than graduates; and "Function to be a leader" (S9) is more expected by graduates than professionals.

Table 5- 82 Differences between graduates and professionals on expected skills

Stakeholder	Attribute Code	Mean	Median	Explanation
Graduates	S4	6.72	7.00	Graduates < Professionals
Professionals	S4	8.33	8.50	
Graduates	S9	4.06	3.00	Graduates > Professionals
Professionals	S9	1.75	1.50	

Source: Description presented in Table 5- 44 and Table 5- 48

5.3.1.15 Comparison of graduates and professionals on expected attitude

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 83. The table shows several items including the probability of similarity between graduates' and professionals' expectations for each variable. The inference indicates that between the two stakeholders, there is no difference in the importance of those competencies. The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 83 Comparison of graduates and professionals on expected attitude

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Think critically, creatively, reflectively (A1)	213.5	-1.3288974	0.183	Not different
2	Committed to lifelong learning (A2)	251	-0.4482743	0.653	Not different
3	Committed to ethic (A3)	178.5	-1.9338711	0.053	Not different
4	Committed to environment (A4)	234.5	-0.7835139	0.433	Not different
5	Work with global perspectives (A5)	186	-1.7899564	0.073	Not different
6	Committed to professional skills (A6)	254	-0.3875446	0.698	Not different
7	Committed to different cultural groups (A7)	193	-1.630692	0.102	Not different
8	Committed to group skills (A8)	204	-1.4058644	0.159	Not different
9	Committed to interpersonal skills (A9)	266	-0.1436256	0.885	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

5.3.1.16 Comparison of academicians and professionals on expected knowledge

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 84. The table shows several items including the probability of similarity between academicians' and professionals' expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to understand the problem identification, formulation and solution (K4); and how to utilise a systems approach to design and operational performance (K5). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 84 Comparison of academicians and professionals on expected knowledge

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Principles and concepts (K1)	214	-1.7400921	0.081	Not different
2	Basic science and engineering (K2)	288.5	-0.3616352	0.717	Not different
3	In-depth technical knowledge (K3)	269	-0.7144987	0.474	Not different

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
4	Problem solution (K4)	183	-2.3195128	0.020 (<.05)	Different
5	Systems approach (K5)	173.5	-2.4865205	0.012 (<.05)	Different
6	Sustainable design (K6)	210	-1.8007077	0.071	Not different
7	Laws, regulations and standards (K7)	257	-0.9420646	0.346	Not different
8	Management and business (K8)	257	-0.9464523	0.3439	Not different
9	Other disciplines (K9)	305.5	-0.0480497	0.961	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 85 which indicates that: “Problem solution” (K4) is more expected by professionals than academicians; and “Systems approach” (K5) is more expected by professionals than academicians.

Table 5- 85 Differences between academicians and professionals on expected knowledge

Stakeholder	Attribute Code	Mean	Median	Explanation
Academicians	K4	6.89	7.00	Academicians < Professionals
Professionals	K4	7.92	8.50	
Academicians	K5	4.63	5.00	Academicians < Professionals
Professionals	K5	5.17	5.50	

Source: Description presented in Table 5- 38 and Table 5- 40

5.3.1.17 Comparison of academicians and professionals on expected skills

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 86. The table shows several items including the probability of similarity between academicians’ and professionals’ expectations for each variable. The inference indicates that between the two stakeholders, there is a difference in the importance of ability to communicate effectively not only with engineers but also with the community at large (S4). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 86 Comparison of academicians and professionals on expected skills

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Apply in-depth technical skills (S1)	305.5	-0.0459675	0.963	Not different
2	Use technologies (S2)	254	-0.9898942	0.322	Not different
3	Synthesise information (S3)	290.5	-0.324737	0.745	Not different

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
4	Communicate effectively (S4)	108.5	-3.6629622	0.000 (<.05)	Different
5	Function as an individual (S5)	298.5	-0.1747316	0.861	Not different
6	Function in multi-disciplinary teams (S6)	295.5	-0.2304226	0.817	Not different
7	Function to be a member (S7)	270.5	-0.6911802	0.489	Not different
8	Function to be a manager (S8)	283	-0.4681187	0.639	Not different
9	Function to be a leader (S9)	290	-0.3451688	0.729	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The difference needs to be investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 87 which indicates that "Communicate effectively" (S4) is more expected by professionals than academicians.

Table 5- 87 Differences between academicians and professionals on expected skills

Stakeholder	Attribute Code	Mean	Median	Explanation
Academicians	S4	5.69	6.00	Academicians < Professionals
Professionals	S4	8.33	8.50	

Source: Description presented in Table 5- 46 and Table 5- 48

5.3.1.18 Comparison of academicians and professionals on expected attitude

The calculations of differences of the Mann-Whitney-U are presented in Table 5- 88. The table shows several items including the probability of similarity between academicians' and professionals' expectations for each variable. The inference indicates that between the two stakeholders, there is no difference in the importance of those competencies. The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.1.

Table 5- 88 Comparison of academicians and professionals on expected attitude

No	Tested Item	Mann-Whitney U	Z	Probability of Similarity	Inference
1	Think critically, creatively, reflectively (A1)	261	-0.9946634	0.319	Not different
2	Committed to lifelong learning (A2)	306.5	-0.0275402	0.978	Not different
3	Committed to ethic (A3)	235.5	-1.3469387	0.177	Not different
4	Committed to environment (A4)	265	-0.793068	0.427	Not different
5	Work with global perspectives (A5)	247.5	-1.1281952	0.259	Not different
6	Committed to professional skills (A6)	304.5	-0.064313	0.948	Not different
7	Committed to different cultural groups (A7)	271.5	-0.6774608	0.498	Not different
8	Committed to group skills (A8)	281.5	-0.4865665	0.626	Not different
9	Committed to interpersonal skills (A9)	204.5	-1.8986053	0.057	Not different

Source: Output of Mann-Whitney U calculated by the SPSS

The differences between stakeholders (employers, graduates, academicians and professionals) with the rankings of expected competence have been presented in sections 5.3.1.1 to 5.3.1.18. The differences were combined and discussed to achieve general information about the differences of stakeholders' expectation with ranking of graduates' competence. The combination and discussion were presented in section 6.3.1.

5.3.2. Analyses using Kruskal-Wallis-H

The Kruskal-Wallis-H was used to compare expectations among the four stakeholders. Because there were three attribute groups, this analysis will contain 3 sub-analyses presented from section 5.3.2.1 to section 5.3.2.3.

5.3.2.1 Comparison of all stakeholders on expected knowledge

The calculations of differences of the Kruskal-Wallis-H are presented in Table 5- 89. The table shows several items including the probability of similarity among four stakeholders' expectation for each variable. The inference indicates that among the four stakeholders, there is a difference in the importance of ability to understand the principles and concepts (K1). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.3.

Table 5- 89 Comparison of all stakeholders on expected knowledge

No	Tested Item	Chi-Square	df	Probability of Similarity	Inference
1	Principles and concepts (K1)	12.33	3	0.01	Different
2	Basic science and engineering (K2)	7.18	3	0.07	Not Different
3	In-depth technical knowledge (K3)	4.77	3	0.19	Not Different
4	Problem solution (K4)	3.69	3	0.30	Not Different
5	Systems approach (K5)	2.02	3	0.57	Not Different
6	Sustainable design (K6)	5.44	3	0.14	Not Different
7	Laws, regulations and standards (K7)	0.60	3	0.90	Not Different
8	Management and business (K8)	7.77	3	0.05	Not Different
9	Other disciplines (K9)	6.34	3	0.10	Not Different

Source: Output of Kruskal-Wallis-H calculated by the SPSS

The validated difference needs to be further investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 90 which indicates that "Principles and concepts" (K1) is more expected respectively by employers, professionals, academicians and graduates.

Table 5- 90 Differences of all stakeholders on expected knowledge

Attribute Code	Employers		Graduates		Academicians		Professionals		Explanation
K1	8.43	1	6.06	2	6.69	3	7.50	2	Employers > Professionals > Academicians > Graduates

Source: Description presented in Table 5- 34, Table 5- 36, Table 5- 38 and Table 5- 40

5.3.2.2 Comparison of all stakeholders on expected skills

The calculations of differences of the Kruskal-Wallis-H are presented in Table 5- 91. The table shows several items including the probability of similarity among four stakeholders' expectation for each variable. The inference indicates that among the four stakeholders, there is a difference in the importance of ability to: access, evaluate and synthesise information (S3); communicate effectively not only with engineers but also with the community at large (S4); and function effectively in teams with the capacity to be a leader (S9). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.3.

Table 5- 91 Comparison of all stakeholders on expected skills

No	Tested Item	Chi-Square	df	Probability of Similarity	Inference
1	Apply in-depth technical skills (S1)	4.68	3	0.20	Not Different
2	Use technologies (S2)	2.31	3	0.51	Not Different
3	Synthesise information (S3)	13.40	3	0.00	Different
4	Communicate effectively (S4)	16.09	3	0.00	Different
5	Function as an individual (S5)	3.90	3	0.27	Not Different
6	Function in multi-disciplinary teams (S6)	1.31	3	0.73	Not Different
7	Function to be a member (S7)	2.42	3	0.49	Not Different
8	Function to be a manager (S8)	7.37	3	0.06	Not Different
9	Function to be a leader (S9)	11.27	3	0.01	Different

Source: Output of Kruskal-Wallis-H calculated by the SPSS

The validated difference needs to be further investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 92 which indicates that: "Synthesise information" (S3) is more expected respectively by professionals, academicians, employers and graduates; "Communicate effectively" (S4) is more expected respectively by professionals, employers, graduates and academicians; and S9 is more expected respectively by graduates, academicians, employers and professionals.

Table 5- 92 Differences of all stakeholders on expected skills

Attribute Code	Employers		Graduates		Academicians		Professionals		Explanation
S3	6.71	2	4.94	6	6.94	1	7.08	2	Professionals > Academicians > Employers > Graduates
S4	7.57	1	6.72	1	5.69	5	8.33	1	Professionals > Employers > Graduates > Academicians
S9	2.50	8	4.06	8	2.51	9	1.75	9	Graduates > Academicians > Employers > Professionals

Source: Description presented in Table 5- 42, Table 5- 44, Table 5- 46 and Table 5- 48

5.3.2.3 Comparison of all stakeholders on expected attitude

The calculations of differences of the Kruskal-Wallis-H are presented in Table 5- 93. The table shows several items including the probability of similarity among four stakeholders' expectation for each variable. The inference indicates that among the four stakeholders, there is a difference in the importance of ability to: work effectively with different cultural groups (A7) and develop effective interpersonal skills in his or her workplace (A9). The inference is based on the probability of a similarity of less than 0.05. An example of the calculation can be seen in section 3.9.1.3.

Table 5- 93 Comparison of all stakeholders on expected attitude

No	Tested Item	Chi-Square	df	Probability of Similarity	Inference
1	Think critically, creatively, reflectively (A1)	3.07	3	0.38	Not Different
2	Committed to lifelong learning (A2)	6.59	3	0.09	Not Different
3	Committed to ethic (A3)	5.20	3	0.16	Not Different
4	Committed to environment (A4)	4.22	3	0.24	Not Different
5	Work with global perspectives (A5)	7.75	3	0.05	Not Different
6	Committed to professional skills (A6)	1.69	3	0.64	Not Different
7	Committed to different cultural groups (A7)	9.07	3	0.03	Different
8	Committed to group skills (A8)	7.13	3	0.07	Not Different
9	Committed to interpersonal skills (A9)	9.12	3	0.03	Different

Source: Output of Kruskal-Wallis-H calculated by the SPSS

The validated difference needs to be further investigated to discover which stakeholders more expect the ability. The results of investigation are presented in Table 5- 94 which indicates that: "Committed to different cultural groups" (A7) is more expected respectively by graduates, academicians, employers and professionals; and "Committed to interpersonal skills" (A9) is more expected respectively by employers, professionals, graduates and academicians.

Table 5- 94 Differences of all stakeholders on expected attitude

Attribute Code	Employers		Graduates		Academicians		Professionals		Explanation
A7	2.86	8	4.00	8	2.94	8	2.25	8	Graduates > Academicians > Employers > Professionals
A9	6.29	3	5.63	2	4.40	6	6.25	3	Employers > Professionals > Graduates > Academicians

Source: Description presented in Table 5- 50, Table 5- 52, Table 5- 54 and Table 5- 56

The differences among of stakeholders (employers, graduates, academicians and professionals) with the rankings of graduates' competence have been presented in sections 5.3.2.1 to 5.3.2.3. The differences were combined and discussed to achieve general information about the differences of stakeholders' expectation with ranking of graduates' competence . The combination and discussion were presented in section 6.3.2.

5.3.3. Summary of comparisons between stakeholders' expectations

This comparison found competencies that were expected differently by stakeholders of employers, graduates, academicians and professional separately. The stakeholders can be combined to form a wider stakeholders of the education.

Perception of the wider stakeholders must produce more reliable recommendations. Hence, all of stakeholders' perceptions in what competencies are differently expected by stakeholders of civil engineering education would be combined and discussed in section 6.3.3.

5.4. Investigation of the prioritised competencies

The aim of this analysis is to identify competencies (attributes) that should be prioritized based on expected and actual competence.

In this analysis, the competencies are categorized into knowledge, skills and attitude; while stakeholders are categorized into employers, graduates, academicians and professionals. The steps in this analysis can be categorized into three stages as shown in Figure 5- 5. The first is the establishment of validated rankings of expected competence; the second is the establishment of validated rankings of actual competence; and the third is calculation of the prioritized competencies. The first and the second stages have been conducted in sections 5.1 and 5.2. The calculation of priority is based logically that "if an expectation value on a variable is higher than the actual competence, the variable should be prioritized".

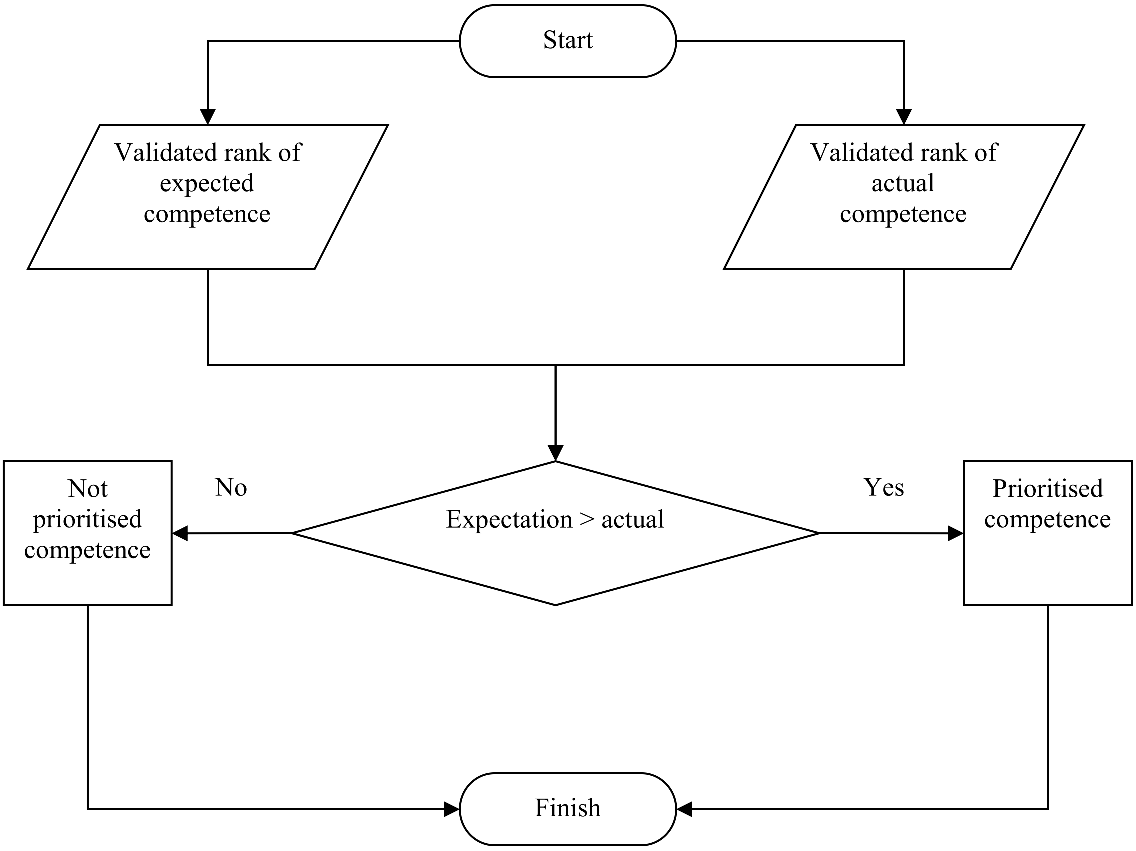

Figure 5- 5 Flowchart of competence prioritisation

As the variables of expected and actual competence are categorized into three groups and there are four stakeholders, the analysis will contain 12 sub-analyses.

5.4.1. Knowledge prioritised by stakeholders

As the data presented in sections 4.3 and 4.5, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.4.1.1 Knowledge prioritised by employers

The calculations in what graduates' knowledge should be improved based on employers' perception are presented in Table 5- 95. The table was developed based on the analyses in sections 5.1.1.1 and 5.2.1.1.

Table 5- 95 Knowledge prioritised by employers

Item / Attribute Code	Expectation	Competence	Inference
Principles and concepts (K1)	High	High	It should not be prioritised
Basic science and engineering (K2)	High	High	It should not be prioritised
In-depth technical knowledge (K3)	Somewhat	High	It should not be prioritised
Problem solution (K4)	High	Somewhat	It should be prioritised
Systems approach (K5)	Somewhat	Somewhat	It should not be prioritised
Sustainable design (K6)	Low	Somewhat	It should not be prioritised
Laws, regulations and standards (K7)	Somewhat	Low	It should be prioritised
Management and business (K8)	Low	Low	It should not be prioritised
Other disciplines (K9)	Low	Low	It should not be prioritised

Source: Description presented in Table 5- 34 and Table 5- 6

The table indicates that based on the employers' perception, two of seven areas of graduates' competence should be improved. The areas are ability: to understand the problem identification, formulation and solution (K4); and to understand the laws, regulations and standards (K7).

The indication is based on the level of the employers' expectation (Table 5- 34) and the employers' assessment with graduates' competence (Table 5- 6). Of the two areas, the area of "Problem solution" (K4) should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.2.1). Therefore, those areas, especially the area of "Problem solution" (K4), should be prioritised in civil engineering education.

5.4.1.2 Knowledge prioritised by graduates

The calculations in what graduates' knowledge should be improved based on graduates' perception are presented in Table 5- 96. The table was developed based on the analyses in sections 5.1.1.2 and 5.2.1.2.

Table 5- 96 Knowledge prioritised by graduates

Item / Attribute Code	Expectation	Competence	Inference
Principles and concepts (K1)	High	High	It should not be prioritised
Basic science and engineering (K2)	High	High	It should not be prioritised
In-depth technical knowledge (K3)	Somewhat	Somewhat	It should not be prioritised

Attribute Code \ Item	Expectation	Competence	Inference
Problem solution (K4)	High	High	It should not be prioritised
Systems approach (K5)	Low	Somewhat	It should not be prioritised
Sustainable design (K6)	Low	Low	It should not be prioritised
Laws, regulations and standards (K7)	Somewhat	Low	It should be prioritised
Management and business (K8)	Somewhat	Somewhat	It should not be prioritised
Other disciplines (K9)	Low	Low	It should not be prioritised

Source: Description presented in Table 5- 36 and Table 5- 8

The table indicates that based on the graduates' perception, one of seven areas of graduates' competence should be improved. The area is ability to understand the laws, regulations and standards (K7).

The indication is based on the level of the graduates' expectation (Table 5- 36) and the graduates' assessment with graduates' competence (Table 5- 8). Therefore, providers of civil engineering education should prioritise the area of "Laws, regulations and standards" (K7). Therefore, that area should be prioritised in civil engineering education.

5.4.1.3 Knowledge prioritised by academicians

The calculations in what graduates' knowledge should be improved based on academicians' perception are presented in Table 5- 97. The table was developed based on the analyses in sections 5.1.1.3 and 5.2.1.3.

Table 5- 97 Knowledge prioritised by academicians

Attribute Code \ Item	Expectation	Competence	Inference
Principles and concepts (K1)	High	High	It should not be prioritised
Basic science and engineering (K2)	High	High	It should not be prioritised
In-depth technical knowledge (K3)	Somewhat	High	It should not be prioritised
Problem solution (K4)	High	Somewhat	It should be prioritised
Systems approach (K5)	Somewhat	Low	It should be prioritised
Sustainable design (K6)	Somewhat	Somewhat	It should not be prioritised
Laws, regulations and standards (K7)	Low	Somewhat	It should not be prioritised
Management and business (K8)	Low	Low	It should not be prioritised
Other disciplines (K9)	Low	Low	It should not be prioritised

Source: Description presented in Table 5- 38 and Table 5- 10

The table indicates that based on the academicians' perception, two of seven areas of graduates' competence should be improved. The areas are ability to understand: the problem identification, formulation and solution (K4); and how to utilise a systems approach to design and operational performance (K5).

The indication is based on the level of the academicians' expectation (Table 5- 38) and the academicians' assessment with graduates' competence (Table 5- 10). Of the two areas, the area of "Problem solution" (K4) should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.2.1). Therefore, those areas, especially the area of "Problem solution" (K4), should be prioritised in civil engineering education.

5.4.1.4 Knowledge prioritised by professionals

The calculations in what graduates' knowledge should be improved based on professionals' perception are presented in Table 5- 98. The table was developed based on the analyses in sections 5.1.1.4 and 5.2.1.4.

Table 5- 98 Knowledge prioritised by professionals

Item / Attribute Code	Expectation	Competence	Inference
Principles and concepts (K1)	High	High	It should not be prioritised
Basic science and engineering (K2)	High	High	It should not be prioritised
In-depth technical knowledge (K3)	Somewhat	Somewhat	It should not be prioritised
Problem solution (K4)	High	High	It should not be prioritised
Systems approach (K5)	Somewhat	Somewhat	It should not be prioritised
Sustainable design (K6)	Low	Somewhat	It should not be prioritised
Laws, regulations and standards (K7)	Somewhat	Low	It should be prioritised
Management and business (K8)	Low	Low	It should not be prioritised
Other disciplines (K9)	Low	Low	It should not be prioritised

Source: Description presented in Table 5- 40 and Table 5- 12

The table indicates that based on the professionals' perception, one of seven areas of graduates' competence should be improved. The area is ability to understand the laws, regulations and standards (K7).

The indication is based on the level of the professionals' expectation (Table 5- 40) and the professionals' assessment with graduates' competence (Table 5- 12). Therefore, that area should be prioritised in civil engineering education.

The knowledge that should be prioritised by civil engineering education based on groups of stakeholders' perceptions have been presented in sections 5.1.1.1 to 5.1.1.4. The prioritised knowledge were combined and discussed to achieve general information about knowledge that should be prioritised by in civil engineering education. The combination and discussion were presented in section 6.4.1.

5.4.2. Skills prioritised by stakeholders

As the data presented in sections 4.3 and 4.5, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.4.2.1 Skills prioritised by employers

The calculations in what graduates' skills should be improved based on employers' perception are presented in Table 5- 99. The table was developed based on the analyses in sections 5.1.2.1 and 5.2.2.1.

Table 5- 99 Skills prioritised by employers

Item / Attribute Code	Expectation	Competence	Inference
Apply in-depth technical skills (S1)	High	High	It should not be prioritised
Use technologies (S2)	Somewhat	High	It should not be prioritised
Synthesise information (S3)	High	Somewhat	It should be prioritised
Communicate effectively (S4)	High	Low	It should be prioritised
Function as an individual (S5)	Somewhat	High	It should not be prioritised
Function in multi-disciplinary teams (S6)	Low	High	It should not be prioritised
Function to be a member (S7)	Somewhat	Somewhat	It should not be prioritised
Function to be a manager (S8)	Low	Low	It should not be prioritised
Function to be a leader (S9)	Low	Low	It should not be prioritised

Source: Description presented in Table 5- 42 and Table 5- 14

The table indicates that based on the employers' perception, two of seven areas of graduates' competence should be improved. The areas are ability to: access, evaluate and synthesise information (S3); and communicate effectively not only with engineers but also with the community at large (S4).

The indication is based on the level of the employers' expectation (Table 5- 42) and the employers' assessment with graduates' competence (Table 5- 14). Of the two areas, the area of "Communicate effectively" (S4) should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.2.2). Therefore, providers of civil engineering education should prioritise those areas especially the area of "Communicate effectively" (S4).

5.4.2.2 Skills prioritised by graduates

The calculations in what graduates' skills should be improved based on graduates' perception are presented in Table 5- 100. The table was developed based on the analyses in sections 5.1.2.2 and 5.2.2.2.

Table 5- 100 Skills prioritised by graduates

Item / Attribute Code	Expectation	Competence	Inference
Apply in-depth technical skills (S1)	Somewhat	Low	It should be prioritised
Use technologies (S2)	Somewhat	Low	It should be prioritised
Synthesise information (S3)	Somewhat	Somewhat	It should not be prioritised
Communicate effectively (S4)	High	Somewhat	It should be prioritised
Function as an individual (S5)	High	High	It should not be prioritised
Function in multi-disciplinary teams (S6)	Low	High	It should not be prioritised
Function to be a member (S7)	High	High	It should not be prioritised
Function to be a manager (S8)	Low	Low	It should not be prioritised
Function to be a leader (S9)	Low	Somewhat	It should not be prioritised

Source: Description presented in Table 5- 44 and Table 5- 16

The table indicates that based on the graduates' perception, three of seven areas of graduates' competence should be improved. The areas are ability to: Apply in-depth technical skills in at least one Civil Engineering discipline (S1); Use technologies appropriately (S2); and Communicate effectively not only with engineers but also with the community at large (S4)

The indication is based on the level of the graduates expectation (Table 5- 44) and the graduates' assessment with graduates' competence (Table 5- 16). Of the three areas, the area of "Communicate effectively" (S4) should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.2.2). Therefore, those areas, especially the area of "Communicate effectively" (S4), should be prioritised in civil engineering education.

5.4.2.3 Skills prioritised by academicians

The calculations in what graduates' skills should be improved based on academicians' perception are presented in Table 5- 101. The table was developed based on the analyses in sections 5.1.2.3 and 5.2.2.3.

Table 5- 101 Skills prioritised by academicians

Item / Attribute Code	Expectation	Competence	Inference
Apply in-depth technical skills (S1)	High	High	It should not be prioritised
Use technologies (S2)	High	High	It should not be prioritised
Synthesise information (S3)	High	Somewhat	It should be prioritised
Communicate effectively (S4)	Somewhat	Low	It should be prioritised
Function as an individual (S5)	Somewhat	Somewhat	It should not be prioritised
Function in multi-disciplinary teams (S6)	Low	Somewhat	It should not be prioritised
Function to be a member (S7)	Somewhat	High	It should not be prioritised
Function to be a manager (S8)	Low	Low	It should not be prioritised
Function to be a leader (S9)	Low	Low	It should not be prioritised

Source: Description presented in Table 5- 46 and Table 5- 18

The table indicates that based on the academicians' perception, two of seven areas of graduates' competence should be improved. The areas are ability to: access, evaluate and synthesise information (S3) and communicate effectively not only with engineers but also with the community at large (S4)

The indication is based on the level of the academicians' expectation (Table 5- 46) and the academicians' assessment with graduates' competence (Table 5- 18). Of the two areas, the area "Communicate effectively" (S4) should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.2.2). Therefore, those areas, especially the area of "Communicate effectively" (S4), should be prioritised in civil engineering education.

5.4.2.4 Skills prioritised by professionals

The calculations in what graduates' skills should be improved based on professionals' perception are presented in Table 5- 102. The table was developed based on the analyses in sections 5.1.2.4 and 5.2.2.4.

Table 5- 102 Skills prioritised by professionals

Item / Attribute Code	Expectation	Competence	Inference
Apply in-depth technical skills (S1)	Somewhat	High	It should not be prioritised
Use technologies (S2)	High	Somewhat	It should be prioritised
Synthesise information (S3)	High	High	It should not be prioritised
Communicate effectively (S4)	High	Low	It should be prioritised
Function as an individual (S5)	Low	Somewhat	It should not be prioritised
Function in multi-disciplinary teams (S6)	Somewhat	Somewhat	It should not be prioritised
Function to be a member (S7)	Somewhat	High	It should not be prioritised

Item / Attribute Code	Expectation	Competence	Inference
Function to be a manager (S8)	Low	Low	It should not be prioritised
Function to be a leader (S9)	Low	Low	It should not be prioritised

Source: Description presented in Table 5- 48 and Table 5- 20

The table indicates that based on the professionals' perception, two of seven areas of graduates' competence should be improved. The areas are ability to: use technologies appropriately (S2) and communicate effectively not only with engineers but also with the community at large (S4)

The indication is based on the level of the professionals' expectation (Table 5- 48) and the professionals' assessment with graduates' competence (Table 5- 20). Of the two areas, the area of "Communicate effectively" (S4) should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.2.2). Therefore, those areas, especially the area of "Communicate effectively" (S4), should be prioritised in civil engineering education.

The skills that should be prioritised by civil engineering education based on groups of stakeholders' perceptions have been presented in sections 5.1.1.1 to 5.1.1.4. The prioritised skills were combined and discussed to achieve general information about skills that should be prioritised by in civil engineering education. The combination and discussion were presented in section 6.4.2.

5.4.3. Attitude prioritised by stakeholders

As the data presented in sections 4.3 and 4.5, the stakeholders of civil engineering education were employers of civil engineering graduates, civil engineering graduates, academicians in civil engineering education and professionals related to civil engineering.

5.4.3.1 Attitude prioritised by employers

The calculations in what graduates' attitude should be improved based on employers' perception are presented in Table 5- 103. The table was developed based on the analyses in sections 5.1.3.1 and 5.2.3.1.

Table 5- 103 Attitude prioritised by employers

Attribute Code \ Item	Expectation	Competence	Inference
Think critically, creatively, reflectively (A1)	High	High	It should not be prioritised
Committed to lifelong learning (A2)	Somewhat	Low	It should be prioritised
Committed to ethic (A3)	High	High	It should not be prioritised
Committed to environment (A4)	Low	High	It should not be prioritised
Work with global perspectives (A5)	Low	Low	It should not be prioritised
Committed to professional skills (A6)	Somewhat	Somewhat	It should not be prioritised
Committed to different cultural groups (A7)	Low	Low	It should not be prioritised
Committed to group skills (A8)	Somewhat	Somewhat	It should not be prioritised
Committed to interpersonal skills (A9)	High	High	It should not be prioritised

Source: Description presented in Table 5- 50 and Table 5- 22

The table indicates that based on the employers' perception, one of seven areas of graduates' competence should be improved. The area is ability to: undertake lifelong learning (A2).

The indication is based on the level of the employers' expectation (Table 5- 50) and the employers' assessment with graduates' competence (Table 5- 22). The area of A2 should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.3.2). Therefore, that area of "Committed to lifelong learning" (A2) should be prioritized by civil engineering education.

5.4.3.2 Attitude prioritised by graduates

The calculations in what graduates' attitude should be improved based on graduates' perception are presented in Table 5- 104. The table was developed based on the analyses in sections 5.1.3.2 and 5.2.3.2.

Table 5- 104 Attitude prioritised by graduates

Attribute Code \ Item	Expectation	Competence	Inference
Think critically, creatively, reflectively (A1)	High	Low	It should be prioritised
Committed to lifelong learning (A2)	Somewhat	Low	It should be prioritised
Committed to ethic (A3)	Somewhat	High	It should not be prioritised
Committed to environment (A4)	Low	Somewhat	It should not be prioritised
Work with global perspectives (A5)	Low	Low	It should not be prioritised
Committed to professional skills (A6)	Somewhat	High	It should not be prioritised
Committed to different cultural groups (A7)	Low	High	It should not be prioritised
Committed to group skills (A8)	High	Somewhat	It should be prioritised
Committed to interpersonal skills (A9)	High	Somewhat	It should be prioritised

Source: Description presented in Table 5- 52 and Table 5- 24

The table indicates that based on the graduates' perception, two of seven areas of graduates' competence should be improved. The areas are ability to: Think critically, creatively, reflectively in their work (A1); Committed to undertake lifelong learning (A2); Committed to working effectively with different cultural groups (A7); and Committed to using effective group skills in his or her workplace (A8).

The indication is based on the level of the graduates' expectation (Table 5- 52) and the graduates' assessment with graduates' competence (Table 5- 24). Of the four areas, the area of "Committed to interpersonal skills" (A9) should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.3.2). Therefore, those areas, especially the area of "Committed to interpersonal skills" (A9), should be prioritised in civil engineering education.

5.4.3.3 Attitude prioritised by academicians

The calculations in what graduates' attitude should be improved based on academicians' perception are presented in Table 5- 105. The table was developed based on the analyses in sections 5.1.3.3 and 5.2.3.3.

Table 5- 105 Attitude prioritised by academicians

Item / Attribute Code	Expectation	Competence	Inference
Think critically, creatively, reflectively (A1)	High	High	It should not be prioritised
Committed to lifelong learning (A2)	High	Low	It should be prioritised
Committed to ethic (A3)	High	High	It should not be prioritised
Committed to environment (A4)	Somewhat	Somewhat	It should not be prioritised
Work with global perspectives (A5)	Low	Low	It should not be prioritised
Committed to professional skills (A6)	Somewhat	Somewhat	It should not be prioritised
Committed to different cultural groups (A7)	Low	Low	It should not be prioritised
Committed to group skills (A8)	Low	High	It should not be prioritised
Committed to interpersonal skills (A9)	Somewhat	Somewhat	It should not be prioritised

Source: Description presented in Table 5- 54 and Table 5- 26

The table indicates that based on the academicians' perception, one of seven areas of graduates' competence should be improved. The areas are ability to undertake lifelong learning (A2)

The indication is based on the level of the academicians' expectation (Table 5- 54) and the academicians' assessment with graduates' competence (Table 5- 26). The area of

"Committed to lifelong learning" (A2)should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.3.2). Therefore, the area of "Committed to lifelong learning" (A2) should be prioritized by civil engineering education.

5.4.3.4 Attitude prioritised by professionals

The calculations in what graduates' attitude should be improved based on professionals' perception are presented in Table 5- 106. The table was developed based on the analyses in sections 5.1.3.4 and 5.2.3.4.

Table 5- 106 Attitude prioritised by professionals

Item / Attribute Code	Expectation	Competence	Inference
Think critically, creatively, reflectively (A1)	High	High	It should not be prioritised
Committed to lifelong learning (A2)	Somewhat	Somewhat	It should not be prioritised
Committed to ethic (A3)	High	High	It should not be prioritised
Committed to environment (A4)	Somewhat	Somewhat	It should not be prioritised
Work with global perspectives (A5)	Low	Low	It should not be prioritised
Committed to professional skills (A6)	Low	High	It should not be prioritised
Committed to different cultural groups (A7)	Low	Low	It should not be prioritised
Committed to group skills (A8)	Somewhat	Low	It should be prioritised
Committed to interpersonal skills (A9)	High	Somewhat	It should be prioritised

Source: Description presented in Table 5- 56 and Table 5- 28

The table indicates that based on the professionals' perception, two of seven areas of graduates' competence should be improved. The areas are ability to use effective group skills in his or her workplace (A8) and to develop effective interpersonal skills in his or her workplace (A9)

The indication is based on the level of the professionals' expectation (Table 5- 56) and the professionals' assessment with graduates' competence (Table 5- 28). Of the two areas, the area "Committed to interpersonal skills" (A9) should be emphasized because the area significantly affects stakeholders' satisfaction (section 7.3.2). The stakeholders include employers of civil engineering graduates. Therefore, those areas, especially the area of "Committed to interpersonal skills" (A9), should be prioritised in civil engineering education.

The attitude that should be prioritised by civil engineering education based on groups of stakeholders' perceptions have been presented in sections 5.1.1.1 to 5.1.1.4. The prioritised attitude were combined and discussed to achieve general information about attitude that should be prioritised by in civil engineering education. The combination and discussion were presented in section 6.4.3.

5.4.4. Summary of investigation of the prioritised competencies

This investigation found several competencies that should be prioritised in civil engineering education based on respondents i.e. employers, graduates, academicians and professional separately. The respondents can be combined to form a wider stakeholders of the education.

Perception of the wider stakeholders must produce more reliable recommendations. Hence, all of stakeholders' perceptions in what competence should be prioritized would be combined and discussed in section 6.4.

5.5. Investigation of the stakeholders' satisfaction

The aim is to identify the relationship between stakeholders' satisfaction with graduates and performance graduates' job. In this analysis, stakeholders consist of employers and graduates. As presented in section 4.4, the stakeholders' satisfactions and the performance was measured in five levels. The performance consists of three factors or variables i.e. time, cost and quality. The performance is measured in five levels.

Steps in this analysis can be categorized into three stages as shown in Figure 5- 6. The first is the establishment of samples; the second is identification of data distribution; and the third is correlation calculations and validation.

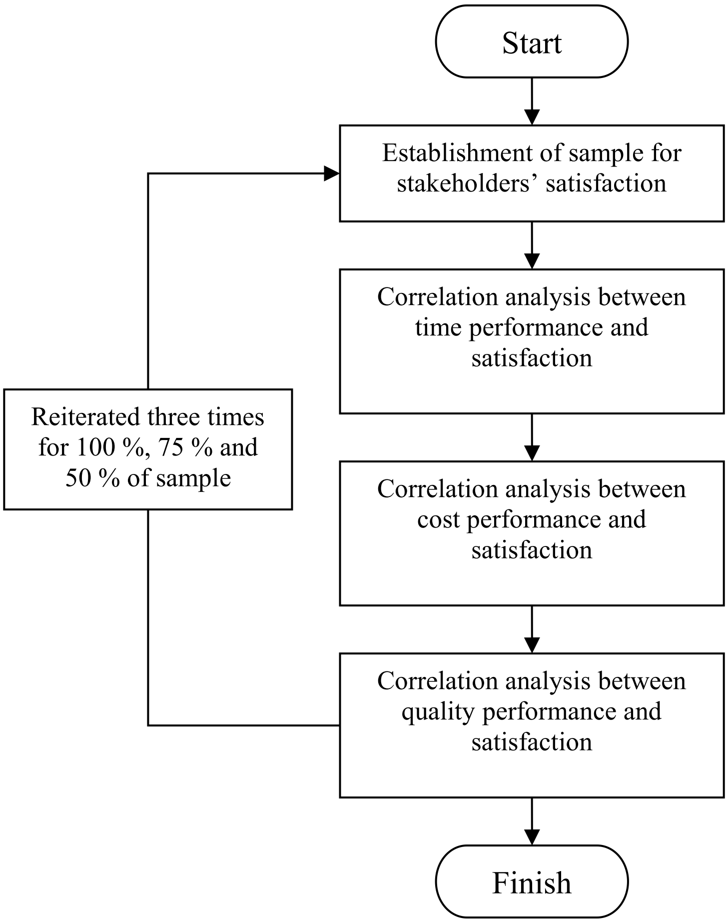

Figure 5- 6 Flowchart of satisfaction investigation

a) Samples of the investigation

As mentioned in the figure, there are three samples in the analysis. The first consists of 15 employers and 39 graduates; the second consists of 12 employers and 28 graduates; and the third consists of 9 employers and 18 graduates. The samples are presented in Table 5- 107. A sample selection was conducted by excluding the most outlier cases or data. As, there are three correlation in each sample, this analysis will contain 9 sub-analyses.

Table 5- 107 Samples for satisfaction analyses

No	Sample Code	Sample I	Sample II	Sample III
1	11000	Selected	Selected	Selected
2	11101	Selected	Selected	Selected
3	11122	Selected	Selected	Selected
4	11145	Selected	Selected	Selected
5	11152	Selected	-	-

No	Sample Code	Sample I	Sample II	Sample III
6	11156	Selected	Selected	Selected
7	11167	Selected	Selected	-
8	11170	Selected	Selected	-
9	11175	Selected	Selected	Selected
10	11177	Selected	Selected	Selected
11	11180	Selected	-	-
12	11276	Selected	-	-
13	11284	Selected	Selected	-
14	11293	Selected	Selected	Selected
15	11330	Selected	Selected	Selected
16	12000	Selected	Selected	Selected
17	12003	Selected	-	-
18	12005	Selected	Selected	Selected
19	12006	Selected	-	-
20	12007	Selected	Selected	Selected
21	12010	Selected	Selected	Selected
22	12013	Selected	Selected	-
23	12016	Selected	Selected	-
24	12017	Selected	Selected	Selected
25	12019	Selected	Selected	Selected
26	12021	Selected	Selected	-
27	12024	Selected	Selected	-
28	12025	Selected	-	-
29	12031	Selected	Selected	Selected
30	12034	Selected	-	-
31	12039	Selected	-	-
32	12042	Selected	Selected	-
33	12043	Selected	-	-
34	12046	Selected	Selected	-
35	12048	Selected	Selected	Selected
36	12060	Selected	Selected	Selected
37	12061	Selected	-	-
38	12062	Selected	Selected	-
39	12066	Selected	Selected	-
40	12069	Selected	Selected	Selected
41	12070	Selected	Selected	Selected
42	12075	Selected	Selected	Selected
43	12086	Selected	Selected	Selected
44	12087	Selected	Selected	-
45	12100	Selected	Selected	Selected
46	12105	Selected	-	-
47	12106	Selected	Selected	-
48	12107	Selected	-	-
49	12109	Selected	Selected	Selected
50	12117	Selected	Selected	Selected
51	12120	Selected	-	-
52	12122	Selected	-	-
53	12129	Selected	Selected	Selected
54	12130	Selected	Selected	Selected
Total	-	54 (100 %)	40 (±75 %)	27 (50%)

Source: Analysis of sample selection by excluding the outlier cases

b) Distribution and correlation

Distribution of the samples is presented in cross tabulation so that correlations between variables in columns and rows can be known. The correlation coefficient was calculated and validated using the Spearman Rank that the formulae of which have been presented in Equation 3- 7. An example of the calculation can be seen in section 3.9.2.

5.5.1. The relationship between Time performance and Satisfaction

As there were three samples for this investigation (Table 5- 107), the relationship between Time performance of graduates' job and stakeholders' satisfaction was examined in each sample.

5.5.1.1 The relationship in Sample I

The first relationship between time performance and satisfaction was investigated based on Sample I. The investigation initially conducted with cross tabulation containing values in the variables is presented in Table 5- 108. The table indicates that relationship between stakeholders' satisfaction and time performance of graduates' job is not strong. The indication can bee seen in several cases, the performance was very low when the satisfaction was very high. However, a statistical test must be conducted to know the correlation between them.

Table 5- 108 Distribution of Satisfaction and Time performance of Sample I

Satisfaction / Time performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low		1		1	2
Low			4	20	3
Somewhat			1	14	5
High					1
Very High				2	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 109 which shows sample number, correlation coefficient and probability of independence and inference. This test confirms that in Sample I, correlation between time performance of graduates' job and stakeholders' satisfaction is not strong and not significant. This condition makes it necessary to conduct the next test with Sample II.

Table 5- 109 Correlation tests between Satisfaction and Time performance

Item	First Test Explanation
Tested Variables	Time performance and satisfaction
Included Sample	15 employers + 39 graduates
Spearman Correlation Coef.	.153
Probability of Independence	.270 (> .05)
Inference	No significant correlation

Source: Output of Spearman R calculated by the SPSS

5.5.1.2 The relationship in Sample II

The second relationship between time performance of graduates' job and stakeholders' satisfaction was investigated based on Sample II. The investigation was initially conducted with cross tabulation containing values in the variables as presented in Table 5- 110. The table indicates that relationship between stakeholders' satisfaction and time performance of graduates' job is stronger. This is because the 14 outlier cases in Sample I were excluded. However, a statistical test must be conducted to know the correlation between them.

Table 5- 110 Distribution of Satisfaction in Time performance of Sample II

Satisfaction / Time Performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low		1			
Low			4	14	
Somewhat			1	14	3
High					1
Very High				2	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 111 which contains explanations of sample number, correlation coefficient and validation. This test confirms that in Sample II (75 % of Sample I), correlation between time performance of graduates' job and stakeholders' satisfaction is increase and significant. This condition needs to be confirmed with the next test with Sample III.

Table 5- 111 Correlation tests between Satisfaction and Time performance of Sample II

Item	Second Test Explanation
Tested Variables	Time performance and satisfaction
Included Sample	12 employers + 28 graduates

Item	Second Test Explanation
Spearman Correlation	.455
Probability of Independence	.003 (<.05)
Inference	Significant correlation

Source: Output of Spearman R calculated by the SPSS

5.5.1.3 The relationship in Sample III

The third relationship between time performance of graduates' job and stakeholders' satisfaction was investigated based Sample III. The investigation was initially conducted with cross tabulation containing values in the variables as presented in Table 5- 112. The table indicates that relationship between stakeholders' satisfaction and time performance of graduates' job is increase again. This is because the 13 outlier cases in Sample II were excluded However, a statistical test must be conducted to know the correlation between them.

Table 5- 112 Distribution of Satisfaction in Time performance of Sample III

Satisfaction / Time Performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low		1			
Low			4	5	
Somewhat			1	13	1
High					
Very High				2	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 113 which contains explanations of sample number, correlation coefficient and validation. This test confirms that in Sample III (50 % Sample I), correlation between time performance of graduates' job and stakeholders' satisfaction is stronger and significant. This condition confirms the correlation in Sample II.

Table 5- 113 Correlation tests between Satisfaction and Time performance of Sample III

Item	Third Test Explanation
Tested Variables	Time performance and satisfaction
Included Sample	9 employers + 18 graduates
Spearman Correlation	.531
Probability of Independence	.004 (<.05)
Inference	Significant correlation

Source: Output of Spearman R calculated by the SPSS

5.5.2. The relationship between Cost performance and Satisfaction

As there were three samples for this investigation (Table 5- 107), the relationship between Cost performance of graduates' job and stakeholders' satisfaction was examined in each sample.

5.5.2.1 The relationship in Sample I

The first relationship between cost performance and satisfaction was investigated based on Sample I. The investigation was initially conducted with cross tabulation containing values in the variables as presented in Table 5- 114. The table indicates that relationship between stakeholders' satisfaction and cost performance of graduates' job is not strong. This is because in several cases, the performance was very low when the satisfaction was very high. However, a statistical test must be conducted to know the correlation between them.

Table 5- 114 Distribution of Satisfaction in Cost performance of Sample I

Satisfaction / Cost performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low				1	3
Low		1	2	17	5
Somewhat			3	15	2
High				3	1
Very High				1	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 115 which contains explanations of sample number, correlation coefficient and validation. This test confirms that in Sample I, correlation between cost performance of graduates' job and stakeholders' satisfaction is not significant. This condition requires to conduct the next test with Sample II.

Table 5- 115 Correlation tests between Satisfaction and Cost performance of Sample I

Item	First Test Explanation
Tested Variables	Cost performance and satisfaction
Included Sample	15 employers + 39 graduates
Spearman Correlation	-.199
Probability of Independence	.149 (>.05)
Inference	No significant correlation

Source: Output of Spearman R calculated by the SPSS

5.5.2.2 The relationship in Sample II

The second relationship between cost performance of graduates' job and stakeholders' satisfaction was investigated based Sample II. The investigation was initially conducted with cross tabulation containing values in the variables as presented in Table 5- 116. The table indicates that relationship between stakeholders' satisfaction and cost performance of graduates' job is increase because the 14 outlier cases in Sample I were excluded. However, a statistical test must be conducted to know the correlation between them.

Table 5- 116 Distribution of Satisfaction in Cost performance of Sample II

Satisfaction / Cost Performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low					
Low		1	2	11	2
Somewhat			3	15	2
High				3	
Very High				1	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 117 which contains explanations of sample number, correlation coefficient and validation. This test confirms that in Sample II (75 % of Sample I), correlation between cost performance of graduates' job and stakeholders' satisfaction is increase but not significant. This condition indicates the need to conduct the next test with Sample III.

Table 5- 117 Correlation tests between Satisfaction and Cost performance of Sample II

Item	Second Test Explanation
Tested Variables	Cost performance and satisfaction
Included Sample	12 employers + 28 graduates
Spearman Correlation	.040
Probability of Independence	.805(>.05)
Inference	No significant correlation

Source: Output of Spearman R calculated by the SPSS

5.5.2.3 The relationship in Sample III

The third relationship between cost performance of graduates' job and stakeholders' satisfaction was investigated based on Sample III. The investigation was initially conducted with cross tabulation containing values in the variables as presented in Table 5- 118. The table indicates that relationship between stakeholders' satisfaction and cost performance of graduates' job is increase again. However, a statistical test must be conducted to know the correlation between them.

Table 5- 118 Distribution of Satisfaction in Cost performance of Sample III

Satisfaction / Cost performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low					
Low		1	2	5	
Somewhat			3	13	1
High				1	
Very High				1	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 119 which contains explanations of sample number, correlation coefficient and validation. This test confirms that in Sample III (50 % Sample I), correlation between cost performance of graduates' job and stakeholders' satisfaction is increase again.

Table 5- 119 Correlation tests between Satisfaction and Cost performance of Sample III

Item	Third Test Explanation
Tested Variables	Cost performance and satisfaction
Included Sample	9 employers + 18 graduates
Spearman Correlation	.284
Probability of Independence	.151(>.05)
Inference	No significant correlation

Source: Output of Spearman R calculated by the SPSS

5.5.3. The relationship between Quality performance and Satisfaction

As there were three samples for this investigation (Table 5- 107), the relationship between Quality performance of graduates' job and stakeholders' satisfaction was examined in each sample.

5.5.3.1 The relationship in Sample I

The first relationship between quality performance and satisfaction was investigated based on Sample I. The investigation was initially conducted with cross tabulation containing values in the variables as presented in Table 5- 120. The table indicates that relationship between stakeholders' satisfaction and quality performance of graduates' job is not strong. This is because in several cases, the performance was low when the satisfaction was high. However, a statistical test must be conducted to know the correlation between them.

Table 5- 120 Distribution of Satisfaction in Quality performance of Sample I

Satisfaction / Quality performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low					
Low		1		2	
Somewhat			3	22	4
High			2	10	7
Very High				3	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 121 which contains explanations of sample number, correlation coefficient and validation. This test confirms that in Sample I, correlation between quality performance of graduates' job and stakeholders' satisfaction is not significant. This condition requires the need to conduct the next test with Sample II.

Table 5- 121 Correlation tests between Satisfaction and Quality performance of Sample I

Item	First Test Explanation
Tested Variables	Quality performance and satisfaction
Included Sample	15 employers + 39 graduates
Spearman Correlation	.221
Probability of Independence	.108(>.05)
Inference	No significant correlation

Source: Output of Spearman R calculated by the SPSS

5.5.3.2 The relationship in Sample II

The second relationship between quality performance of graduates' job and stakeholders' satisfaction was investigated based on Sample II. The investigation was initially conducted with cross tabulation containing values in the variables as presented in Table 5- 122. The table indicates that relationship between stakeholders' satisfaction and quality performance of graduates' job is not increase significantly, although the 14 outlier cases in Sample I were excluded. However, a statistical test must be conducted to know the correlation between them.

Table 5- 122 Distribution of Satisfaction in Quality performance of Sample II

Satisfaction / Quality performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low					
Low		1		1	
Somewhat			3	17	1
High			2	9	3
Very High				3	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 123 which contains explanations of sample number, correlation coefficient and validation. This test confirms that in Sample II (75 % of Sample I), correlation between quality performance of graduates' job and stakeholders' satisfaction is not strong and not significant. This condition requires the need to conduct the next test with Sample III.

Table 5- 123 Correlation tests between Satisfaction and Quality performance of Sample II

Item	Second Test Explanation
Tested Variables	Quality performance and satisfaction
Included Sample	12 employers + 28 graduates
Spearman Correlation	.224
Probability of Independence	.165(>.05)
Inference	No significant correlation

Source: Output of Spearman R calculated by the SPSS

This correlation would be combined and discussed in section 6.5.

5.5.3.3 The relationship in Sample III

The third relationship between quality performance of graduates' job and stakeholders' satisfaction was investigated based on Sample III. The investigation was initially conducted with cross tabulation containing values in the variables as presented in Table 5- 124. The table indicates that relationship between stakeholders' satisfaction and quality performance of graduates' job is also not increase. However, a statistical test must be conducted to know the correlation between them.

Table 5- 124 Distribution of Satisfaction in Quality performance of Sample III

Satisfaction / Quality performance	Highly Unsatisfied	Unsatisfied	Not sure	Satisfied	Highly Satisfied
Very Low					
Low		1		1	
Somewhat			3	11	
High			2	5	1
Very High				3	

Source: Data presented in Table 4- 51 and Table 4- 55

The resume of the correlation is presented in Table 5- 125 which contains explanations of sample number, correlation coefficient and validation. This test confirms that in Sample III (50 % Sample I),, correlation between time performance and satisfaction is not increase significantly.

Table 5- 125 Correlation tests between Satisfaction and Quality performance of Sample III

Item	Third Test Explanation
Tested Variables	Quality performance and satisfaction
Included Sample	9 employers + 18 graduates
Spearman Correlation	.234
Probability of Independence	.240(>.05)
Inference	No significant correlation

Source: Output of Spearman R calculated by the SPSS

5.5.4. Summary of investigation of the stakeholders' satisfaction

This investigation found that the correlation between performance of graduates' job and stakeholders' satisfaction is vary. Each factor of performance has specific characteristics. This correlation would be combined and discussed in section 6.5.

5.6. Summary of data analysis

In this chapter, the data have been analysed and the results have been presented. The results are viewed as the findings of this study. The resume is shown in Table 5- 126.

Table 5- 126 Resume of data analysis

No	Data	Analyses	Findings	Sections
1	Graduates' competence	Description	Rankings of graduates' competence assessed by stakeholder groups	5.1.

No	Data	Analyses	Findings	Sections
2	Stakeholders' expectation	Description	Rankings of expected competence assessed by stakeholder groups	5.2.
3	Stakeholders' expectation	Comparison	Differences between stakeholders in expectation	5.3.
4	Competence and expectation	Comparison	Priority of competencies based on stakeholders' perceptions	5.4.
5	Performance and Satisfaction	Correlation	Relationship between graduates' performance and stakeholders' satisfaction	5.5.

Source: Analyses presented in chapter 5.

Rankings of graduates' competence and rankings of expected competence from each stakeholder groups need to be combined to achieve general information about the rankings. Rankings of graduates' competence will be compared with rankings of expected competence to know if the rankings of graduates' competence meet the expectations.

Differences between stakeholders in expectation need to be combined to achieve general information about the characteristics of stakeholders. Perceptions of stakeholders about competencies that should be mastered by civil engineering graduates also need to be discussed to get depth information about the perceptions. Relationships between graduates' performance and stakeholders' satisfaction need to be discussed to get information about characteristics of stakeholders' satisfaction.

Therefore, the findings of this study need to be discussed to achieve more reliable information about the findings . The discussion will be conducted in the next chapter.

6. DISCUSSION OF FINDINGS

This chapter discusses findings of this study achieved in chapter 5. The discussion will be addressed to achieve more reliable information about the findings As the objectives of this study, the analyses has found six finding groups. The discussion conducted in this chapter is shown in Table 6- 1.

Table 6- 1 Discussion of finding

Sections	Discussion
6.1	Rankings of graduates' competence
6.1.1	Ranking of graduates' knowledge
6.1.2	Ranking of graduates' skills
6.1.3	Ranking of graduates' attitudes
6.1.4	Validity of the rankings
6.1.5	Comparison among the rankings
6.1.6	Benefits of the rankings
6.2	Rankings of expected competence
6.2.1	Ranking of expected knowledge
6.2.2	Ranking of expected skills
6.2.3	Ranking of expected attitudes
6.2.4	Validity of the rankings
6.2.5	Comparison among the rankings
6.2.6	Benefits of the rankings
6.3	Difference of stakeholders in expectation
6.3.1	Analyses using Mann-Whitney-U
6.3.1.1	Difference of stakeholders in expectation of graduates' knowledge
6.3.1.2	Difference of stakeholders in expectation of graduates' skills
6.3.1.3	Difference of stakeholders in expectation of graduates' attitudes
6.3.2	Analyses using Kruskal-Wallis H
6.3.3	Combination of the results
6.3.3.1	Difference of stakeholders in expectation of graduates' knowledge
6.3.3.2	Difference of stakeholders in expectation of graduates' skills
6.3.3.3	Difference of stakeholders in expectation of graduates' attitudes
6.3.4	Validity of the findings
6.3.5	Comparison of among the findings
6.3.6	Benefits of the findings
6.4	Priority of competence
6.4.1	Graduates' knowledge prioritised by stakeholders
6.4.2	Graduates' skills prioritised by stakeholders
6.4.3	Graduates' attitudes prioritised by stakeholders
6.4.4	Validity of the findings
6.4.5	Comparison among the findings
6.4.6	Benefits of the findings
6.5	The relationship between graduates' performance and stakeholders' satisfaction
6.5.1	Finding of the relationship
6.5.2	Validity of the relationship

Sections	Discussion
6.5.3	Trends of the relationship
6.5.4	Benefits of the finding

As the sequence of this study, the theory, variables, data and analyses can affect the reliability of findings. Hence, problems related to the reliability of the findings can be traced on the development of theory, the establishing of variables, quality of data and correctness of the analyses.

6.1. Rankings of graduates' competence

The first objective of this study was to measure the quality of civil engineering graduates (section 1.3). To measure the quality, the quality was defined as competencies mastered by graduates (section 2.4.2.1), so the measurement was focused on the graduates' competence. The result of the measurement was viewed as actual or existing competence mastered by civil engineering graduates in the workplace.

The graduates' competence have been ranked (section 5.1) so that the strength and weakness of graduates' competence can be known. To discuss the rankings of graduates' competence, they are represented in Table 6- 2 to Table 6- 4 which show the ranking assessed by stakeholders i.e. employers, graduates, academicians and professionals. The ranking numbers indicate the order of graduates' competence level in the groups. Number 1 indicates competence that is the most mastered by graduates while number 9 is the least.

To get general information about ranking of graduates' competence, rankings form all stakeholders were combined and named as "Combined ranking". The combination was made based on the assessment of stakeholders i.e. employers, graduates, academicians and professionals with the same weight. The combined ranking is viewed as the ranking of graduates' competence assessed by stakeholders of civil engineering education. For simplicity in this discussion, the rankings in this finding can be simplified into 3 levels and still be valid (Santoso 2001). Rankings of 1, 2 and 3 are high level, 4, 5 and 6 are somewhat, and 7, 8 and 9 are low level. As theory of this study, the graduates' competence was divided into three groups, i.e. knowledge, skills and attitude.

6.1.1. Ranking of graduates' knowledge

Table 6- 2 shows the rankings of graduates' knowledge presented in the variable order. The table is a resume based on the results of analyses in sections 5.1.1.1, 5.1.1.2, 5.1.1.3 and 5.1.1.4.

Table 6- 2 Rankings of graduates' knowledge

Knowledge variable (Code)	Ranking by employers	Ranking by graduates	Ranking by academicians	Ranking by professionals	Combined ranking (Number)	Combined ranking (Term)
Principles and concepts (K1)	3	2	1	1	2	High
Basic science and engineering (K2)	1	1	2	2	1	High
In-depth technical knowledge (K3)	1	5	3	4	3	High
Problem solution (K4)	4	3	4	3	4	Moderate
Systems approach (K5)	5	6	8	5	5	Moderate
Sustainable design (K6)	6	8	6	6	6	Moderate
Laws, regulations and standards (K7)	7	6	5	7	7	Low
Management and business (K8)	9	4	7	9	8	Low
Other disciplines (K9)	8	9	9	8	9	Low

Source: Description presented in Table 5- 6, Table 5- 8, Table 5- 10 and Table 5- 12

The combined ranking in Table 6- 2 shows that graduates' competence to understand the principles of management and business (K8) was ranked as low competence category. This should be a concern in civil engineering education because graduates' competence in that area will significantly affect stakeholders' satisfaction (section 7.2.1) and graduates' performance (section 7.2.2). Therefore, graduates' competence in area of management and business should be improved in order to meet expectation of the stakeholders.

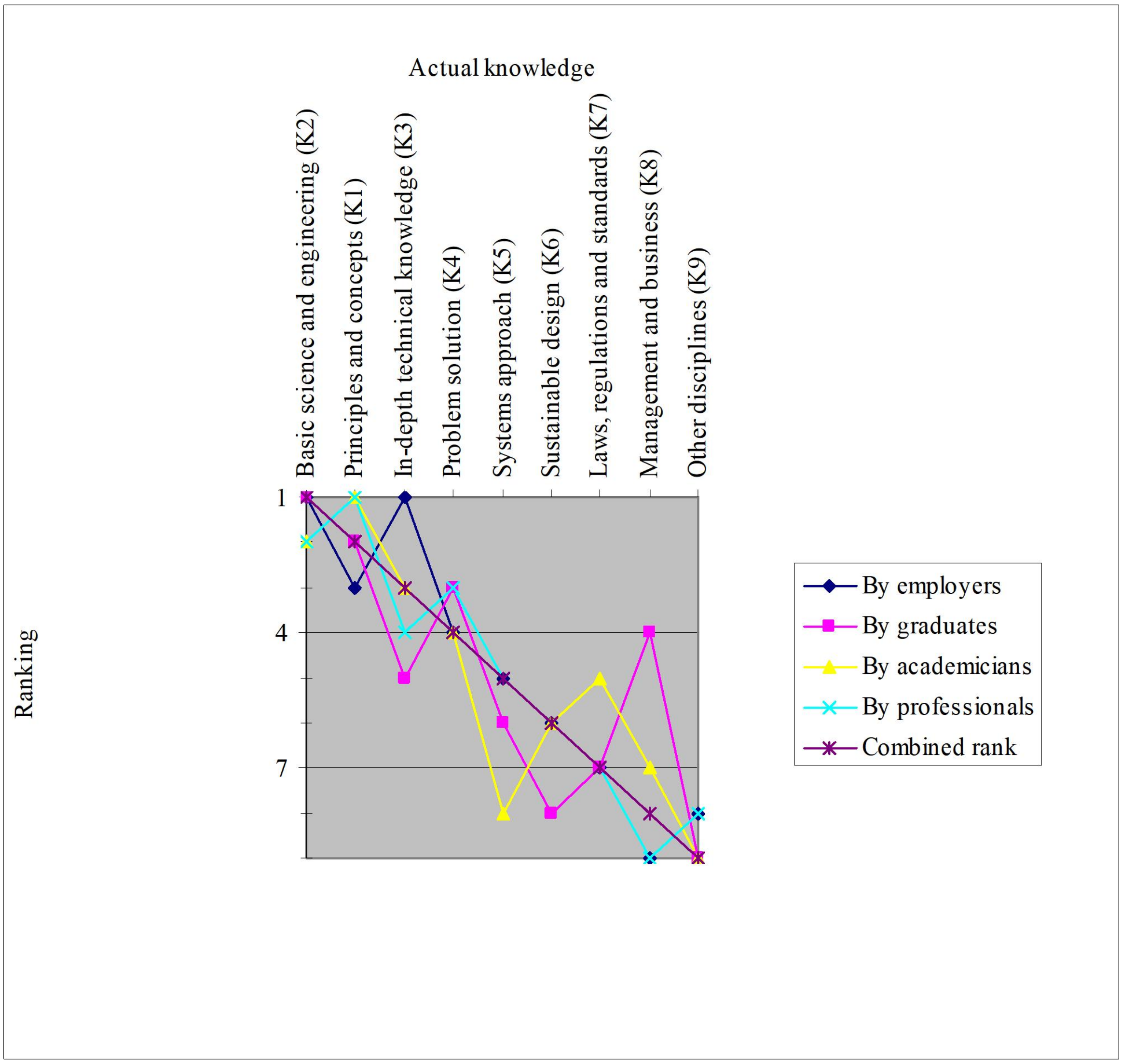

Figure 6- 1 Rankings of graduates' knowledge

Figure 6- 1 illustrates the content of Table 6- 2 in the order of the combined ranking. Based on the figure, the rankings of the variables "Basic science and engineering" (K2), "Problem solution" (K4) and "Other disciplines" (K9) show the least variation; while "Management and business" (K8) shows the most variation. This variation indicates the variation of graduates' competence. Therefore variation level in "Management and business" (K8) indicates that subjects related to "Management and business" in the civil engineering education is less standardised. This should be a concern because in graduates' ability in "Management and business" (K8) significantly affects stakeholders' satisfaction (section 7.2.1) and graduates' performance (section 7.2.2).

6.1.2. Ranking of graduates' skills

Table 6- 3 shows the rankings of graduates' skills presented in the variable order. The table is based on the results of analyses in sections 5.1.2.1, 5.1.2.2, 5.1.2.3 and 5.1.2.4.

Table 6- 3 Rankings of graduates' skills

Skill variables (Code)	Ranking by employers	Ranking by graduates	Ranking by academicians	Ranking by professionals	Combined ranking (Number)	Combined ranking (Term)
Apply in-depth technical skills (S1)	3	8	3	1	4	Moderate
Use technologies (S2)	5	7	1	6	6	Moderate
Synthesise information (S3)	4	5	6	2	5	Moderate
Communicate effectively (S4)	7	4	7	7	7	Low
Function as an individual (S5)	1	2	4	4	1	High
Function in multi-disciplinary teams (S6)	2	3	5	5	3	High
Function to be a member (S7)	6	1	2	3	2	High
Function to be a manager (S8)	9	9	9	9	9	Low
Function to be a leader (S9)	8	6	8	8	8	Low

Source: Description presented in Table 5- 14, Table 5- 16, Table 5- 18 and Table 5- 20

The combined ranking in Table 6- 3 shows that graduates' competencies: to communicate effectively not only with engineers but also with the community at large (S4); to function effectively in teams with the capacity to be a manager (S8); to function effectively in teams with the capacity to be a leader (S9) were ranked as a low competence category. This should be a concern in civil engineering education because graduates' competencies in those areas will significantly affect stakeholders' satisfaction (section 7.3.1). Therefore, graduates' competence in those areas should be improved in order to meet expectation of the stakeholders.

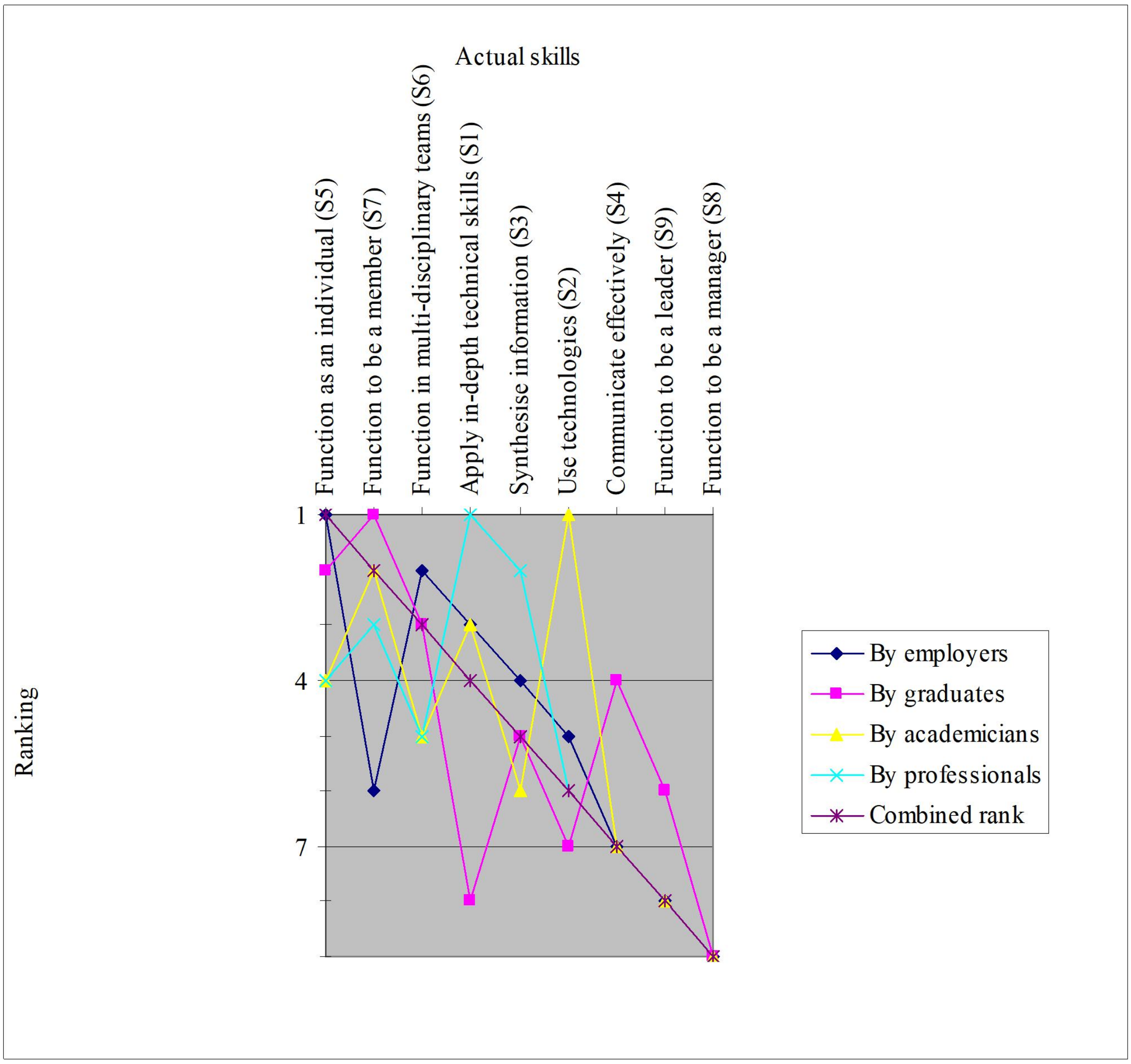

Figure 6- 2 Rankings of graduates' skills

Figure 6- 2 illustrates the content of Table 6- 3 in the order of the combined ranking. Based on the figure, the rankings of the variable "Function to be a manager" (S8) shows the least variation; while "Apply in-depth technical skills" (S1) shows the most variation. The variation indicates the variation of graduates' competence. Therefore, variation level in "Apply in-depth technical skills" (S1) indicates that subjects related to "Apply in-depth technical skills" in the civil engineering education is less standardised. However, standardisation is needed to improve the quality in education (Kelly 2008).

6.1.3. Ranking of graduates' attitudes

Table 6- 4 shows the rankings of graduates' attitude presented in the variable order. The table is based on the results of analyses in sections 5.1.3.1, 5.1.3.2, 5.1.3.3 and 5.1.3.4.

Table 6- 4 Rankings of graduates' attitude

Attitude variable (Code)	Ranking by employers	Ranking by graduates	Ranking by academicians	Ranking by professionals	Combined ranking (Number)	Combined ranking (Term)
Think critically, creatively, reflectively (A1)	3	7	1	2	3	High
Committed to lifelong learning (A2)	7	9	8	5	8	Low
Committed to ethic (A3)	2	2	2	3	1	High
Committed to environment (A4)	4	6	5	4	5	Moderate
Work with global perspectives (A5)	9	8	7	9	9	Low
Committed to professional skills (A6)	5	1	4	1	2	High
Committed to different cultural groups (A7)	8	3	9	8	7	Low
Committed to group skills (A8)	6	4	3	7	6	Moderate
Committed to interpersonal skills (A9)	1	5	6	6	4	Moderate

Source: Description presented in Table 5- 22, Table 5- 24, Table 5- 26 and Table 5- 28

The combined ranking in Table 6- 3 shows that graduates' competence to undertake lifelong learning (A2) was ranked as a low competence category. This should be a concern in civil engineering education because graduates' competence in that area will significantly affect stakeholders' satisfaction (section 7.4.1).

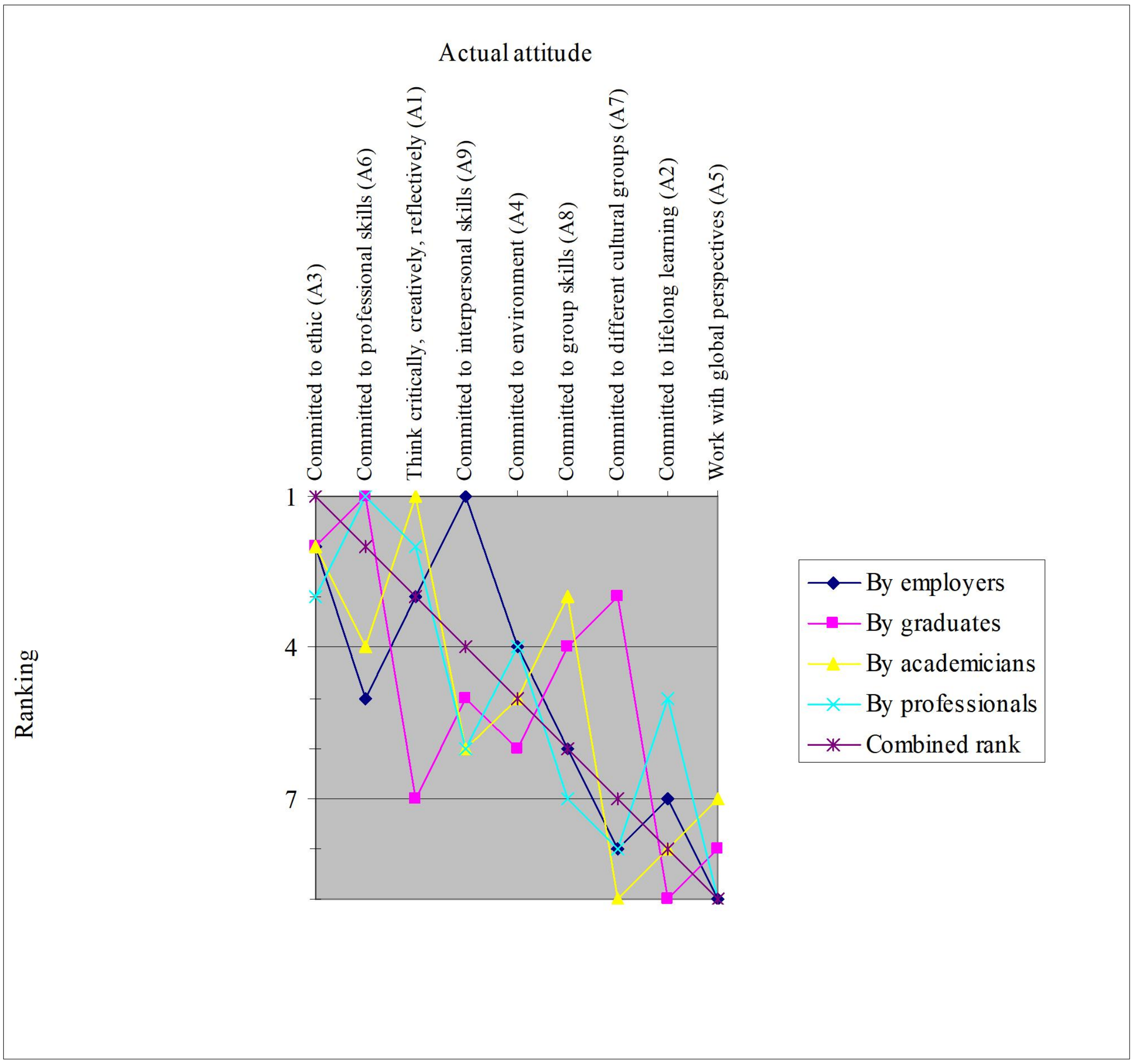

Figure 6- 3 Rankings of graduates' attitude

Figure 6- 3 illustrates the content of Table 6- 4 in the order of the combined ranking. Based on the figure, the rankings of the variables "Committed to ethic" (A3), "Committed to environment" (A4) and "Work in global perspectives" (A5) show the least variation while "Think critically, creatively, reflectively" (A1) and "Committed to different cultural groups" (A7) show the most variation. The variation indicates the variation of graduates' competence. Therefore, variation level in "Think critically, creatively, reflectively" (A1) and "Committed to different cultural groups" (A7) indicates that subjects to develop: students' ability to think critically, creatively, reflectively; and students' commitment to different cultural groups in the

civil engineering education is less standardised. However, standardisation is needed to improve the quality in education (Kelly 2008).

6.1.4. Validity of the rankings of graduates' competence

This finding is valid to represent rankings of graduates' actual competence because its concordance has been tested Kendall's W which is recommended by statisticians (Santoso 2001; Sugiyono 1999) as presented in section 5.1. Validity of this finding supports the hypothesis stated in section 3.1.1 that competence has many variables and that the levels of mastering the components are different. Because of the validity, it can be concluded that:

1. The number of variables and the divisions as shown in Table 2- 2 to Table 2- 4 are suitable in terms of data collection and analyses;

2. The data of this study presented in section 4.3 are adequate for analysis to rank graduates' competence;
3. The randomness and distribution of the data presented in section 4.3 are adequate to indicate the quality of data;
4. The methods used in this study including the analyses (section 3.9.1.2), measurements (Table 3- 7) and data collection (Table 3- 23) are appropriate.

6.1.5. Comparison among the rankings of graduates' competence

The comparison among three figures (Figure 6- 1, Figure 6- 2 and Figure 6- 3) reveals that variation of graduates' knowledge is the least. This may mean that knowledge competencies indicated by civil engineering graduates in the workplace are more uniform than skills or attitude. In other words, it indicates that skills or attitude competencies mastered by civil engineering graduates in the workplace have much variation. This could be caused by variety of curriculum and or learning methods during their education therefore efforts standardize skills and attitude should be undertaken (Kelly 2008).

6.1.6. Benefits of the rankings of graduates' competence

This finding can be used to know the strength and weakness of graduates' competence so that strategies could be decided to improve the quality of civil engineering graduates. The finding also can be used to obtain other information if combined with ranking of stakeholders' expectation with graduates' competence. By comparing this finding with ranking of stakeholders' expectation, gaps between actual and expected competence of graduates can be known. The gaps are problems that should be solved in order to improve the education. The comparison will be conducted in section 5.4.

6.2. Rankings of expected competence

The second objective of this study was to measure the stakeholders' expectations with civil engineering graduates' competence (section 1.3). The expectation was measured to know the importance levels or rankings of competence that should be mastered by graduates (2.4.2.2). The analyses in section 5.2 have found that the rankings is valid to represent the ranking of competence that should be mastered by graduates in the workplace. To discuss the rankings of expected competence, they are represented in Table 6- 5 to Table 6- 7 which show the rankings assessed by stakeholders i.e. employers, graduates, academicians and professionals. The ranking numbers indicate the order of importance level of competence that should be mastered by civil engineering graduates in the group. Number 1 indicates the most important competence that to be mastered by graduates in the group while number 9 is the least.

To get general information about ranking of stakeholders' expectation, rankings form all stakeholders were combined and named as "Combined ranking".

The combination was made based on the expectation of stakeholders i.e. employers, graduates, academicians and professionals with the same weight. The combined ranking is viewed as the ranking of graduates' competence expected by stakeholders of civil engineering education. For simplicity in this discussion, the rankings in this finding can be simplified into 3 levels and still be valid (Santoso 2001). Rankings of 1, 2 and 3 are high level, 4, 5 and 6 are somewhat, and 7, 8 and 9 are low level. As theory of this study, the graduates' competence was divided into three groups, i.e. knowledge, skills and attitude.

6.2.1. Ranking of expected knowledge

Table 6- 5 shows the rankings of graduates' knowledge expected by stakeholders presented in the variable order. The table is a resume based on the results of analyses in sections 5.2.1.1, 5.2.1.2, 5.2.1.3 and 5.2.1.4.

Table 6- 5 Rankings of expected knowledge

Knowledge variable (Code)	Ranking by employers	Ranking by graduates	Ranking by academicians	Ranking by professionals	Combined ranking (Number)	Combined ranking (Term)
Principles and concepts (K1)	1	2	3	2	2	High
Basic science and engineering (K2)	3	3	2	3	3	High
In-depth technical knowledge (K3)	4	5	4	5	4	Moderate
Problem solution (K4)	2	1	1	1	1	High
Systems approach (K5)	5	7	5	4	5	Moderate
Sustainable design (K6)	8	9	6	7	8	Low
Laws, regulations and standards (K7)	6	6	7	6	6	Moderate
Management and business (K8)	7	4	8	8	7	Low
Other disciplines (K9)	9	8	9	9	9	Low

Source: Description presented in Table 5- 34, Table 5- 36, Table 5- 38 and Table 5- 40

The combined ranking Table 6- 5 shows that graduates' competence in "Problem solution" (K4) is the most expected while graduates' competence in "Other disciplines" (K9) is the least expected by stakeholders. The table indicates that the ranking of knowledge expected by stakeholders is different with the ranking of knowledge mastered by graduates. Therefore, this ranking should be a concern for civil engineering education because graduates' competence to understand the problem identification, formulation and solution (K4) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the area is classified only as medium (section 6.1.1). Plus, competence in "Problem solution" (K4) affects significantly to stakeholders' satisfaction (section 7.2.1).

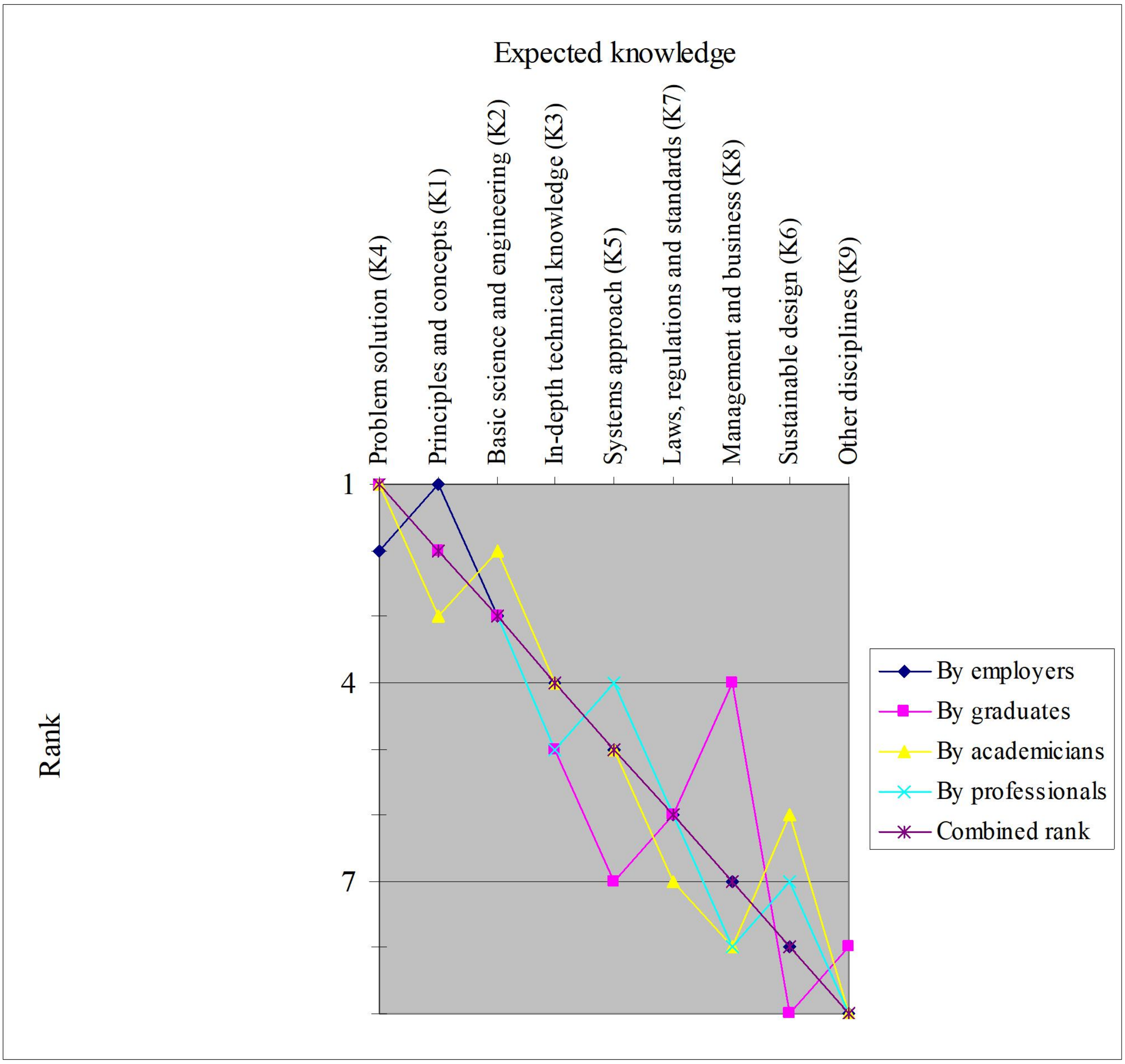

Figure 6- 4 Rankings of expected knowledge

Figure 6- 4 shows the content of Table 6- 5 in the order of the combined rankings. Based on the figure, the rankings of the variables "Problem solution" (K4), "Basic science and engineering" (K2), "In-depth technical knowledge" (K3), "Laws, regulations and standards" (K7) and "Other disciplines" (K9) show the least variation while "Management and business" (K8) shows the most variation. The variation indicates the variation of stakeholders' expectation. Therefore variation level in "Management and business" (K8) indicates that the importance "Management and business" in the civil engineering education has much variation. The variation may be caused by type of graduates' job.

6.2.2. Ranking of expected skills

Table 6- 6 shows the rankings of graduates' skills expected by stakeholders presented in the variable order. The table is a resume based on the results of analyses in sections 5.2.2.1, 5.2.2.2, 5.2.2.3 and 5.2.2.4.

Table 6- 6 Rankings of expected skills

Skill variables (Code)	Ranking by employers	Ranking by graduates	Ranking by academicians	Ranking by professionals	Combined ranking (Number)	Combined ranking (Term)
Apply in-depth technical skills (S1)	3	5	2	4	4	Moderate
Use technologies (S2)	4	4	3	3	3	High
Synthesise information (S3)	2	6	1	2	2	High
Communicate effectively (S4)	1	1	5	1	1	High
Function as an individual (S5)	5	2	4	7	5	Moderate
Function in multi-disciplinary teams (S6)	7	7	7	6	7	Low
Function to be a member (S7)	6	3	6	5	6	Moderate
Function to be a manager (S8)	9	9	8	8	8	Low
Function to be a leader (S9)	8	8	9	9	9	Low

Source: Description presented in Table 5- 42, Table 5- 44, Table 5- 46 and Table 5- 48

The combined ranking Table 6- 6 shows that graduates' competence in "Communicate effectively" (S4) is the most expected and graduates' competence in "Function to be a leader" (S9) is the least expected by stakeholders. The table indicates that the ranking of skills expected by stakeholders is different with the ranking of skills mastered by graduates. Therefore, this ranking should be a concern for civil engineering education because graduates' competencies: to use technologies appropriately (S2); to access, evaluate and synthesise information (S3); and to communicate effectively not only with engineers but also with the community at large (S4) were ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the areas is classified only as medium, medium and low respectably (section 6.1.2). Plus, graduates' competence in "Synthesise information" (S3) and "Communicate effectively" (S4) will affect significantly to stakeholders' satisfaction (section 7.3.1).

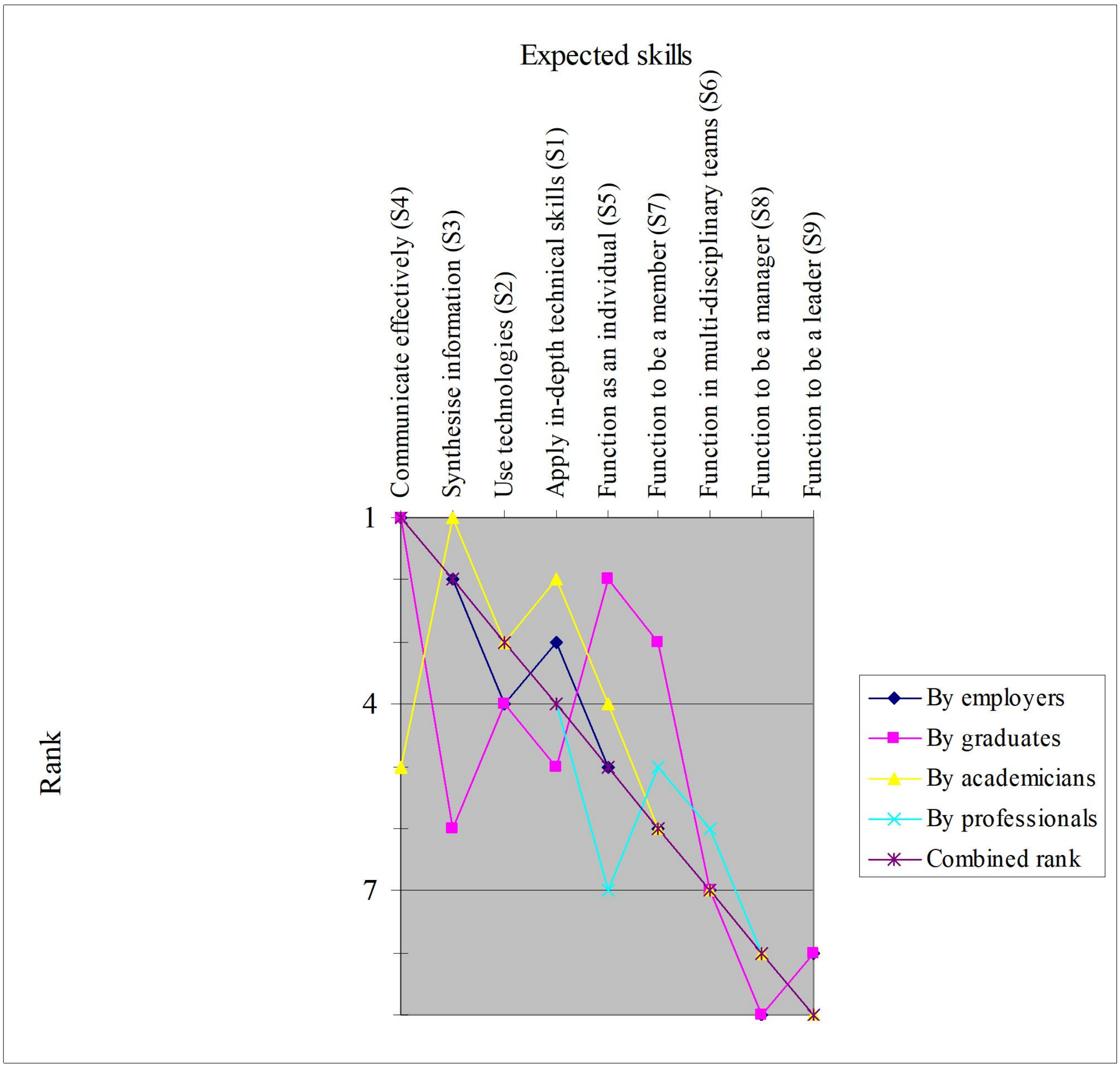

Figure 6- 5 Rankings of expected skills

Figure 6- 5 shows the content of Table 6- 6 in the order of the combined rankings. Based on the figure, the rankings of the variables “Use technologies” (S2), “Function in multi-disciplinary teams” (S6), “Function to be a manager” (S8) and “Function to be a leader” (S9) show the least variation while “Synthesise information” (S3) and “Function as an individual” (S5) show the most variation. The variation indicates the variation of stakeholders’ expectation. Therefore, variation level in “Synthesise information” (S3) and “Function as an individual” (S5) indicates that the importance “Synthesise information” and “Function as an individual” in the

civil engineering education has much variation. The variation may be caused by type of graduates' job.

6.2.3. Ranking of expected attitudes

Table 6- 7 shows the rankings of graduates' attitude expected by stakeholders presented in the variable order. The table is a resume based on the results of analyses in sections 5.2.3.1, 5.2.3.2, 5.2.3.3 and 5.2.3.4.

Table 6- 7 Rankings of expected attitude

Attitude variable (Code)	Ranking by employers	Ranking by graduates	Ranking by academicians	Ranking by professionals	Combined ranking (Number)	Combined ranking (Term)
Think critically, creatively, reflectively (A1)	1	1	1	1	1	High
Committed to lifelong learning (A2)	6	6	3	4	5	Moderate
Committed to ethic (A3)	2	4	2	2	2	High
Committed to environment (A4)	7	7	5	6	7	Low
Work with global perspectives (A5)	9	9	9	9	9	Low
Committed to professional skills (A6)	4	4	4	7	6	Moderate
Committed to different cultural groups (A7)	8	8	8	8	8	Low
Committed to group skills (A8)	4	2	7	5	4	Moderate
Committed to interpersonal skills (A9)	3	2	6	3	3	High

Source: Description presented in Table 5- 50, Table 5- 52, Table 5- 54 and Table 5- 56

The combined ranking Table 6- 7 also shows that graduates' competence to "Think critically, creatively, reflectively" (A1) is the most expected and graduates' competence to "Work with global perspectives" (A5) is the least expected by stakeholders. The table indicates that the ranking of attitude expected by stakeholders is different with the ranking of attitude mastered by graduates. Therefore, this ranking should be a concern for civil engineering education because graduates' competence to develop effective interpersonal skills in their workplace (A9) was ranked as a high important competence to be mastered by graduates. Whereas, the level of graduates' competence in the area is classified only as medium (section 6.1.3). Plus, competence in "Committed to interpersonal skills" (A9) affects significantly to stakeholders' satisfaction (section 7.4.1).

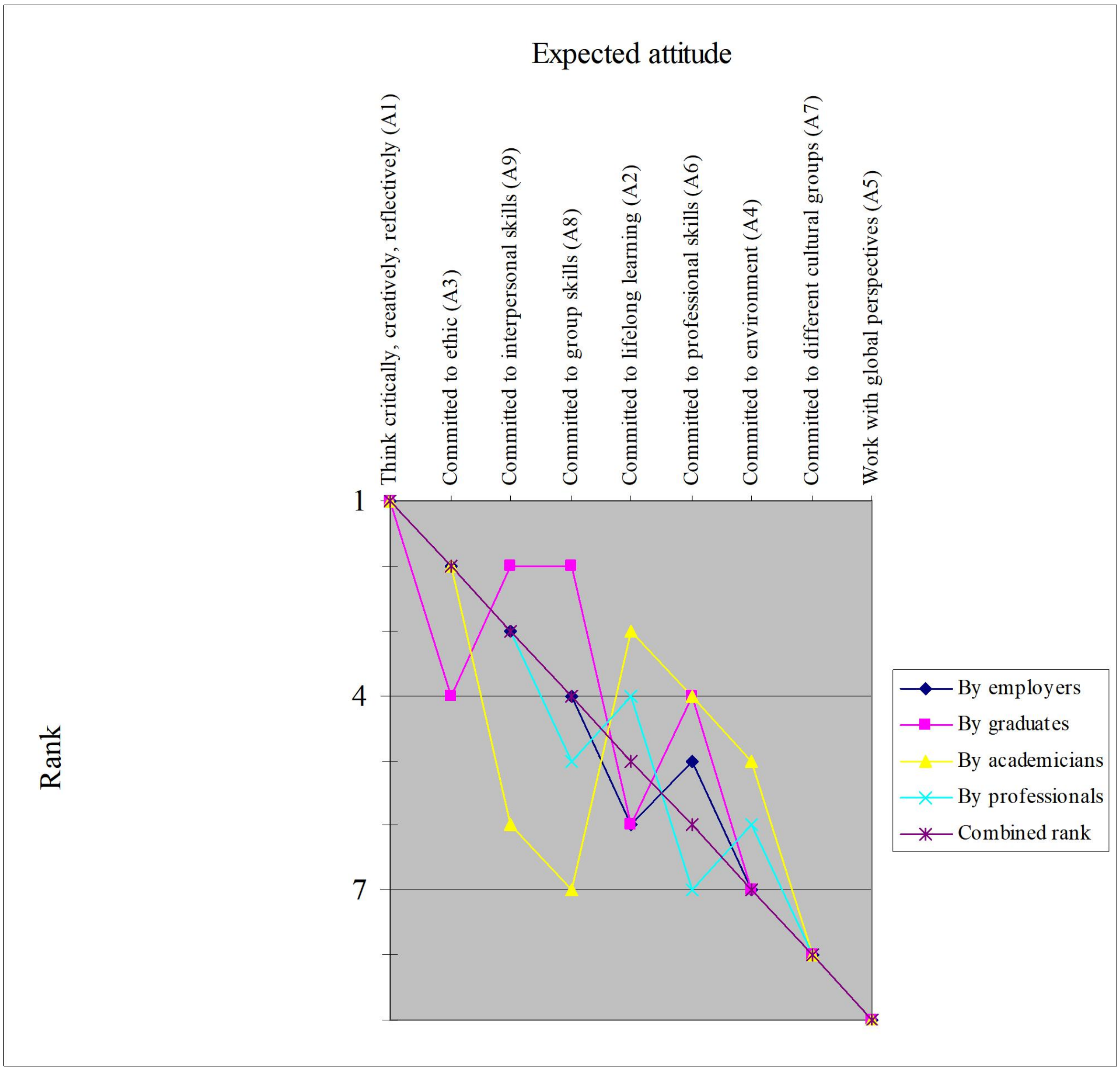

Figure 6- 6 Rankings of expected attitude competence

Figure 6- 6 shows the content of Table 6- 7 in the order of the combined rankings. Based on the figure, the rankings of the variables "Think critically, creatively, reflectively" (A1), "Committed to different cultural groups" (A7), and "Committed to professional skills" (A6) show the least variation while "Committed to group skills" (A8) shows the most variation. The variation indicates the variation of stakeholders' expectation. Therefore, variation level in "Committed to group skills" (A8) indicates that the importance "Committed to group skills" in

the civil engineering education has much variation. The variation may be caused by type of graduates' job.

6.2.4. Validity of the rankings of expected competence

This finding is valid to represent rankings of stakeholders' expectation with civil engineering graduates. The rankings can also be viewed as importance of competence that should be mastered by the graduates because its concordance has been tested with The Kendall's W (Coefficient of Concordance) which is recommended by statisticians (Santoso 2001; Sugiyono 1999) as presented in section 5.2. Validity of this finding supports the hypothesis stated in section 3.1.2 that the expectation on competence has many variables and that levels of importance of each component are different. Because of the validity, it can be concluded that:

1. The number of variables and the divisions as shown in Table 2-2 to Table 2-4 are suitable in terms of data collection and analyses;

2. The data of this study presented in section 4.5 are adequate for analysis to rank stakeholders' expectation;
3. The randomness and distribution of the data presented in section 4.5 are adequate to indicate the quality of data;
4. The methods used in this study including the analyses (section 3.9.1.2), measurements (Table 3-12) and data collection (Table 3-23) are appropriate.

6.2.5. Comparison among the rankings of expected competence

The comparison among the three figures reveals that the variation of expectation with knowledge is the least. This means that stakeholders' expectations on knowledge that should be mastered by graduates are more uniform than skills or attitude. In other words, it indicates that skills or attitude competencies expected by stakeholders in the workplaces have a great deal of variation. The differences of expectation among stakeholders has been analysed in section 5.3 and discussed in the section 6.3. The variation could be caused by variety of jobs undertaken by civil engineering graduates, therefore, studies to know what skills and attitudes that should be mastered by the graduates should be conducted.

6.2.6. Benefits of the rankings of expected competence

This finding can be used to know levels of stakeholders' expectation so that strategies could be decided to improve the quality of civil engineering graduates. The finding also can be used to obtain other information if combined with the other data such as ranking of graduates' competence. By comparing this finding with rankings of graduates' competence, gaps between actual and expected competence of graduates can be known. The gaps are problems that should be solved in order to improve the education. The comparison will be conducted in section 5.4.

6.3. Difference of stakeholders in expectation

The third objective of this study was to compare between groups of stakeholders in their expectations (section 1.3). The groups are employers, graduates, academicians, and professionals. The analyses in section 5.3 have found different expectations by the groups. The results of the analyses need to be compiled so that the finding can be easily discussed.

6.3.1. Analyses using Mann-Whitney-U

The findings of different expectations analysed using Man-Whitney U are shown in Table 6- 8 to Table 6- 10. As the theory of this study, the differences of stakeholders in their expectation are divided into three categories, i.e. knowledge, skills and attitudes.

6.3.1.1 Difference of stakeholders in expectation of graduates' knowledge

Table 6- 8 shows the codes of knowledge differently expected between stakeholders. The table is based on the analyses in sections 5.3.1.1, 5.3.1.4, 5.3.1.7, 5.3.1.10, 5.3.1.13 and 5.3.1.16. The meaning of the codes was presented in Table 2- 2.

Table 6- 8 Differences in knowledge importance between stakeholders

Stakeholder / Stakeholder	Graduates	Academicians	Professionals
Employers	"Principles and concepts" (K1) "Management and business" (K8)	"Principles and concepts" (K1)	"Problem solution" (K4)
Graduates	-	"Management and business" (K8)	"Principles and concepts" (K1) "Management and business" (K8)
Academicians	-	-	"Problem solution" (K4), "Systems approach" (K5)

Source: Analyses presented in sections 5.3.1.1, 5.3.1.4, 5.3.1.7, 5.3.1.10, 5.3.1.13 and 5.3.1.16

6.3.1.2 Difference of stakeholders in expectation of graduates' skills

Table 6- 9 shows the codes of skills differently expected between stakeholders. The table is based on the analyses in sections 5.3.1.2, 5.3.1.5, 5.3.1.8, 5.3.1.11, 5.3.1.14 and 5.3.1.17. The meaning of the codes was presented in Table 2- 3.

Table 6- 9 Differences in skills importance between stakeholders

Stakeholder / Stakeholder	Graduates	Academicians	Professionals
Employers	"Function to be a manager" (S8) ,"Function to be a leader" (S9)	"Communicate effectively" (S4)	-
Graduates	-	"Communicate effectively" (S4) "Function to be a leader" (S9)	"Communicate effectively" (S4), "Function to be a leader" (S9)
Academicians	-	-	"Communicate effectively" (S4)

Source: Analyses presented sections 5.3.1.2, 5.3.1.5, 5.3.1.8, 5.3.1.11, 5.3.1.14 and 5.3.1.17

6.3.1.3 Difference of stakeholders in expectation of graduates' attitudes

Table 6- 10 shows the codes of attitude differently expected between stakeholders. The table is based on the analyses in sections 5.3.1.3, 5.3.1.6, 5.3.1.9, 5.3.1.12, 5.3.1.15 and 5.3.1.18. The meaning of the codes was presented in Table 2- 4.

Table 6- 10 Differences in attitude importance between stakeholders

Stakeholder \ Stakeholder	Graduates	Academicians	Professionals
Employers	-	"Committed to group skills" (A8), "Committed to interpersonal skills" (A9)	-
Graduates	-	"Committed to different cultural groups" (A7), "Committed to group skills" (A8), "Committed to interpersonal skills" (A9)	-
Academicians	-	-	-

Source: Analyses presented in sections 5.3.1.3, 5.3.1.6, 5.3.1.9, 5.3.1.12, 5.3.1.15 and 5.3.1.18

6.3.2. Analyses using Kruskal-Wallis H

The findings of different expectations analysed using Kruskal-Wallis H are shown in Table 5- 89, Table 5- 91 and Table 5- 93. These findings have been combined so that differences can be easily noted.

6.3.3. Combination of the results

The combination, shown in Table 6- 11, Table 6- 12 and Table 6- 13 indicates that variables are different if the majority of valid tests state so.

6.3.3.1 Difference of stakeholders in expectation of graduates' knowledge

Table 6- 11 shows the knowledge competence differently expected by the four stakeholders. The table is based on the analysis in section 5.3.2.1 and Table 6- 8. The combination of the analyses indicates that variable K1 is expected differently by stakeholders.

Table 6- 11 Differences in knowledge importance among stakeholders

Attribute Code	Inference from section 5.3.2.1	Inference from Table 6- 8	Combination
Principles and concepts (K1)	Different (in 1/1 test)	Different (in 3/6 tests)	Different
Basic science and engineering (K2)	-	-	-
In-depth technical knowledge (K3)	-	-	-
Problem solution (K4)	-	Different (in 2/6 tests)	-
Systems approach (K5)	-	Different (in 1/6 tests)	-
Sustainable design (K6)	-	-	-
Laws, regulations and standards (K7)	-	-	-
Management and business (K8)	-	Different (in 3/6 tests)	-
Other disciplines (K9)	-	-	-

Source: Analyses presented in section 5.3.2.1 and Table 6- 8

The differences in expectation of "Principles and concepts" (K1) among stakeholders can be seen in Table 6- 5 showing that this variable is most expected by employers and least expected by academicians. The difference of stakeholders perception about importance level of variable "Principles and concepts" (K1) is unimportant because the variable does not significantly affect stakeholders' satisfaction (section 7.2.1).

6.3.3.2 Difference of stakeholders in expectation of graduates' skills

Table 6- 12 shows the skills competence differently expected by the four stakeholders. The table is based on the analysis in section 5.3.2.2 and Table 6- 9. The combination of the analyses indicates that variables S4 and S9 are expected differently by stakeholders.

Table 6- 12 Differences in skills importance among stakeholders

Attribute Code	Inference from section 5.3.2.2	Inference from Table 6- 9	Combination
Apply in-depth technical skills (S1)	-	-	-
Use technologies (S2)	-	-	-
Synthesise information (S3)	Different (in 1/1 test)	-	-
Communicate effectively (S4)	Different (in 1/1 test)	Different (in 4/6 tests)	Different
Function as an individual (S5)	-	-	-
Function in multi-disciplinary teams (S6)	-	-	-
Function to be a member (S7)	-	-	-
Function to be a manager (S8)	-	Different (in 1/6 tests)	-
Function to be a leader (S9)	Different (in 1/1 test)	Different (in 3/6 tests)	Different

Source: Analyses presented in section 5.3.2.2 and Table 6- 9

The differences in expectation of "Communicate effectively" (S4) and "Function to be a leader" (S9) among stakeholders can be seen in Table 6- 6. The table shows that variable "Communicate effectively" S4 is more expected by employers, graduates and professionals than by academicians and variable S9 is more expected by employers and graduates than by academicians and professionals. The difference of stakeholders perception about importance level of variables "Communicate effectively" (S4) and "Function to be a leader" (S9) should be concern because the variables significantly affect stakeholders' satisfaction (section 7.2.2).

6.3.3.3 Difference of stakeholders in expectation of graduates' attitudes

Table 6- 13 shows the attitude competence differently expected by the four stakeholders. The table is based on the analysis in section 5.3.2.3 and Table 6- 10. The combination of the

analyses indicates that no variable is expected differently by stakeholders but the analyses still indicate difference in some variables.

Table 6- 13 Differences in attitude importance among stakeholders

Attribute Code	Inference from section 5.3.2.3	Inference from Table 6- 10	Combination
Think critically, creatively, reflectively (A1)	-	-	-
Committed to lifelong learning (A2)	-	-	-
Committed to ethic (A3)	-	-	-
Committed to environment (A4)	-	-	-
Work with global perspectives (A5)	-	-	-
Committed to professional skills (A6)	-	-	-
Committed to different cultural groups (A7)	Different (in 1/1 test)	Different (in 1/6 tests)	-
Committed to group skills (A8)	-	Different (in 2/6 tests)	-
Committed to interpersonal skills (A9)	Different (in 1/1 test)	Different (in 2/6 tests)	-

Source: Analyses presented in section 5.3.2.3 and Table 6- 10

6.3.4. Validity of the findings

This finding is valid to represent different expectations among stakeholders because it has been statistically tested. The test was conducted using the Mann-Whitney-U and Kruskal-Wallis-H tests recommended by several statisticians (Santoso 2001; Sugiyono 1999). The expectation describes the importance of what competencies should be mastered by graduates

This valid finding also support the hypothesis stated in section 3.1.3. i.e. that the stakeholders have differences of expectation on what competencies should be mastered by civil engineering graduates. This finding is useful to understand the characteristic of stakeholders' expectation. Because of the validity, it can be concluded that:

1. The number of variables and the divisions as shown in Table 2-2 to Table 2-4 are suitable in terms of data collection and analyses;

2. The data of this study presented in section 4.5 are adequate for analysis to discover differences among stakeholders' expectation;
3. The randomness and distribution of the data presented in section 4.5 are adequate to indicate the quality of data;
4. The methods used in this study including the analyses (sections 3.9.1.1 and 3.9.1.3), measurements (Table 3-12) and data collection (Table 3-23) are appropriate.

6.3.5. Comparison of among the findings

By comparing the three tables (Table 6-11, Table 6-12 and Table 6-13), it reveals that in the skills factors, stakeholders have the greatest number of differences in variables that should be mastered by civil engineering graduates. This may mean that stakeholders' expectations on skills that should be mastered by graduates are more vary than knowledge or attitude. As stated in section 6.2, such a variation could be caused by the variety of jobs undertaken by the graduates. Therefore, what skills should be mastered by the should be further studied. Differences between stakeholders are often small but significant in details (Rodrigues, Oliveira & De Souza 2005).

6.3.6. Benefits of the findings

The differences of stakeholders' expectation can be used to understand characteristics of stakeholders. Understanding stakeholders' characteristics is an important step for providers of civil engineering education in efforts to improve their outcome.

6.4. Priority of competence

The fourth objective of this study was to select competencies that should be prioritised to be mastered by civil engineering graduates (section 1.3). The prioritised competencies were achieved based on comparison between rankings of expected competence and rankings of actual competence (section 5.4). The analyses in section 5.4 have found competencies that should be prioritised based on stakeholders' perceptions.

The findings of the analyses are shown in Table 6- 14 to Table 6- 16. The tables show the variables that are prioritized according to perceptions of stakeholders, i.e. employers, graduates, academicians, academicians, professionals and combinations of stakeholders. The combination would show "Prioritised" if a variable is prioritised by at least two stakeholders.

6.4.1. Graduates' knowledge prioritised by stakeholders

Table 6- 14 shows the knowledge should be prioritised in improvement of the quality of civil engineering graduates. The table is based on the results of analyses in sections 5.4.1.1, 5.4.1.2, 5.4.1.3 and 5.4.1.4. It shows that graduates' competence in "Problem solution" (K4) and "Laws, regulations and standards" (K7) should be prioritised by education institutions because the expectation rankings are higher than the actual one. Of the two variables, the variable "Problem solution" (K4) should be concern because graduates' competence in understanding the problem identification, formulation and solution will significantly affect stakeholders' satisfaction (section 7.2.1).

Table 6- 14 Priority of knowledge

Knowledge variable code	Employers	Graduates	Academicians	Professionals	Combination	Reliability
Principles and concepts (K1)	-	-	-	-	-	
Basic science and engineering (K2)	-	-	-	-	-	
In-depth technical knowledge (K3)	-	-	-	-	-	
Problem solution (K4)	Prioritised	-	Prioritised	-	Prioritised	100 %
Systems approach (K5)	-	-	Prioritised	-	-	
Sustainable design (K6)	-	-	-	-		
Laws, regulations and standards (K7)	Prioritised	Prioritised	-	Prioritised	Prioritised	50 %
Management and business (K8)	-	-	-	-	-	
Other disciplines (K9)	-	-	-	-	-	

Source: Analyses presented in sections 5.4.1.1, 5.4.1.2, 5.4.1.3 and 5.4.1.4

The reliability of this finding was measured by comparing the values of expectation and actual competence in each variable. The values of expectation and actual competence of the variables are shown in Figure 6- 7 and Figure 6- 8.

Figure 6- 7 shows the mean rankings of expectation and assessment of the “Problem solution” (K4), a prioritized variable in Table 6- 14. The figure shows that the expectations of all stakeholders are higher than actual graduate’ competence. This means that the reliability of prioritization of this variable is 100 %.

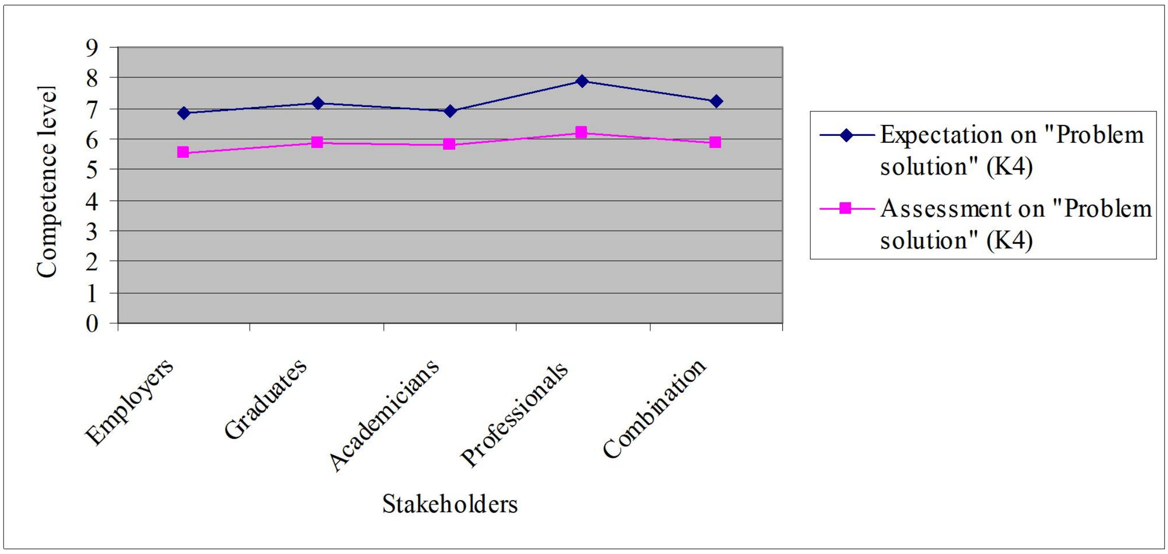

Figure 6- 7 Expectation and assessment in competence of “Problem solution” (K4)

Figure 6- 8 shows the mean rankings of expectation and assessment of the “Laws, regulations and standards” (K7), a prioritized variable in Table 6- 14. The figure shows that the expectations of two stakeholders are higher than actual graduate’ competence. This means that the reliability of prioritization of this variable is 50 %.

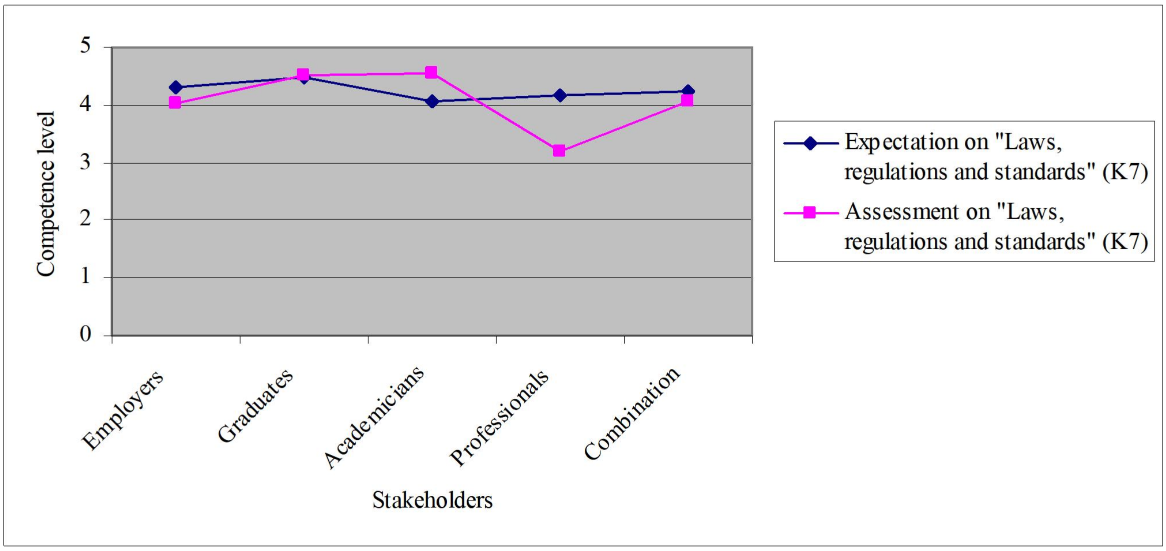

Figure 6- 8 Expectation and assessment in competence of “Laws, regulations and standards” (K7)

6.4.2. Graduates’ skills prioritised by stakeholders

Table 6- 15 shows the priority of skill variables. The table is based on results of analyses in section 5.4.2.1, 5.4.2.2, 5.4.2.3 and 5.4.2.4. The combination shows that variables “Use technologies” (S2), “Synthesise information” (S3) and “Communicate effectively” (S4) should be prioritized by the education institution because the expectation rankings are higher than the actual one. Of the three variables, the variable “Synthesise information” (S3) and “Communicate effectively” (S4) should be concern because graduates’ competence: to access, evaluate and synthesise information (S3); and to communicate effectively not only with engineers but also with the community at large (S4) will significantly affect stakeholders’ satisfaction (section 7.2.2).

Table 6- 15 Priority of skills

Skills variable code	Employers	Graduates	Academicians	Professionals	Combination	Reliability
Apply in-depth technical skills (S1)	-	Prioritised	-	-	-	
Use technologies (S2)	-	Prioritised	-	Prioritised	Prioritised	75 %
Synthesise information (S3)	Prioritised	-	Prioritised	-	Prioritised	100 %
Communicate effectively (S4)	Prioritised	Prioritised	Prioritised	Prioritised	Prioritised	100 %

Skills variable code	Employers	Graduates	Academicians	Professionals	Combination	Reliability
Function as an individual (S5)	-	-	-	-	-	
Function in multi-disciplinary teams (S6)	-	-	-	-	-	
Function to be a member (S7)	-	-	-	-	-	
Function to be a manager (S8)	-	-	-	-	-	
Function to be a leader (S9)	-	-	-	-	-	

Source: Analyses presented in sections 5.4.2.1, 5.4.2.2, 5.4.2.3 and 5.4.2.4

The reliability of this finding is measured by comparing the values of expectation and actual competence in each variable. The values of expectation and actual competence of the variables are shown in Figure 6- 9 to Figure 6- 11.

Figure 6- 9 shows the mean rankings of expectation and assessment of the variable "Use technologies" (S2), as a prioritized competence in Table 6- 15. The figure shows that the expectations of all stakeholders, except academicians, are higher than actual graduate' competence. This means that the reliability of prioritization of this variable is 75 %.

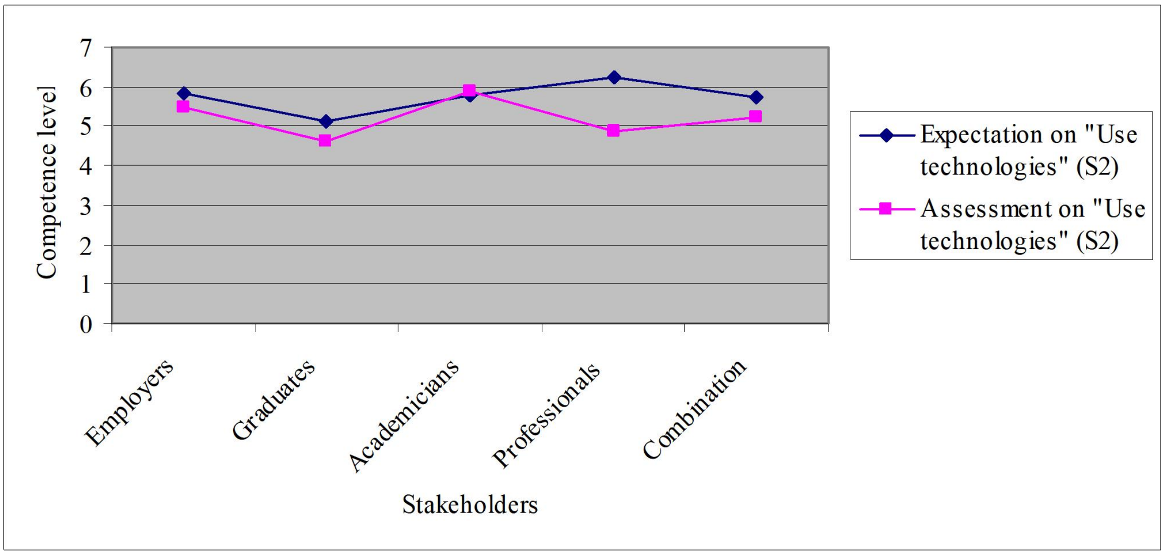

Figure 6- 9 Expectation and assessment in competence of "Use technologies" (S2)

Figure 6- 10 shows the mean rankings of expectation and assessment of the "Synthesise information" (S3) variable, as a prioritized competence in Table 6- 15. The figure shows that

the expectations of all stakeholders are higher than actual graduate' competence. This means that the reliability of prioritization of this variable is 100 %.

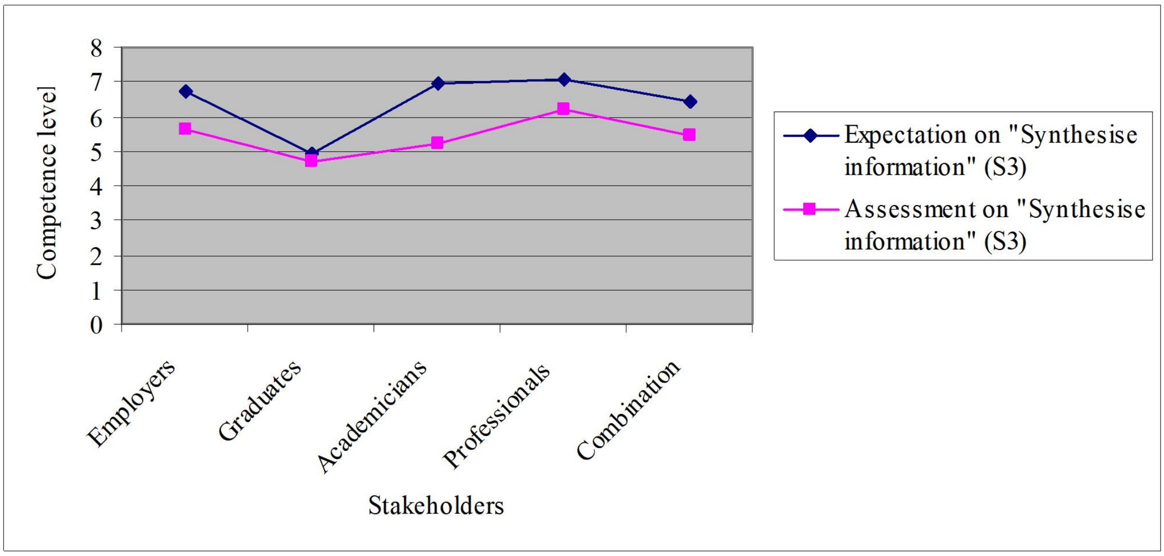

Figure 6- 10 Expectation and assessment in competence of "Synthesise information" (S3)

Figure 6- 11 shows the mean rankings of expectation and assessment of the "Communicate effectively" (S4) variable, as a prioritized competence in Table 6- 15. The figure shows that the expectations of all stakeholders are higher than actual graduate' competence. This means that the reliability of prioritization of this variable is 100 %.

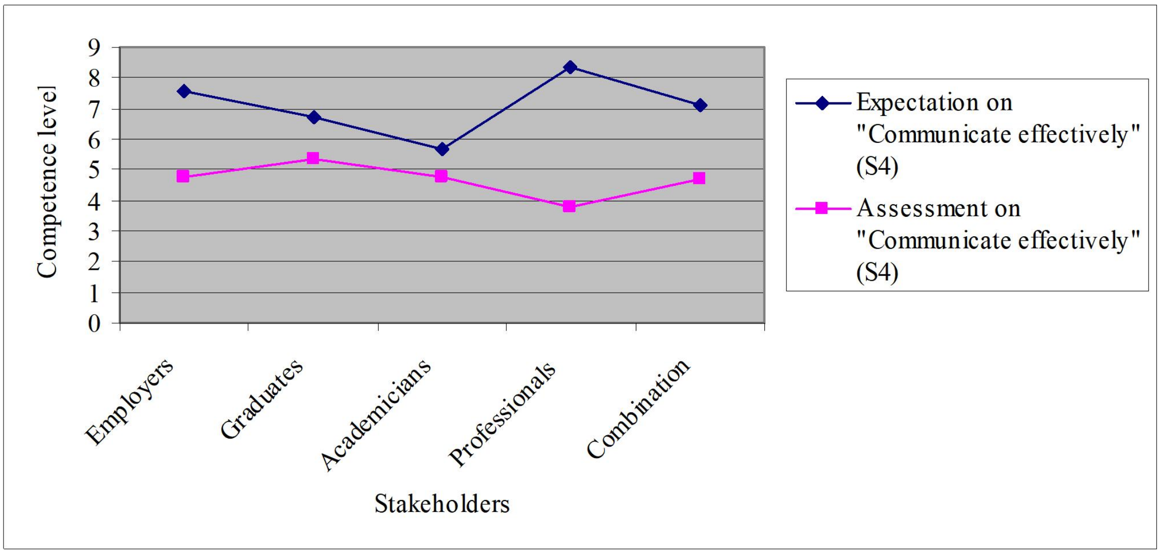

Figure 6- 11 Expectation and assessment in competence of "Communicate effectively" (S4)

6.4.3. Graduates' attitudes prioritised by stakeholders

Table 6- 16 shows the priority of attitude variables. The table is based on results of analyses in section 5.4.3.1, 5.4.3.2, 5.4.3.3 and 5.4.3.4. The combination shows that variables "Committed to lifelong learning" (A2), "Committed to group skills" (A8) and "Committed to interpersonal skills" (A9) should be prioritized by the education institution because expectation rankings are higher than the actual one. Of the three variables, the variable "Committed to lifelong learning" (A2) and "Committed to interpersonal skills" (A9) should be concern because graduates' competence: to develop effective interpersonal skills in his or her workplace (A9); and to undertake lifelong learning (A2) will significantly affect stakeholders' satisfaction (section 7.3.2).

Table 6- 16 Priority of attitude

Attitude variable code	Employers	Graduates	Academicians	Professionals	Combination	Reliability
Think critically, creatively, reflectively (A1)	-	Prioritised	-	-	-	-
Committed to lifelong learning (A2)	Prioritised	Prioritised	Prioritised	-	Prioritised	75 %
Committed to ethic (A3)	-	-	-	-	-	-
Committed to environment (A4)	-	-	-	-	-	-
Work with global perspectives (A5)	-	-	-	-	-	-
Committed to professional skills (A6)	-	-	-	-	-	-
Committed to different cultural groups (A7)	-	-	-	-	-	-
Committed to group skills (A8)	-	Prioritised	-	Prioritised	Prioritised	75 %
Committed to interpersonal skills (A9)	-	Prioritised	-	Prioritised	Prioritised	75 %

Source: Analyses presented in sections 5.4.3.1, 5.4.3.2, 5.4.3.3 and 5.4.3.4

The reliability of this finding is measured by comparing the values expectation and actual competence in of each variable. The values of expectation and actual competence of the variables are shown in Figure 6- 12 to Figure 6- 14.

Figure 6- 12 shows the mean rankings of expectation and assessment of the variable "Think critically, creatively, reflectively" (A1), as a prioritized competence in Table 6- 16. The

figure shows that the expectations of all stakeholders, except employers, are higher than actual graduate' competence. This means that the reliability of prioritization of this variable is 75 %.

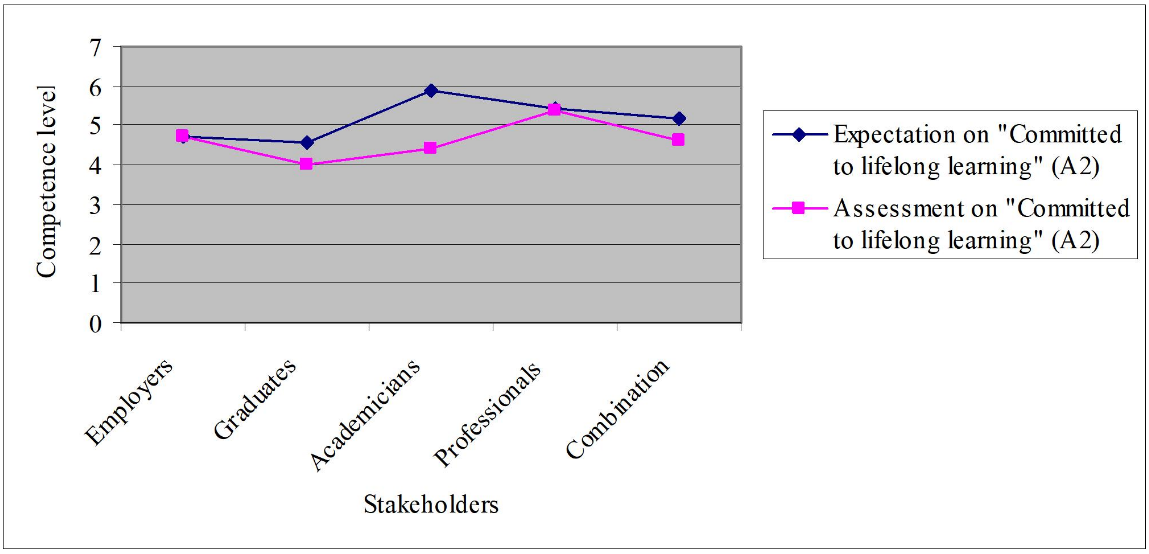

Figure 6- 12 Expectation and Assessment in competence of "Committed to lifelong learning" (A2)

Figure 6- 13 shows the mean rankings of expectation and assessment of the "Committed to group skills" (A8) variable, as a prioritized competence in Table 6- 16. The figure shows that the expectations of all stakeholders, except academicians, are higher than actual graduate' competence. This means that the reliability of prioritization of this variable is 100 %.

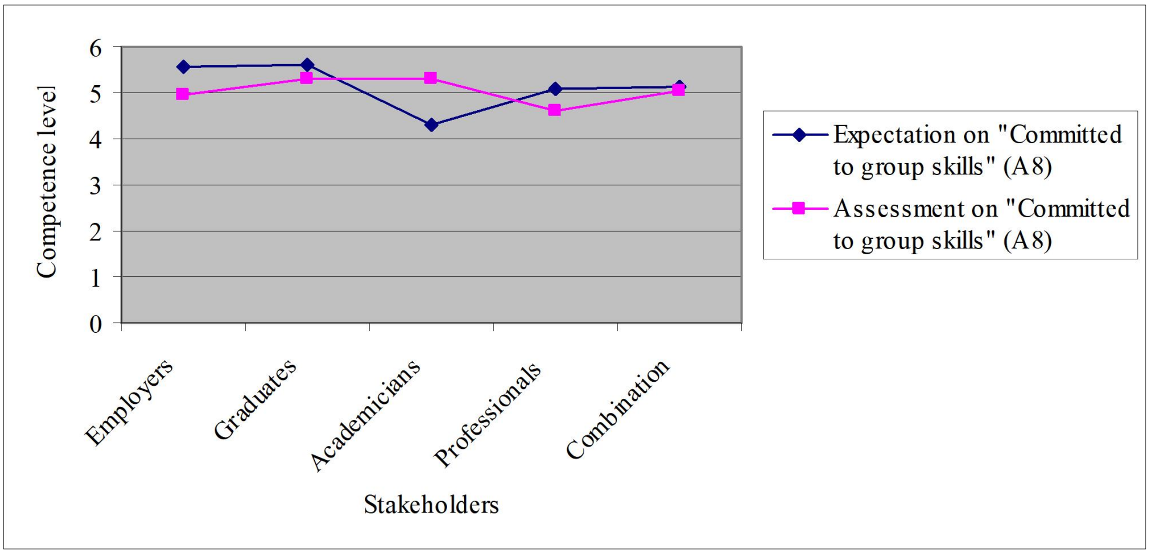

Figure 6- 13 Expectation and assessment in competence of "Committed to group skills" (A8)

Figure 6- 14 shows the mean rankings of expectation and assessment of the "Committed to interpersonal skills" (A9) variable, as a prioritized competence in Table 6- 16. The figure shows that the expectations of all stakeholders, except academicians, are higher than actual graduate' competence. This means that the reliability of prioritization of this variable is 100 %.

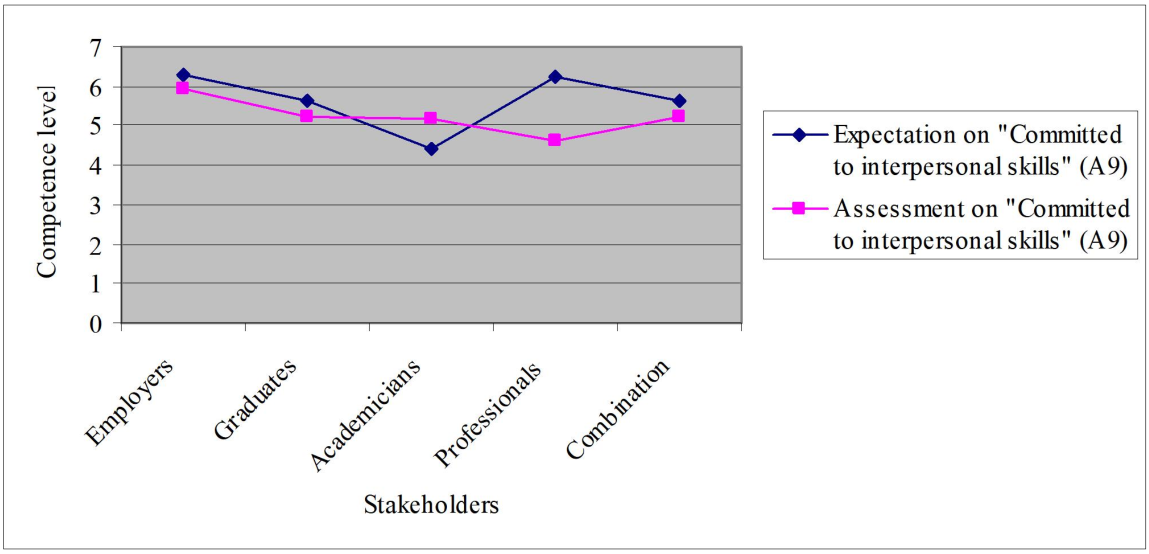

Figure 6- 14 Expectation and assessment in competence of "Committed to interpersonal skills" (A9)

6.4.4. Validity of the findings

This finding is valid to represent competencies that should be prioritised by education institution of civil engineering because the ranking of expectation and actual competence has been validated in sections 5.1, 5.2, 6.1 and 6.2. This finding also supports the hypothesis stated in section 3.1.4 that some competence variables should be prioritized because of gaps between expectation and actual competence. This finding is useful to know what kind of competence should be prioritized in education institution of Civil Engineering. Because of the validity, it can be concluded that:

1. The number of variables and the divisions as shown in Table 2-2 to Table 2-4 are suitable in terms of data collection and analyses;

2. The data of this study presented in sections 4.3 and 4.5 are adequate for analyses to discover competencies that should be prioritised by civil engineering education;
3. The randomness and distribution of the data presented in sections 4.3 and 4.5 are adequate to indicate the quality of data;
4. The methods used in this study including the analyses (5.4), measurements (Table 3-7 and Table 3-12) and data collection (Table 3-23) are appropriate.

6.4.5. Comparison among the findings

By comparing the three tables (Table 6-14, Table 6-15 and Table 6-16), it reveals that in civil engineering education, the skills and the attitudes should be prioritised than the knowledge. This means that in the skills and attitude, gaps between expectation and actual competence are bigger than in the knowledge. As has been mentioned in section 6.2.4 the gaps could be caused by variation in the jobs undertaken by civil engineering graduates. Therefore, competencies that should be prioritized should be concern of civil engineering education.

6.4.6. Benefits of the findings

The prioritised competence can be used to improve stakeholders' satisfaction. Improvement of stakeholders' satisfaction is an important in improvement of the quality of outcome of civil engineering education.

6.5. The relationship between graduates' performance and stakeholders' satisfaction

The fifth objective of this study was to investigate the relationship between graduates' performance and stakeholders' satisfaction(section 1.3). The analyses in section 5.5 have found the correlations between performance of graduates' job and stakeholders' satisfaction. The correlations need to be plotted to understand trends of the correlations.

6.5.1. Finding of the relationship

The findings of the relationship between performance and satisfaction are shown in Table 6- 17. The table is a resume of the analyses in section 5.5. The table shows the correlation coefficients between graduates' performance and stakeholders' satisfaction in variations of samples. The correlation tests were conducted using the Spearman Rho method recommended by several statisticians (Santoso 2001; Sugiyono 1999).

Table 6- 17 Correlation between performance and satisfaction in sample percentages

Correlation / Sample	Time performance of graduates' job and Stakeholders' satisfaction	Cost performance of graduates' job and Stakeholders' satisfaction	Quality performance of graduates' job and Stakeholders' satisfaction
100 %	.153	-.199	.221
75 %	.455	.040	.224
50 %	.531	.284	.234

Source: Output of Spearman R calculated by SPSS

The variations of samples from 100 % to 75 % were made by excluding the 14 most outlier cases. The variations of samples 75 % and 50 % were made by excluding the 13 most outlier cases. The samples used in these analyses were presented in Table 5- 107. The variations are needed to obtain the trends of the relationship.

Based on the table and figure, when the outlier data were excluded, the correlation between the performance of graduates job and the stakeholders' satisfaction is increase. The reliability of the correlations was conducted by interpreting the trends of the correlation between performance and satisfaction. The trends can be easily seen in Figure 6- 15. In entire samples (100 % samples), correlations between the variables of performance and satisfaction are weak. Then 25 % of most outlier samples are excluded. In 75 % of the samples, correlation between the variables of performance and satisfaction increase except for quality performance. In 50 % of samples, correlations between the variables of performance and satisfaction increase again except for quality performance. If outlier cases in the samples are excluded, the correlations proportionally increase as can be viewed in the figure.

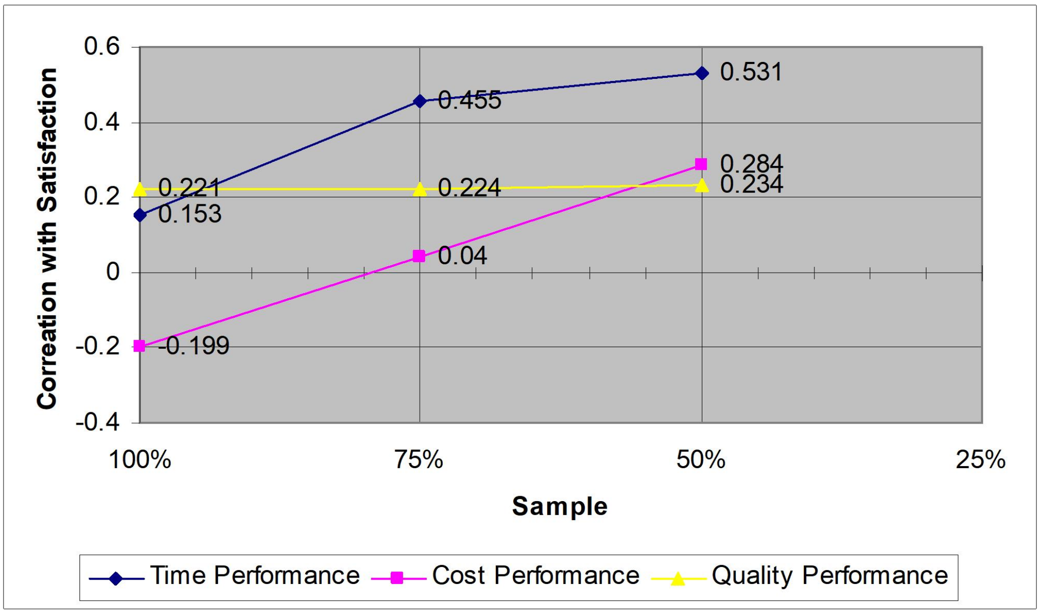

Figure 6- 15 Plotting correlations between performance and satisfaction

6.5.2. Validity of the relationship

This finding depicted the relationship between graduates' performance and stakeholders' satisfaction. The finding indicates that time performance and cost performance have positive correlation with stakeholders' satisfaction. This finding supports the hypothesis stated in section 3.1.5 that graduates' performance should affect stakeholders' satisfaction and that the relationship between them can be analysed. This finding is useful to know what kind of graduates' performance affecting stakeholders' satisfaction. Because of the finding, it can be concluded that:

1. The number of variables and the divisions as shown in Table 2- 5 are suitable in terms of data collection and analyses;

2. The data of this study presented in section 4.4 are adequate for analyses to discover relationship between graduates' performance and stakeholders' satisfaction;
3. The randomness and distribution of the data presented in section 4.4 are adequate to indicate the quality of data;
4. The methods used in this study including the analyses (section 3.9.2), measurements (Table 3- 8 to Table 3- 11) and data collection (Table 3- 23) are appropriate.

6.5.3. Trends of the relationship

Based on the correlation coefficients presented in the table and figure, the stakeholders' satisfaction has positive correlation with the time and cost performance, however correlation with the time performance occurs in more cases than cost performance does. This is because a strong correlation (the coefficient > 0.4) of time performance occurs in about 80 % of samples, while the cost performance occurs in about 40 % of samples. These values were calculated by extrapolation methods. Meanwhile quality performance has no correlation with stakeholders' satisfaction. This may be the result of the kinds and scope of graduates' jobs.

The trends of the correlation presented in Figure 6- 15 indicate that the time and cost performances have positive effects on stakeholders' satisfaction. The slopes indicate that their effect is likely to be the same but time performance occurs in more cases than cost performance does. This finding can represent relationship between graduates' performance and stakeholders' satisfaction. However, this finding is limited to young Civil Engineering graduates with experience of less than 3 years in the workplaces. Therefore, to identify performance and satisfaction in broader areas, further studies need to be undertaken.

6.5.4. Benefits of the finding

This finding can be used to identify characteristics of stakeholders' satisfaction with civil engineering graduates. Since stakeholders' satisfaction can be defined, relationship between graduates' competence and stakeholders' satisfaction can be formulated. The formulation was conducted in chapter 7.

6.6. Summary of the discussion

The discussion of findings of this study have been conducted resulting significant information. The rankings of graduates' competence revealed the strength and the weakness of graduates in the workplace. The ranking of expected competence revealed discovered the importance levels of competence based on stakeholders' expectation. The lists of differences in expectations identified the characteristics of stakeholders of civil engineering education. The lists of prioritised competencies can be used as inputs in the quality improvement of civil engineering education. The relationship between the performance of graduates' job and stakeholders' satisfaction identified the characteristics of stakeholders' satisfaction.

The discussion also found that data of graduates' competence and stakeholders' satisfaction were valid, therefore, the data can be used to develop relationship models linking graduates' competence and stakeholders' satisfaction. The model development will be conducted in the next chapter.

7. DEVELOPMENT OF THE MODELS

This chapter develops models that link graduates' competence and stakeholders' satisfaction. The model development is the sixth objective of this study (section 1.3). The models, once their reliability established, can be used to predict stakeholders' satisfaction based on graduates' competence. Models linking graduates' competence and stakeholders' satisfaction need to be developed for the following reasons.

Stakeholders' perception of satisfaction with graduates reflects the quality of the graduates. The quality of graduates is a complex issue (sections 2.1 and 2.3), therefore the models will assist to understand complex relationship between graduates' competence and the quality of graduates. By understanding the relationship, improvement of the quality can focus on certain competencies that have significant effect to the quality. Stakeholders' satisfaction with graduates also can be seen as a benchmark of quality of graduates in workplace. The benchmark is very important in efforts to improve the outcomes of civil engineering education i.e. graduates.

7.1. Steps of the model development

In the model development, the competence attributes are categorized into knowledge, skills and attitude based on two sample groups. Therefore, this analysis will contain 6 sub-analyses. Stakeholders include employers and graduates. Steps in this analysis can be categorized into three stages as shown in Figure 7- 1. The first is establishment of the samples, the second is selection of variables, and the third is model development.

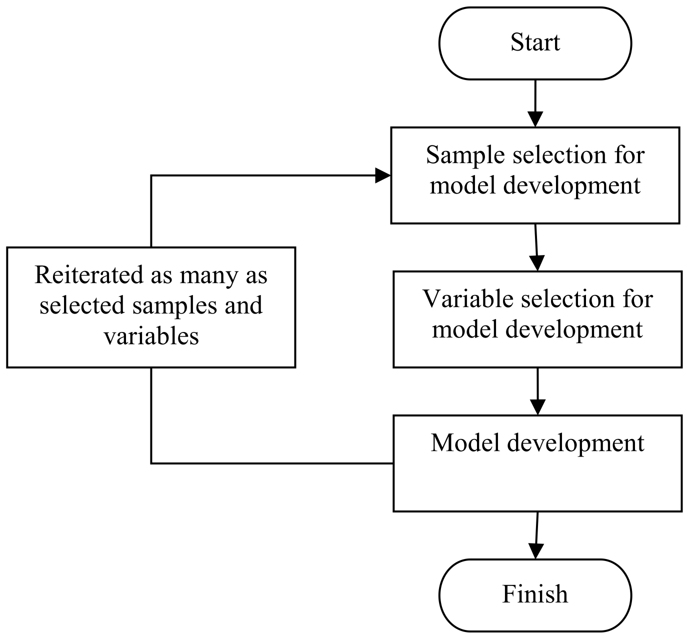

Figure 7- 1 Flowchart of model development

a) Samples for the model development

Samples for this analysis are presented in Table 5- 107, i.e. those in Sample I and II. Sample I contains data of stakeholders' satisfaction that has no significant correlation with performance of graduates' job. Sample II contains cases that the stakeholders' satisfaction has a significant correlation with performance of graduates' job (section 5.5).

b) Selection of variables

The selection of variables for model development was conducted by investigating correlation between variables of graduates' competence and stakeholders' satisfaction. The correlation was calculated using the Spearman Rank (Santoso 2001; Sugiyono 1999) that the formulae of which have been presented in Equation 3- 7. An example of the calculation can be seen in section 3.9.2.

c) **Model development**

The models were developed using linear regression. This method was selected because of its simplicity and it could produce a reliable model (section 7.5). The model development was calculated by the SPSS software.

7.2. Model linking graduates' knowledge and stakeholders' satisfaction

The models of graduates' knowledge and stakeholders' satisfaction were developed based on Sample I and II. Those samples have specific characteristic i.e. Sample I represents stakeholders' satisfaction that has no significant relationship with performance of graduates' job, while Sample II represent stakeholders' satisfaction that has significant relationship with performance of graduates' job (section 5.5).

7.2.1. The model based on Sample I

The attributes for developing models that link graduates' knowledge and stakeholders' satisfaction were selected by investigating the correlation between graduates' knowledge with stakeholders' satisfaction within Sample I (Table 5- 107). The resume of the correlation tests is presented in Table 7- 1. The table shows values of the Spearman correlation coefficient and the probability of independence.

The Spearman correlation coefficient is a coefficient indicating correlation between variables of graduates' competence and stakeholders' satisfaction calculated using the Spearman-r method. Value of the coefficient may be from minus 1.00 to plus 1.00. The probability of independence is a probability of the two variables do not relate each other. Value of this probability is between 0 to 100 %.

Table 7- 1 Selection of graduates' knowledge for model development

Attribute Code / Item	K1	K2	K3	K4	K5	K6	K7	K8	K9
Number of Samples	54	54	54	54	54	54	54	54	54
Spearman Correlation Coef. With Satisfaction	.079	.155	.132	.281	.154	.027	.157	.381	.128
Probability of Independence	.570	.262	.343	.039	.265	.849	.256	.005	.357
Inference				Selected				Selected	

Source: Output of Spearman R calculated by the SPSS

The table shows that two (2) knowledge attributes have significant correlations with stakeholders' satisfaction. The significance is indicated by the probability of independence less then 0.05. The graduates' attributes are ability: to understand the problem identification, formulation and solution (K4); and to understand the principles of management and business (K8). The attributes were used to develop the models.

The models of graduates' knowledge-stakeholders' satisfaction were developed based on Equation 3- 8 and Equation 3- 9. The results are presented in Equation 7- 1 and Equation 7- 2. An example of model development can be seen in section 3.9.3. Reliability of the models will be discussed in section 7.5.

$$S = 3.194 + 0.223\,(K4)$$ ***Equation 7- 1***

Note: S = Stakeholder satisfaction with Civil Engineering Graduates
K4 = Understanding of graduate in problem identification, formulation and solution associated with Civil Engineering. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 3.285 + 0.229\,(K8)$$ ***Equation 7- 2***

Note: S = Stakeholder satisfaction with Civil Engineering Graduates
K8 = Understanding of graduate in the principles of management and business associated with Civil Engineering. The values may be from 1 to 5 as shown in Table 3- 3.

7.2.2. The model based on Sample II

The attributes for developing models that link graduates' knowledge and stakeholders' satisfaction were selected by investigating the correlation between graduates' knowledge with stakeholders' satisfaction within Sample II (Table 5- 107). The resume of the correlation tests is presented in Table 7- 2.

Table 7- 2 Selection of graduates' knowledge for model development

Item \ Attribute Code	K1	K2	K3	K4	K5	K6	K7	K8	K9
Number of Samples	40	40	40	40	40	40	40	40	40
Spearman Correlation Coef.	-.083	.036	.162	.192	.085	.072	.121	.335	-.042

Attribute Code / Item	K1	K2	K3	K4	K5	K6	K7	K8	K9
With Satisfaction									
Probability of Independence	.611	.825	.318	.235	.601	.661	.456	.034	.796
Inference	-	-	-	-	-	-	-	Selected	-

Source: Output of Spearman R calculated by the SPSS

The table shows that a graduates' knowledge has significant correlation with stakeholders' satisfaction. The significance is indicated by the probability of independence less then 0.05. The graduates' attribute is ability to understand the principles of management and business (K8). The attribute was used to develop the model.

The model of knowledge-performance-satisfaction was developed based on Equation 3- 8 and Equation 3- 9. The result is presented in Equation 7- 3. An example of model development can be seen in section 3.9.3.

$$S_p = 3.286 + 0.194\,(K8)$$ ***Equation 7- 3***

Note: Sp = Stakeholder satisfaction with Civil Engineering Graduates that has significant correlation with performance
K8 = Understanding of graduate in the principles of management and business associated with Civil Engineering. The values may be from 1 to 5 as shown in Table 3- 3.

In this analysis, Sample I produced two models (section 7.2.1) while Sample II only a model (section 7.2.2). The difference may be caused by the number of samples and the characteristics of stakeholders' satisfaction in each sample. However, these analyses indicate the importance of graduates' knowledge in management and business (K8).

7.3. Model linking graduates' skills and stakeholders' satisfaction

The models of graduates' skills and stakeholders' satisfaction were developed based on Sample I and Sample II. The characteristic of those samples is that Sample I represents stakeholders' satisfaction that has no significant relationship with performance of graduates' job, while Sample II represent stakeholders' satisfaction that has significant relationship with performance of graduates' job (section 5.5).

7.3.1. The model based on Sample I

The attributes for developing models that link graduates' skills and stakeholders' satisfaction were selected by investigating the correlation between graduates' skills with stakeholders' satisfaction within Sample I (Table 5- 107). The resume of the correlation tests is presented in Table 7- 3.

Table 7- 3 Selection of graduates' skill for model development

Item \ Attribute Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Number of Samples	54	54	54	54	54	54	54	54	54
Spearman Correlation Coef. With Satisfaction	.110	.228	.321	.448	.500*	.330	.457	.296	.387
Probability of Independence	.430	.097	.018	.001	.000	.015	.001	.030	.004
Inference	-	-	Selected	Selected	Selected	Selected	Selected	Selected	Selected

Source: Output of Spearman R calculated by the SPSS

The table shows that seven (7) skills attributes have significant correlations with stakeholders' satisfaction. The significance is indicated by the probability of independence less then 0.05. The graduates' attributes are ability: to access, evaluate and synthesise information (S3); to communicate effectively not only with engineers but also with the community at large (S4); to function effectively as an individual (S5); to function effectively in multi-disciplinary or multi-cultural teams (S6); to function effectively in teams with the capacity to be a member (S7); to function effectively in teams with the capacity to be a manager (S8); and to function effectively in teams with the capacity to be a leader (S9). The attributes were used to develop the models.

The models of skills-satisfaction were developed based on Equation 3- 8 and Equation 3- 9. The results are presented in Equation 7- 4 to Equation 7- 10. An example of model development can be seen in section 3.9.3. The models would be discussed in section 7.5.

$$S = 3.065 + 0.255\,(S3)$$ ***Equation 7- 4***

Note: *S = Stakeholder satisfaction with Civil Engineering Graduates*
S3 = Ability of graduate to access, evaluate and synthesise information. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 2.635 + 0.355\,(S4)$$ ***Equation 7- 5***

Note: *S = Stakeholder satisfaction with Civil Engineering Graduates*
S4 = Ability of graduate to communicate effectively not only with engineers but also with the community at large. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 2.778 + 0.308\,(S5)$$ ***Equation 7- 6***

Note: *S = Stakeholder satisfaction with Civil Engineering Graduates*
S5 = Ability of graduate to function effectively as an individual. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 2.881 + 0.282\,(S6)$$ ***Equation 7- 7***

Note: *S = Stakeholder satisfaction with Civil Engineering Graduates*
S6 = Ability of graduate to function effectively in multi-disciplinary or multi-cultural teams. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 2.652 + 0.335\,(S7)$$ ***Equation 7- 8***

Note: *S = Stakeholder satisfaction with Civil Engineering Graduates*
S7 = Ability of graduate to function effectively in teams with the capacity to be a member. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 3.392 + 0.194\,(S8)$$ ***Equation 7- 9***

Note: S = Stakeholder satisfaction with Civil Engineering Graduates
S8 = Ability of graduate to function effectively in teams with the capacity to be a manager. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 3.157 + 0.243\,(S9)$$ ***Equation 7- 10***

Note: S = Stakeholder satisfaction with Civil Engineering Graduates
S9 = Ability of graduate to function effectively in teams with the capacity to be a leader. The values may be from 1 to 5 as shown in Table 3- 3.

7.3.2. The model based on Sample II

The attributes for developing models that link graduates' skills and stakeholders' satisfaction were selected by investigating the correlation between graduates' skills with stakeholders' satisfaction within Sample II (Table 5- 107). The resume of the correlation tests is presented in Table 7- 4.

Table 7- 4 Selection of graduates' skill for model development

Item \ Attribute Code	S1	S2	S3	S4	S5	S6	S7	S8	S9
Number of Samples	40	40	40	40	40	40	40	40	40
Spearman Correlation Coef. With Satisfaction	.110	.080	.259	.289	.347	.158	.379	.127	.241
Probability of Independence	.499	.626	.106	.071	.028	.329	.016	.435	.133
Inference	-	-	-	-	Selected	-	Selected	-	-

Source: Output of Spearman R calculated by the SPSS

The table shows that two (2) skills attributes have significant correlations with stakeholders' satisfaction. The significance is indicated by the probability of independence less then 0.05. The graduates' attributes are ability: to function effectively as an individual (S5); and to function effectively in teams with the capacity to be a member (S7). The attributes were used to develop the models.

The models of skills-performance-satisfaction were developed based on Equation 3- 8 and Equation 3- 9. The results are presented in Equation 7- 11 and Equation 7- 12. An example of model development can be seen in section 3.9.3.

$$S_p = 2.772 + 0.355(S5)$$ **Equation 7- 11**

Note: *Sp = Stakeholder satisfaction with Civil Engineering Graduates that has significant correlation with performance*
S4 = Ability of graduate to function effectively as an individual. The values may be from 1 to 5 as shown in Table 3- 3.

$$S_p = 2.664 + 0.355(S7)$$ **Equation 7- 12**

Note: *Sp = Stakeholder satisfaction with Civil Engineering Graduates that has significant correlation with performance*
S7 = Ability of graduate to function effectively in teams with the capacity to be a member. The values may be from 1 to 5 as shown in Table 3- 3.

In this model development linking graduates' skills and stakeholders' satisfaction, Sample I produced seven models (section 7.3.1) while Sample II only two models (section 7.3.2). The difference may be caused by the number of samples and the characteristics of stakeholders' satisfaction in each sample. However, these analyses indicate the importance of graduates' skills to function effectively as: an individual (S4); and a member in teams (S7).

7.4. Model linking graduates' attitude and stakeholders' satisfaction

The models of graduates' attitude and stakeholders' satisfaction were developed based on Sample I and Sample II. The characteristic of those samples is that Sample I represents stakeholders' satisfaction that has no significant relationship with performance of graduates' job, while Sample II represent stakeholders' satisfaction that has significant relationship with performance of graduates' job (section 5.5).

7.4.1. The model based on Sample I

The attributes for developing models that link graduates' attitude and stakeholders' satisfaction were selected by investigating the correlation between graduates' attitude with stakeholders' satisfaction within Sample I (Table 5- 107). The resume of the correlation tests is presented in Table 7- 5.

Table 7- 5 Selection of graduates' attitude for model development

Item \ Attribute Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Number of Samples	54	54	54	54	54	54	54	54	54
Spearman Correlation Coef. With Satisfaction	.298	.302	.208	.111	.069	.217	.145	.221	.329*
Probability of Independence	.029	.027	.132	.423	.618	.114	.295	.109	.015
Inference	Selected	Selected							Selected

Source: Output of Spearman R calculated by the SPSS

The table shows that three (3) attitude attributes have significant correlations with stakeholders' satisfaction. The significance is indicated by the probability of independence less then 0.05. The graduates' attributes are ability: to think critically, creatively, reflectively in their work (A1); to undertake lifelong learning (A2); and to develop effective interpersonal skills in his or her workplace (A9). The attributes were used to develop the models.

The models of attitude-satisfaction were developed based on Equation 3- 8 and Equation 3- 9. The results are presented in Equation 7- 13 to Equation 7- 15. An example of model development can be seen in section 3.9.3. The models would be discussed in section 7.5.

$$S = 3.183 + 0.220\,(A1)$$ ***Equation 7- 13***

Note: *S = Stakeholder satisfaction with Civil Engineering Graduates*
A1 = Ability of graduate to think critically, creatively, reflectively in their work. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 3.326 + 0.197\,(A2)$$ ***Equation 7- 14***

Note: *S = Stakeholder satisfaction with Civil Engineering Graduates*
A2 = Ability of graduate to undertake lifelong learning. The values may be from 1 to 5 as shown in Table 3- 3.

$$S = 2.839 + 0.302\,(A9)$$ ***Equation 7-15***

Note: S = Stakeholder satisfaction with Civil Engineering Graduates
A9 = Ability of graduate to develop effective interpersonal skills in his or her workplace. The values may be from 1 to 5 as shown in Table 3-3.

7.4.2. The model based on Sample II

The attributes for developing models that link graduates' attitude and stakeholders' satisfaction were selected by investigating the correlation between graduates' attitude with stakeholders' satisfaction within Sample II (Table 5-107). The resume of the correlation tests is presented in Table 7-6.

Table 7-6 Selection of graduates' attitude for model development

Item \ Attribute Code	A1	A2	A3	A4	A5	A6	A7	A8	A9
Number of Samples	40	40	40	40	40	40	40	40	40
Spearman Correlation Coef. With Satisfaction	.184	.283	.040	.001	-.009	.033	.103	.103	.266
Probability of Independence	.257	.077	.806	.995	.957	.837	.528	.525	.097
Inference	-	-	-	-	-	-	-	-	-

Source: Output of Spearman R calculated by the SPSS

The table shows that no attitude attribute has significant correlations with stakeholders' satisfaction, so that no model was developed. In this model development linking graduates' attitude and stakeholders' satisfaction, Sample I produced three models (section 7.4.1) while Sample II could not produce a model (section 7.4.2). The difference may be caused by the number of samples and the characteristics of stakeholders' satisfaction in each sample.

Totally, Sample I can produce 12 relationship models i.e. 2 for knowledge, 7 for skills, and 3 for attitude (sections 7.2.1, 7.3.1 and 7.4.1) while sample II produced 3 relationship models only, i.e. 1 for knowledge and 2 for skills (sections 7.2.2, 7.3.2 and 7.4.2). Based on the number of those models in both samples, it can be concluded that the graduates' skills are the most important factor to affect stakeholders' satisfaction. Therefore, in efforts to improve quality of civil engineering, graduates' skills should be emphasized.

The development developed some models of graduates' competence-stakeholders' satisfaction relationship. The reliability of the models were discussed in section 7.5, the benefit in section 7.6 and the characteristics in section 7.7.

7.5. Reliability of the models

Before the models produced in 7.2, 7.3 and 7.4 could be adopted, the reliability need to be investigated. The investigation was conducted on models produced based on Sample I (Table 5- 107) because the sample could produce the models of each factor of graduates' competence. As there are three factors of graduates' competence i.e. knowledge, skills and attitude, the reliability of these models is divided into three sections.

In this investigation the reliability was defined as the accuracy of the models in predicting stakeholders' satisfaction. A number of cases was used to define the accuracy.

7.5.1. Reliability of model of graduates' knowledge -stakeholders' satisfaction

The models of relationship between graduates' knowledge and stakeholders' satisfaction are shown in Equation 7- 1 and Equation 7- 2. The equations indicate a positive relationship between graduates' knowledge and stakeholders' satisfaction. In the models, the graduates' knowledge is represented by two variables i.e. ability in "problem identification, formulation and solution" (K4) and "Management and business" (K8).

Reliability of Equation 7- 2 was examined to understand reliability models of graduates' knowledge -stakeholders' satisfaction. The resume of the calculation is presented in Table 7- 7. In this calculation, data of graduates' competence in "Management and business" (K8) and were taken from those presented in sections 4.3.1 and 4.3.2, while data of actual stakeholders' satisfaction presented in sections 4.4.1 and 4.4.2.

Table 7- 7 Reliability of knowledge-satisfaction model

No	Case code	Graduates' ability in "Management and business" K8	Actual stakeholders' satisfaction (A)	Estimation of stakeholders' satisfaction based on Equation 7- 2 (B)	Residual of stakeholders' satisfaction |A – B|
1	11000	2	4	3.74	0.257
2	11101	2	2	3.74	1.743

No	Case code	Graduates' ability in "Management and business" K8	Actual stakeholders' satisfaction (A)	Estimation of stakeholders' satisfaction based on Equation 7-2 (B)	Residual of stakeholders' satisfaction |A – B|
3	11122	3	4	3.97	0.028
4	11145	4	4	4.20	0.201
5	11152	4	5	4.20	0.799
6	11156	2	4	3.74	0.257
7	11167	3	4	3.97	0.028
8	11170	4	4	4.20	0.201
9	11175	1	4	3.51	0.486
10	11177	4	5	4.20	0.799
11	11180	2	4	3.74	0.257
12	11276	4	5	4.20	0.799
13	11284	4	5	4.20	0.799
14	11293	3	4	3.97	0.028
15	11330	2	3	3.74	0.743
16	12000	2	4	3.74	0.257
17	12003	2	4	3.74	0.257
18	12005	4	4	4.20	0.201
19	12006	2	4	3.74	0.257
20	12007	4	4	4.20	0.201
21	12010	3	3	3.97	0.972
22	12013	3	4	3.97	0.028
23	12016	2	4	3.74	0.257
24	12017	4	3	4.20	1.201
25	12019	3	3	3.97	0.972
26	12021	4	4	4.20	0.201
27	12024	4	4	4.20	0.201
28	12025	5	5	4.43	0.570
29	12031	4	4	4.20	0.201
30	12034	5	5	4.43	0.570
31	12039	4	4	4.20	0.201
32	12042	3	5	3.97	1.028
33	12043	4	4	4.20	0.201
34	12046	4	4	4.20	0.201
35	12048	3	3	3.97	0.972
36	12060	4	4	4.20	0.201
37	12061	2	4	3.74	0.257
38	12062	4	4	4.20	0.201
39	12066	4	4	4.20	0.201
40	12069	4	4	4.20	0.201
41	12070	5	4	4.43	0.430
42	12075	4	4	4.20	0.201
43	12086	2	4	3.74	0.257
44	12087	5	4	4.43	0.430
45	12100	3	4	3.97	0.028
46	12105	3	5	3.97	1.028
47	12106	5	5	4.43	0.570
48	12107	4	5	4.20	0.799
49	12109	5	4	4.43	0.430
50	12117	4	4	4.20	0.201
51	12120	4	5	4.20	0.799
52	12122	3	4	3.97	0.028
53	12129	4	4	4.20	0.201
54	12130	4	4	4.20	0.201
				Total	23.038

No	Case code	Graduates' ability in "Management and business" K8	Actual stakeholders' satisfaction (A)	Estimation of stakeholders' satisfaction based on Equation 7- 2 (B)	Residual of stakeholders' satisfaction |A – B|
				Average of 54 cases	0.427
				Error in 5 scale	0.085

Source: Output of reliability calculation

The table shows cases used as samples in the model development, estimations of stakeholders' satisfaction based on Equation 7- 2 and residuals in the model development. The calculation indicated a model of Equation 7- 2 has error of 8.5 % or returns a reliability of 91.5 %. Based on the accuracy level, the equation can be adopted as a model of graduates' knowledge-stakeholders' satisfaction relationship.

7.5.2. Reliability of model of graduates' skills-stakeholders' satisfaction

The models of relationship between graduates' skills and stakeholders' satisfaction are shown in Equation 7- 4 to Equation 7- 10. The equations indicate a positive relationship between graduates' skills and stakeholders' satisfaction. In the models, the graduates' skills are represented by seven variables i.e. abilities of graduates to "synthesise information" (S3), "communicate effectively" (S4), "function as an individual" (S5), "function in multi-disciplinary teams" (S6), "function to be a member" (S7), "function to be a manager" (S8), and "function to be a leader" (S9).

Reliability of Equation 7- 6 was examined to understand reliability the models of graduates' attitude-stakeholders' satisfaction. The resume of accuracy calculations is presented in Table 7- 8. In the calculation, data of graduates' competence "function as an individual" (S5), were taken from those presented in sections 4.3.5 and 4.3.6, while data of actual stakeholders' satisfaction presented in sections 4.4.1 and 4.4.2.

Table 7- 8 Reliability of skills-satisfaction model

No	Case code	Graduates' ability to "function as an individual" S5	Actual stakeholders' satisfaction (A)	Estimation of stakeholders' satisfaction based on Equation 7- 6 (B)	Residual stakeholders' satisfaction |A – B|
1	11000	4	4	4.01	0.010
2	11101	2	2	3.39	1.394
3	11122	4	4	4.01	0.010
4	11145	4	4	4.01	0.010

No	Case code	Graduates' ability to "function as an individual" S5	Actual stakeholders' satisfaction (A)	Estimation of stakeholders' satisfaction based on Equation 7- 6 (B)	Residual stakeholders' satisfaction |A – B|
5	11152	5	5	4.32	0.682
6	11156	5	4	4.32	0.318
7	11167	3	4	3.70	0.298
8	11170	5	4	4.32	0.318
9	11175	2	4	3.39	0.606
10	11177	5	5	4.32	0.682
11	11180	4	4	4.01	0.010
12	11276	5	5	4.32	0.682
13	11284	5	5	4.32	0.682
14	11293	4	4	4.01	0.010
15	11330	3	3	3.70	0.702
16	12000	4	4	4.01	0.010
17	12003	5	4	4.32	0.318
18	12005	5	4	4.32	0.318
19	12006	1	4	3.09	0.914
20	12007	5	4	4.32	0.318
21	12010	4	3	4.01	1.010
22	12013	4	4	4.01	0.010
23	12016	4	4	4.01	0.010
24	12017	4	3	4.01	1.010
25	12019	4	3	4.01	1.010
26	12021	4	4	4.01	0.010
27	12024	4	4	4.01	0.010
28	12025	5	5	4.32	0.682
29	12031	5	4	4.32	0.318
30	12034	5	5	4.32	0.682
31	12039	5	4	4.32	0.318
32	12042	4	5	4.01	0.990
33	12043	4	4	4.01	0.010
34	12046	4	4	4.01	0.010
35	12048	5	3	4.32	1.318
36	12060	4	4	4.01	0.010
37	12061	4	4	4.01	0.010
38	12062	4	4	4.01	0.010
39	12066	4	4	4.01	0.010
40	12069	5	4	4.32	0.318
41	12070	5	4	4.32	0.318
42	12075	5	4	4.32	0.318
43	12086	4	4	4.01	0.010
44	12087	4	4	4.01	0.010
45	12100	4	4	4.01	0.010
46	12105	5	5	4.32	0.682
47	12106	5	5	4.32	0.682
48	12107	5	5	4.32	0.682
49	12109	4	4	4.01	0.010
50	12117	4	4	4.01	0.010
51	12120	5	5	4.32	0.682
52	12122	4	4	4.01	0.010
53	12129	5	4	4.32	0.318
54	12130	2	4	3.39	0.606
				Total	20.396
				Average of 54 cases	0.378

No	Case code	Graduates' ability to "function as an individual" S5	Actual stakeholders' satisfaction (A)	Estimation of stakeholders' satisfaction based on Equation 7- 6 (B)	Residual stakeholders' satisfaction |A – B|
				Error in 5 scale	0.076

Source: Output of reliability calculation

The table shows that Equation 7- 6 has error of 7.6 % or returns a reliability of 92.4 %. Based on the accuracy level, the equation can be adopted as a model of graduates' knowledge-satisfaction relationship.

7.5.3. Reliability of model of graduates' attitude-stakeholders' satisfaction

The models of relationship between graduates' attitude and stakeholders' satisfaction are shown in Equation 7- 13 to Equation 7- 15. The equations indicate a positive relationship between graduates' attitude and stakeholders' satisfaction. The graduates' attitude is represented by three variables i.e. abilities to: "think critically, creatively, reflectively" (A1), "do lifelong learning" (A2), and "do interpersonal skills" (A9).

Reliability of Equation 7- 15 was examined to understand reliability models of graduates' knowledge -stakeholders' satisfaction. The resume of the calculations is presented in Table 7- 9. In this calculation, data of graduates' abilities to "undertake interpersonal skills" (A9) were taken from those presented in sections 4.3.9 and 4.3.10, while data of actual stakeholders' satisfaction presented in sections 4.4.1 and 4.4.2.

Table 7- 9 Reliability of attitude-satisfaction model

No	Case code	Graduates' ability to "undertake interpersonal skills" A9	Actual stakeholders' satisfaction (A)	Estimations of stakeholders' satisfaction based on Equation 7- 15 (B)	Residual of stakeholders' satisfaction |A – B|
1	11000	4	4	4.05	0.047
2	11101	1	2	3.14	1.141
3	11122	5	4	4.35	0.349
4	11145	4	4	4.05	0.047
5	11152	5	5	4.35	0.651
6	11156	4	4	4.05	0.047
7	11167	4	4	4.05	0.047
8	11170	5	4	4.35	0.349
9	11175	1	4	3.14	0.859
10	11177	5	5	4.35	0.651
11	11180	4	4	4.05	0.047

No	Case code	Graduates' ability to "undertake interpersonal skills" A9	Actual stakeholders' satisfaction (A)	Estimations of stakeholders' satisfaction based on Equation 7-15 (B)	Residual of stakeholders' satisfaction |A – B|
12	11276	4	5	4.05	0.953
13	11284	4	5	4.05	0.953
14	11293	4	4	4.05	0.047
15	11330	3	3	3.75	0.745
16	12000	4	4	4.05	0.047
17	12003	4	4	4.05	0.047
18	12005	4	4	4.05	0.047
19	12006	2	4	3.44	0.557
20	12007	4	4	4.05	0.047
21	12010	4	3	4.05	1.047
22	12013	4	4	4.05	0.047
23	12016	5	4	4.35	0.349
24	12017	4	3	4.05	1.047
25	12019	3	3	3.75	0.745
26	12021	4	4	4.05	0.047
27	12024	4	4	4.05	0.047
28	12025	5	5	4.35	0.651
29	12031	5	4	4.35	0.349
30	12034	4	5	4.05	0.953
31	12039	4	4	4.05	0.047
32	12042	4	5	4.05	0.953
33	12043	4	4	4.05	0.047
34	12046	4	4	4.05	0.047
35	12048	5	3	4.35	1.349
36	12060	4	4	4.05	0.047
37	12061	4	4	4.05	0.047
38	12062	5	4	4.35	0.349
39	12066	4	4	4.05	0.047
40	12069	4	4	4.05	0.047
41	12070	4	4	4.05	0.047
42	12075	5	4	4.35	0.349
43	12086	4	4	4.05	0.047
44	12087	5	4	4.35	0.349
45	12100	4	4	4.05	0.047
46	12105	4	5	4.05	0.953
47	12106	4	5	4.05	0.953
48	12107	5	5	4.35	0.651
49	12109	5	4	4.35	0.349
50	12117	4	4	4.05	0.047
51	12120	5	5	4.35	0.651
52	12122	4	4	4.05	0.047
53	12129	5	4	4.35	0.349
54	12130	4	4	4.05	0.047
				Total	20.826
				Average	0.386
				Error	0.077

Source: Output of reliability calculation

The table shows that Equation 7-15 has an error of 7.7 % or reliability of 92.3 % . Based on the reliability, the equation can be adopted as a model of graduates' attitude-stakeholders' satisfaction relationship.

The accuracy of each group in predicting stakeholders' satisfaction is nearly the same. Based on the accuracy of those models, it can be concluded that the three groups have similar reliability. The models with that reliability are the best result that can be achieved. Models with higher reliabilities can not be achieved because of one or a combination of reasons as follows:

1. The competence variables do not contain all knowledge mastered by Civil Engineering graduates.

2. The data or information from respondents do not represent the real competence and satisfaction.
3. The number of samples is low so that it cannot exactly represent the population.

7.6. Benefit of the models

The models can be used as a tool to predict quality of graduates in the workplace. They also can be used by employers to select civil engineering graduates in the employee recruitment. The accuracy of the prediction is indicated by the reliability presented in Table 7- 7 to Table 7- 9.

In the graduates' knowledge-stakeholders' satisfaction models, for example, a civil engineering graduate is assessed to has "high or 4" (see Table 3- 13) in his or her knowledge of "Management and business" (K8), the satisfaction of stakeholders with the graduate in the workplace is predicted by Equation 7- 2 to have value of 4.201 or rounded to be 4. This value means that stakeholders "Satisfied" (see Table 3- 17) with the graduates in the workplace. This prediction has the probability of error of 8.5 % correct (Table 7- 7).

7.7. Characteristic of the models

The models are mathematical equations depicting a positive relationship between certain competence mastered by civil engineering graduates and satisfaction of stakeholders. The equations are straight lines if plotted in a XY diagram. These straight lines were caused by using the simple linear regression in the development (section 3.9.3).

To understand the characteristic of relationship models linking graduates' competence and stakeholders' satisfaction, the models of each competence group are plotted as presented in Figure 7-2. Equation 7-2 depicts relationship between the graduates' knowledge in "Management and business" (K8) and stakeholders' satisfaction, for graduates' skills to "function effectively as an individual" (S5) and stakeholders' satisfaction and for graduates' attitude to " develop effective interpersonal skills in the workplace" (A9) and stakeholders' satisfaction. The figure demonstrates the positive relationship between graduates' competence and stakeholders' satisfaction (sections 7.2.1, 7.3.1 and 7.4.1).

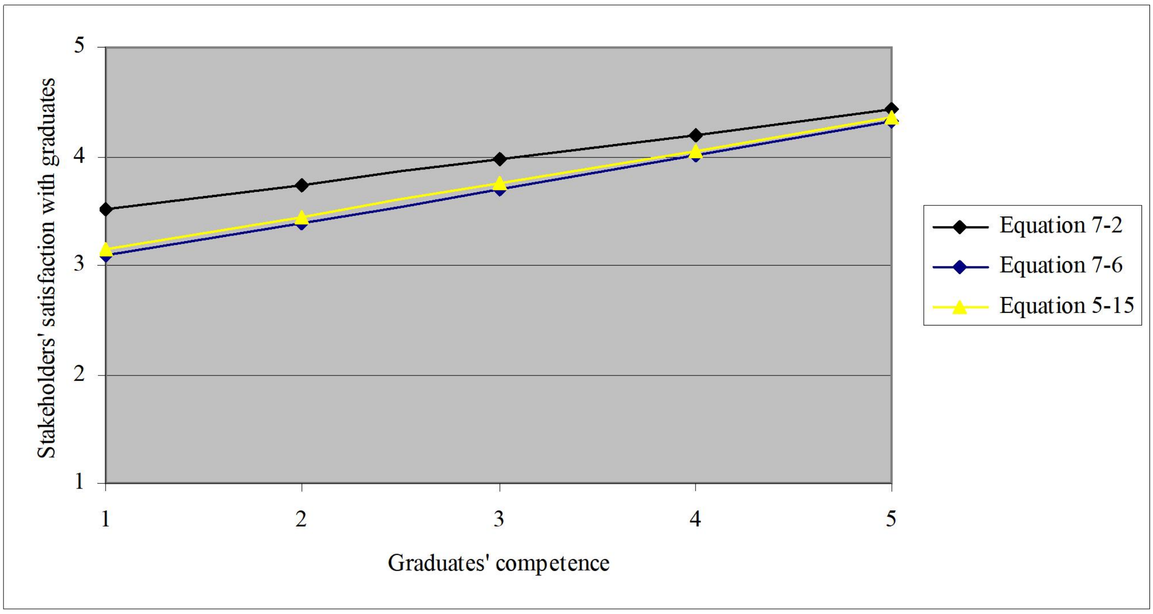

Figure 7- 2 Plotting of reliable models of each competence group

7.8. Summary of the model development

Relationship models linking graduates' competence and stakeholders' satisfaction have been produced. The investigation indicated that the models have reliability to be used as a tool to estimate of stakeholders' satisfaction (section 7.5). Therefore, the models can be used as tool to estimate stakeholders' satisfaction with the graduates. Level of the satisfaction can indicate the quality of graduates in the workplace. The conclusions and recommendations of this study will be presented in the next chapter.

8. CONCLUSIONS AND RECOMMENDATIONS

This chapter draws together conclusions of this study and makes recommendations about further studies. The conclusions are based on the results of study discussed in the previous chapters and recommendations are made to improve and continue further studies in this field. The conclusions and recommendations are presented in the same sequence as the objectives of this study.

8.1. Ranking of graduates' competence

8.1.1. Conclusion on Objective 1

The study revealed rankings of actual competence mastered by civil engineering graduates as presented in Table 6- 2 to Table 6- 4. The competence was divided into three factors i.e. knowledge, skills and attitude that each factor has nine variables. Each variable sits at a certain level in the rankings. Table 6- 2 shows the rankings of knowledge, Table 6- 3 the rankings of skills, and Table 6- 4 the rankings of attitude.

These rankings have been validated so that they could represent ranking of competence of civil engineering graduates. The calculation of the rankings assumed that the weight of each stakeholder is the same. These rankings should be a concern in civil engineering education because these rankings do not fully meet with stakeholders' expectation and satisfaction with graduates (sections 6.1 and 6.4). The graduates' competence that should be concern to be improved are:

4. understanding the principles of management and business (K8);
5. ability to communicate effectively with the community at large (S4); ability to function effectively in teams with the capacity to be a manager (S8); ability to function effectively in teams with the capacity to be a leader (S9); and
6. ability to undertake lifelong learning (A2).

8.1.2. Recommendation to improve Objective 1

In order to improve the reliability of the rankings, the number of samples needs to be increased so that the normal distribution for each variable can be reached. Calculation of the rankings assumed that the weight of each stakeholder is the same (section 8.1.1). Further analyses that use variations of weigh also need to be conducted. Further studies with different methods should be conducted to confirm the rankings. The different methods include: research variables, measurements, data collection methods and data resources. The research variables should be improved by including suitable attributes for certain countries or regions because each country should have specific curriculum in civil engineering education. The measurement should use the Semantic Differential Scale or the Rating Scale in order to confirm this finding. The data collection methods should include the use of interviews, and data source should include more stakeholders, including government in order to get more complicated data and wider stakeholders.

8.2. Rankings of expected competence

8.2.1. Conclusion on Objective 2

This study also revealed rankings of expected competence that should be mastered by civil engineering graduates as presented in Table 6- 5 to Table 6- 7. The expected competencies were divided into three factors i.e. knowledge, skills and attitude that each factor has nine variables. Each variable sits at a certain level in the rankings. Table 6- 5 shows the rankings of expected knowledge, Table 6- 6 the rankings of expected skills, and Table 6- 7 the rankings of expected attitude.

These rankings have been validated so that they can represent of stakeholders' expectations of civil engineering education. In the calculation, each group of stakeholders had the same weight. These rankings should be a concern in civil engineering education because these rankings will affect stakeholders' satisfaction with graduates (section 6.2). The stakeholders' expectation that should be concern are:

1. expectation with graduates' ability to understand the problem identification, formulation and solution (K4);

2. expectation with graduates' ability to use technologies appropriately (S2); to access, evaluate and synthesise information (S3); and to communicate effectively with the community at large (S4); and
3. expectation with graduates' ability to develop effective interpersonal skills in their workplace (A9).

8.2.2. Recommendation to improve Objective 2

In order to get more reliable ranking of expected competence, sample numbers needs to be improved so that the normal distribution for each variable can be reached. This study assumed that the weight of each stakeholder is the same (section 8.2.1). However, further analyses using variations of the weight need to be conducted. Further studies with different methods should be conducted to confirm the ranking. The different methods include: research variables, measurements, data collection methods, data sources and data analyses. The research variables should be improved by including suitable attributes for certain countries or regions because each country should have specific expectation with graduates' attributes. As regards measurement, the Semantic Differential Scale and the Rating Scale. The data collection methods should include the use of interviews to avoid incorrect responses. The data source ought to include a wider selection of stakeholders including government. The data analyses should use the Analytical Hierarchy Process (AHP) in order to know more detail about the importance of graduates' attributes.

8.3. Differences between stakeholders' expectations

8.3.1. Conclusions on Objective 3

The study disclosed the differences among stakeholders' expectations with civil engineering graduates as presented in Table 6- 11 to Table 6- 13. The differences were measured in three factors of graduates' competence i.e. knowledge, skills and attitude, each with nine variables. Table 6- 11 shows the knowledge that were expected differently by stakeholders, Table 6- 12 the skills, and Table 6- 13 the attitude. The differences have been validated so that they can represent differences of stakeholders' expectation with civil engineering graduates. The differences were calculated with criteria established by researcher.

These differences should be a concern in civil engineering education especially academicians or educators that their perception are different with other stakeholders. The differences are as the following.

1. In the knowledge factor, employers consider graduates' competence in understanding "principles and concepts" as the most important knowledge that should be mastered by graduates, while the others (graduates, academicians, professionals) do not so.

2. In the skills factor, employers, graduates and professionals considered graduates' ability in the communication with the community at large as the most important skills that should be mastered by graduates, while academicians did not so.
3. In the other skills factor, graduates, academicians and professional considered graduates' competence to function effectively in teams with the capacity as a leader the least important skills that should be mastered by graduates, but employers did not so.

8.3.2. Recommendation to improve Objective 3

Data in this analysis is the same as the data used to achieve ranking of expected competence (section 8.2.1), therefore, the recommendations how to improve data has been mentioned in section 8.2.2. This differences were investigated using criteria established by the researcher (section 8.3.1). Further analyses should be conducted using different criteria to confirm the results in this analysis.

8.4. Prioritised competence

8.4.1. Conclusions on Objective 4

The study revealed the graduates' competencies that should be prioritised in civil engineering education based on stakeholders' perceptions as presented in Table 6- 14 to Table 6- 16. The competencies were divided into three factors i.e. knowledge, skills and attitude, each with nine variables. Table 6- 14 shows the knowledge that should be prioritised by education, Table 6- 15 the skills, and Table 6- 16 the attitude.

The competencies that should be prioritised in civil engineering education are as the following. In the knowledge field, there were two competencies that should be prioritised i.e. graduates' abilities:

1. to understand problem identification, formulation and solution (K4); and
2. to understand laws, regulations and standards associated with civil engineering (K7).

In the skills field, there were three competencies that should be prioritised i.e. graduates' abilities:

1. to use technologies appropriately (S2);
2. to access, evaluate and synthesise information (S3); and
3. to communicate effectively not only with engineers but also with the community at large (S4).

In the attitude field, there were three competencies that should be prioritised i.e. graduates' abilities:

1. to undertake lifelong learning (A2);
2. to use effective group skills in his or her workplace (A8); and
3. to develop effective interpersonal skills in his or her workplace (A9).

8.4.2. Recommendation to improve Objective 4

The prioritised attributes or competencies are valid to represent competencies that should be prioritised based on stakeholders' perceptions. However, the data in this analysis is the same as the data of graduates' competence (section 8.1.1) and expected competence (section 8.2.1). The recommendations how to improve the data has been mentioned in sections 8.1.2 and 8.2.2. This study uses the criteria that were established by the researcher. Further analyses should be conducted employing different criteria to confirm the results in this analysis.

8.5. Relationships between performance of graduates' job and stakeholders' satisfaction

8.5.1. Conclusions on Objective 5

The study revealed the relationships between graduates' performance and stakeholders' satisfaction. The performance was divided into three factors i.e. time, cost and quality as presented in Table 6- 17 The relationships were measured using the statistical technique of Spearman Rho test. This measurement has shown that:

1. Time performance of graduates' job has significant and positive relationship with stakeholders' satisfaction in about 80 % of cases;

2. Cost performance of graduates' job has significant and positive relationship with stakeholders' satisfaction in about 40 % of cases;
3. Quality performance of graduates' job has no significant relationship with stakeholders' satisfaction (section 6.5).

The stakeholders' satisfaction relates to the graduates' performance especially in time and cost performance. However, graduates' time performance is more important because it often exists. In order to clarify the relationships, they are drawn as shown in Figure 6- 15.

8.5.2. Recommendation to improve Objective 5

In order to more get reliable relationship between performance of graduates' job and stakeholders' satisfaction, the sample number needs to be improved so that the normal distribution for each variable can be reached. This study used methods of sample selection that were established by the researcher (section 5.5). Further analyses should be conducted using different criteria to confirm the results in this analysis.

Further studies with different methods should be conducted to confirm the relationship. The different methods include: research variables, measurements, data collection methods and data resources. The variable of performance should be improved according to actual jobs in the workplaces. Regarding measurement, the Ratio Scale or Interval Scale should be used. The data collection methods should include the use of interviews to do complex measurement about the performance. The data source should include a wider selection stakeholder, including government.

8.6. Models linking graduates' competence and stakeholders' satisfaction

8.6.1. Conclusion on Objective 6

The study has revealed models linking graduates' competence and stakeholders' satisfaction. The models were in linear equations as presented in section 7. Based on a sample, 12 models were developed. The models consist of:

1. 2 models linking graduates' knowledge and stakeholders' satisfaction;
2. 7 models linking graduates' skills and stakeholders' satisfaction; and
3. 3 models linking graduates' attitude and stakeholders' satisfaction.

Based on the number of models it is concluded that graduates' skills has more relationship with stakeholders' satisfaction.

The models can used to predict stakeholders' satisfaction based on graduates' competence. The most reliable models of each category were plotted in Figure 7- 2.

8.6.2. Recommendation to improve Objective 6

Data in model development is the same as the data of graduates' competence and stakeholders' satisfaction. Recommendations how to improve the data has been stated in sections 8.1.2 and 8.5.2. With different data type, other models such as the Non Linear Regression model or the Discriminant model could be developed in order to achieve more reliable models. The model development used criteria of model development and selection (correlations and significance) that were established by the researcher. In future, further analyses should be conducted using different criteria to confirm the results in this analysis.

8.7. Summary of the conclusions and recommendations

All objectives of this study presented in section 1.3 have been realised. The major outcome of this study is a contribution toward the improvement in the quality of civil engineering education. The ranking of graduates' competence could be used to evaluate the strength and weakness of graduates. The ranking of expectations can be used to improve the quality of the education. The differences between stakeholders in their expectations can be used to better understand the characteristics and expectations of the various stakeholders. The prioritised competencies could be used to gradually improve the quality of education. The models can be used to estimate the stakeholders' satisfaction level or the quality of graduates based on graduates' competence. The models also could be used to evaluate and hence to improve the curriculum and learning methods especially in the civil engineering and construction fields.

Finally, the quality of civil engineering graduates could be improved by improvement in graduates' competence in skills, knowledge and then attitude. The most important competencies, as assessed by all stakeholders are:

1. ability to use technologies appropriately (S2);
2. ability to access, evaluate and synthesise information (S3);
3. ability to communicate effectively with the community at large (S4);
4. ability to function effectively as an individual (S5)
5. ability to function effectively in teams with the capacity to be a manager (S8);
6. ability to understand the problem identification, formulation and solution (K4);
7. ability to understand laws, regulations and standards (K7);
8. ability to understanding the principles of management and business (K8);
9. ability to undertake lifelong learning (A2); and
10. ability to develop effective interpersonal skills (A9).

However, the various stakeholders have a difference in perception of importance of graduates' ability in communication with the community at large (S4). Employers, graduates and professionals considered the ability as the most important skills that should be mastered by graduates, while academicians differed.

Regardless of these differences the results from the project can be the basis for designing and improving civil engineering courses.

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Appendix A. The questionnaire set for employers

Code: 11………

ATTRIBUTES, JOB PERFORMANCE, SATISFACTION AND EXPECTATION OF CIVIL ENGINEERING GRADUATES

EMPLOYER/SUPERVISOR OF CIVIL ENGINEERING GRADUATES QUESTIONNAIRE

2006

Dear Respondent

Thank you for agreeing to participate in this questionnaire. As part of my PhD studies, I am conducting a survey to identify the attributes of 4-year civil engineering education graduates, their job performance, the satisfaction of stakeholders with graduates' capabilities, and to identify the expectations with civil engineering graduates. The objective of the study is to produce a model that links graduate attributes, potential job performance, and stakeholder satisfaction with graduate capabilities to inform various communities associated with civil engineering education.

The purpose of this questionnaire is to gather information from you as an employer (or supervisor) in the workplace about the existing attributes, job performance, your satisfaction with a recent graduate performance you have come into contact with, and your expectations of that graduate. For the purpose of this survey, a graduate is defined as a person who has completed a 4-year civil engineering degree within the past three years, i.e. 2003, 2004, 2005, and 2006.

Your responses about each question will be valuable. When responding to each question about the graduate, please choose ONE graduate as a reference point for your responses. Information provided in this questionnaire by you and others will be collated and reported to you by email. Your individual answers will be kept strictly confidential and your anonymity is guaranteed in any written reports. The identification code on this questionnaire is for my purposes in administration of the survey. Furthermore, this survey has been approved by the Human Research Ethics Committee of Curtin University of Technology with the number **SMEC 20060017**.

This questionnaire will take approximately **20 minutes** to complete. While I realise I am taking much of your valuable time, the information gathered from the questionnaire will be helpful to civil engineering education, industry and professional associations. Thank you for your cooperation and assistance in completing this questionnaire.

Perth, 1 October 2006

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PLEASE RETURN THE QUESTIONNAIRE IN THE REPLY PAID ENVELOPE AS SOON AS POSSIBLE.

Indicate your response for each question either by ticking one box or providing details.

RESPONDENT DETAILS

1 Are you male or female? ☐ Male ☐ Female

2 Indicate the city where you work: …………………………

3 What is your association with the graduate?

☐ Employer ☐ Supervisor ☐ Other, specify: ……………..

4 How long have you been in this position?

☐ Up to 1 year ☐ 2 years ☐ 3 years ☐ More than 3 years

GRADUATE DETAILS

5 Is the graduate male or female? ☐ Male ☐ Female

6 Indicate the institution where the 4-year civil engineering graduate studied:

…………………………..

7 Indicate the year when the graduate completed the 4-year civil engineering education.

☐ 2003 ☐ 2004 ☐ 2005 ☐ 2006 ☐ Other, specify…………

8 If the graduate works in a different city from you, indicate the city where the graduate works:

…………………………

9 Does the graduate extend his or her own professional development?

☐ No ☐ Included If Included, indicate the type of professional development the graduate has undertaken.

……………………………………………………………………………………………………

10 How many years experience has the graduate had in the job?

☐ Up to 1 year ☐ 2 years ☐ 3 years

11 Has the graduate been provided with training in the workplace for the job?

☐ No ☐ Included

If Included, how long has the training been carried out?

☐ Up to 8 hours ☐ 9-16 hours ☐ 17-24 hours ☐ More than 24 hours

GRADUATE'S JOB DETAILS

12 What is the nature of the job that the graduate undertakes?

☐ Managerial ☐ Technical ☐ Other, specify………… ……………………………

13 Is the job unique?

☐ No ☐ Included If Included, indicate the unique aspect of the job:

……………………………………………………………………………………………

14 Where is the job mostly undertaken?

☐ In an office ☐ On a site ☐ Other, specify………… ……………………………

15 What kind of communication is most required for the job?

☐ Oral ☐ Letter/Writing ☐ Engineering drawing ☐ Other, specify…………………………...

16 What are the expected results of the job?

☐ Goods ☐ Services ☐ Other, specify………… ……………………………

17 What are the main facilities and required tools or equipment to support the job?

☐ Personal Computers ☐ Machinery ☐ Other, specify………… ………………

EXISTING GRADUATE ATTRIBUTES

The following statements are associated with identifying the existing attributes of the graduate you have in mind. Please circle the number of the response you feel expresses your beliefs about the statement.

1 STRONGLY DISAGREE	2 DISAGREE	3 NOT SURE	4 AGREE	5 STRONGLY AGREE

	Assessment about knowledge **I believe that the graduate:**					
1	Understands **principles** and **concepts** associated with civil engineering	1	2	3	4	5
2	Understands **basic science** and **engineering fundamentals** associated with civil engineering	1	2	3	4	5
3	Understands **in-depth technical knowledge** in at least one civil engineering discipline	1	2	3	4	5
4	Understands **problem identification, formulation** and **solution** associated with civil engineering	1	2	3	4	5
5	Understands to utilise a **systems approach** to design and operational performance associated with civil engineering	1	2	3	4	5
6	Understands the principles of **sustainable design** and **development** associated with civil engineering	1	2	3	4	5
7	Understands **laws, regulations and standards** associated with civil engineering	1	2	3	4	5
8	Understands the principles of **management and business** associated with civil engineering	1	2	3	4	5
9	Understands **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	1	2	3	4	5

	Assessment about skills **I believe that the graduate is able to:**					
10	Apply **in-depth technical skills** in at least one civil engineering discipline	1	2	3	4	5
11	Use **technologies** appropriately	1	2	3	4	5
12	Access, evaluate and synthesise **information**	1	2	3	4	5
13	**Communicate** effectively not only with engineers but also with the community at large	1	2	3	4	5
14	Function effectively as **an individual**	1	2	3	4	5
15	Function effectively in **multi-disciplinary** or **multi-cultural teams**	1	2	3	4	5
16	Function effectively in teams with the capacity to be **a member**	1	2	3	4	5
17	Function effectively in teams with the capacity to be **a manager**	1	2	3	4	5
18	Function effectively in teams with the capacity to be **a leader**	1	2	3	4	5

	Assessment about attitude **I believe that the graduate is able to:**					
19	T**hink** critically, creatively, reflectively in their work	1	2	3	4	5
20	Committed to undertake **lifelong learning**	1	2	3	4	5
21	Committed to meeting **ethical** responsibilities in their work	1	2	3	4	5
22	Committed to meeting **environmental** responsibilities in their work	1	2	3	4	5
23	Work with **international** and **global perspectives**	1	2	3	4	5
24	Committed to developing further his or her **professional skills**	1	2	3	4	5
25	Committed to working effectively with different **cultural groups**	1	2	3	4	5
26	Committed to using effective **group skills** in his or her workplace	1	2	3	4	5
27	Committed to develop effective **interpersonal skills** in his or her workplace	1	2	3	4	5

JOB PERFORMANCE

The following questions are associated with the performance of the job, work or project undertaken by the graduate. Please circle the number of the response that expresses your assessment of the graduate.

	Assessment about performance of any job					
1	What is the **actual duration** of any jobs undertaken by the graduate?	1 Much longer than the planning	2 Longer than the planning	3 Same as the planning	4 Shorter than the planning	5 Much shorter than the planning
2	What is the **actual cost** of any jobs undertaken by the graduate?	1 Much more than the planning	2 More than the planning	3 Same as the planning	4 Less than the planning	5 Much less than the planning
3	What is the **actual quality** of any jobs undertaken by the graduate?	1 Much less than the planning	2 Less than the planning	3 Same as the planning	4 More than the planning	5 Much more than the planning

Indicate the graduate's performance in relation to ONE specific job or project.

	Job performance detail	
1	How long was the **actual duration** of the job?	………………
2	How long was the **planned duration** of the job?	………………
3	How much was the **actual cost** of the job?	$…………………
4	How much was the **planned cost** of the job?	$…………………

SATISFACTION

The following question is associated with your satisfaction with the outcomes of the job, work or project completed by the graduate. Please circle the number of the response that expresses your assessment of the graduate.

	Satisfaction with the outcomes of job, work or projects					
1	How satisfy are you with the outcome of any jobs undertaken by the graduate?	1 Highly Dissatisfie d	2 Dissatisfie d	3 Not sure	4 Satisfied	5 Highly Satisfied

EXPECTATION

Please rank from 1-9 the following knowledge attributes which you expect the graduate to demonstrate when he or she performs the job. Number 1 indicates your most highly ranked knowledge attribute.

	Knowledge	**Rank**	
	The graduate should:		
a	Understand **principles** and **concepts** associated with civil engineering	……..	a
b	Understand **basic science** and **engineering fundamentals** associated with civil engineering	……..	b
c	Understand **in-depth technical knowledge** in at least one civil engineering discipline	……..	c
d	Understand **problem identification, formulation** and **solution** associated with civil engineering	……..	d
e	Understand how to utilise a **systems approach** to design and operational performance associated with civil engineering	……..	e
f	Understand the principles of **sustainable design** and **development** associated with civil engineering	……..	f
g	Understand **laws, regulations and standards** associated with civil engineering	……..	g
h	Understand the principles of **management and business** associated with civil engineering	……..	h
i	Understand **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	……..	i

Please rank from 1-9 the following skill attributes, which you expect for the graduates to demonstrate when he or she performs the job. Number 1 indicates your most highly ranked skill attribute.

	Skills	**Rank**	
	The graduate should be able to:		
a	Apply **in-depth technical skills** in at least one civil engineering discipline	……..	a
b	Use **technologies** appropriately	……..	b
c	Access, evaluate and synthesise **information**	……..	c
d	**Communicate** effectively not only with engineers but also with the community at large	……..	d
e	Function effectively as **an individual**	……..	e
f	Function effectively in multi-disciplinary or multi-cultural **teams**	……..	f
g	Function effectively in teams with the capacity to be **a member**	……..	g
h	Function effectively in teams with the capacity to be **a manager**	……..	h
i	Function effectively in teams with the capacity to be **a leader**	……..	i

Please rank from 1-9 the following attitude attributes, which you expect for the graduates to demonstrate when he or she performs the job. Number 1 indicates your most highly ranked attitude attribute.

	Attitudes	**Rank**	
	The graduate should be:		
a	Able to t**hink** critically, creatively, reflectively in their work	……..	a
b	Committed to undertake **lifelong learning**	……..	b
c	Committed to meeting **ethical** responsibilities in their work	……..	c
d	Committed to meeting **environmental** responsibilities in their work	……..	d
e	Able to work with **international** and **global perspectives**	……..	e
f	Committed to developing further his or her **professional skills**	……..	f
g	Committed to working effectively with different **cultural groups**	……..	g
h	Committed to using effective **group skills** in his or her workplace	……..	h
i	Committed to develop effective **interpersonal skills** in his or her workplace	……..	i

Please make any further comments if you wish.
……
……
……

Please indicate your email address if you wish the information contained in this questionnaire to be supplied to you: …………………………………………………

Appendix B. The questionnaire set for graduates

Code: 12………

ATTRIBUTES, JOB PERFORMANCE, SATISFACTION AND EXPECTATION OF CIVIL ENGINEERING GRADUATES

CIVIL ENGINEERING GRADUATE QUESTIONNAIRE

2006

Dear Respondent

Thank you for agreeing to participate in this questionnaire. As part of my PhD studies, I am conducting a survey to identify the attributes of 4-year civil engineering education graduates, their job performance, the satisfaction of stakeholders with graduates' capabilities, and to identify the expectations with civil engineering graduates. The objective of the study is to produce a model that links graduate attributes, potential job performance, and stakeholder satisfaction with graduate capabilities to inform various communities associated with civil engineering education.

The purpose of this questionnaire is to gather information from you as a graduate of 4-year civil engineering education in a workplace about your existing attributes, job performance, your satisfaction with your performance, and your expectations about your graduate capabilities. For the purpose of this survey, a graduate is defined as a person who has completed a 4-year civil engineering degree within the past three years, i.e. 2003, 2004, 2005, and 2006.

Your responses about each question will be valuable. Information provided in this questionnaire by you and others will be collated and reported to you by email. Your individual answers will be kept strictly confidential and your anonymity is guaranteed in any written reports. The identification code on this questionnaire is for my purposes in administration of the survey. Furthermore, this survey has been approved by the Human Research Ethics Committee of Curtin University of Technology with the number **SMEC 20060017**.

This questionnaire will take approximately **20 minutes** to complete. While I realise I am taking much of your valuable time, the information gathered from the questionnaire will be helpful to civil engineering education, industry and professional associations. Thank you for your cooperation and assistance in completing this questionnaire.

Perth, 1 October 2006

Albani Musyafa
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Ph.D. Student
Building T.120.014
Civil Engineering Department
Curtin University of Technology
GPO Box U1987, Perth, 6845, Australia
albani.musyafa@postgrad.curtin.edu.au

PLEASE RETURN THE QUESTIONNAIRE IN THE REPLY PAID ENVELOPE AS SOON AS POSSIBLE.

Indicate your response for each question either by ticking one box or providing details.

RESPONDENT DETAILS

1 Are you male or female? ☐ Male ☐ Female

2 Indicate the city where you work: …………………………

3 Indicate the institution where you studied your 4-year civil engineering degree: …………………………..

4 Indicate the year when you completed the 4-year civil engineering education?
☐ 2003 ☐ 2004 ☐ 2005 ☐ 2006 ☐ Other, specify…………

5 Have you extended your education with other professional development or training?
☐ No ☐ Included If Included,
specify: ………………………………………………..
…………………………………………………………………………………………………

6 How many years have you been in you current job?
☐ Up to 1 year ☐ 2 years ☐ 3 years

7 Have you received specialised training in the workplace for your current job?
☐ No ☐ Included

If Included, for what period of time was the training carried out?
☐ Up to 8 hours ☐ 9-16 hours ☐ 17-24 hours ☐ More than 24 hours

RESPONDENT'S JOB DETAILS

8 What is the nature of the job that you undertake?
☐ Managerial ☐ Technical ☐ Other, specify………… ……………………………

9 Is the job unique?
☐ No
☐ Included
If Included, indicate the unique aspect of the job:
……………………………………………………………………………………………………
……………

10 Where is the job mostly undertaken?
☐ In an office ☐ On a site ☐ Other, specify………… ……………………………

11 What kind of communication is most required for the job?
☐ Oral ☐ Letter/Writing ☐ Engineering drawing ☐ Other, specify…………

12 What are the expected results of the job?
☐ Goods ☐ Services ☐ Other, specify………… ……………………………

13 What are the main facilities and required tools or equipment to support the job?
☐ Personal Computers ☐ Machinery ☐ Other,
specify………… ……………………………

EXISTING GRADUATE ATTRIBUTES

The following statements are associated with identifying your existing attributes. Please circle the number of the response you believe expresses your assessment of the statement.

1	2	3	4	5
STRONGLY DISAGREE	DISAGREE	NOT SURE	AGREE	STRONGLY AGREE

	Assessment about knowledge					
	I believe that I:					
1	Understand **principles** and **concepts** associated with civil engineering	1	2	3	4	5
2	Understand **basic science** and **engineering fundamentals** associated with civil engineering	1	2	3	4	5
3	Understand **in-depth technical knowledge** in at least one civil engineering discipline	1	2	3	4	5
4	Understand **problem identification, formulation** and **solution** associated with civil engineering	1	2	3	4	5
5	Understand to utilise a **systems approach** to design and operational performance associated with civil engineering	1	2	3	4	5
6	Understand the principles of **sustainable design** and **development** associated with civil engineering	1	2	3	4	5
7	Understand **laws, regulations and standards** associated with civil engineering	1	2	3	4	5
8	Understand the principles of **management and business** associated with civil engineering	1	2	3	4	5
9	Understand **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	1	2	3	4	5

	Assessment about skills					
	I believe that I am able to:					
10	Apply **in-depth technical skills** in at least one civil engineering discipline	1	2	3	4	5
11	Use **technologies** appropriately	1	2	3	4	5
12	Access, evaluate and synthesise **information**	1	2	3	4	5
13	**Communicate** effectively not only with engineers but also with the community at large	1	2	3	4	5
14	Function effectively as **an individual**	1	2	3	4	5
15	Function effectively in **multi-disciplinary** or **multi-cultural teams**	1	2	3	4	5
16	Function effectively in teams with the capacity to be **a member**	1	2	3	4	5
17	Function effectively in teams with the capacity to be **a manager**	1	2	3	4	5
18	Function effectively in teams with the capacity to be **a leader**	1	2	3	4	5

	Assessment about attitude					
	I believe that I am able to:					
19	T**hink** critically, creatively, reflectively in their work	1	2	3	4	5
20	Committed to undertake **lifelong learning**	1	2	3	4	5
21	Committed to meeting **ethical** responsibilities in their work	1	2	3	4	5
22	Committed to meeting **environmental** responsibilities in their work	1	2	3	4	5
23	Work with **international** and **global perspectives**	1	2	3	4	5
24	Committed to developing further my **professional skills**	1	2	3	4	5
25	Committed to working effectively with different **cultural groups**	1	2	3	4	5
26	Committed to using effective **group skills** in my workplace	1	2	3	4	5
27	Committed to develop effective **interpersonal skills** in my workplace	1	2	3	4	5

JOB PERFORMANCE

The following questions are associated with the performance of the jobs, work or projects undertaken by you. Please circle the number of the response that expresses your assessment of the statement.

	Assessment about performance of any job					
1	What is the **actual duration** of any jobs undertaken by you?	1 Much longer than the planning	2 Longer than the planning	3 Same as the planning	4 Shorter than the planning	5 Much shorter than the planning
2	What is the **actual cost** of any jobs undertaken by you?	1 Much more than the planning	2 More than the planning	3 Same as the planning	4 Less than the planning	5 Much less than the planning
3	What is the **actual quality** of any jobs undertaken by you?	1 Much less than the planning	2 Less than the planning	3 Same as the planning	4 More than the planning	5 Much more than the planning

Indicate your job performance in relation to ONE specific job or project.

	Job performance detail	
1	How long was the **actual duration** of the job?	………………
2	How long was the **planned duration** of the job?	………………
3	How much was the **actual cost** of the job?	$…………………
4	How much was the **planned cost** of the job?	$…………………

SATISFACTION

The following question is associated with your satisfaction with the outcomes of the jobs, work or projects completed by you. Please circle the number of the response that expresses your assessment with the statement.

	Satisfaction with the outcomes of the job					
1	How satisfy are you with the outcome of any jobs undertaken by you?	1 Highly Dissatisfie d	2 Dissatisfie d	3 Not sure	4 Satisfied	5 Highly Satisfied

EXPECTATION

Please rank from 1-9 the following knowledge attributes which you expect to demonstrate when you perform the job. Number 1 indicates your most highly ranked knowledge attribute.

	Knowledge	**Rank**	
	I should be:		
a	Understand **principles** and **concepts** associated with civil engineering	……..	a
b	Understand **basic science** and **engineering fundamentals** associated with civil engineering	……..	b
c	Understand **in-depth technical knowledge** in at least one civil engineering discipline	……..	c
d	Understand **problem identification, formulation** and **solution** associated with civil engineering	……..	d
e	Understand to utilise a **systems approach** to design and operational performance associated with civil engineering	……..	e
f	Understand the principles of **sustainable design** and **development** associated with civil engineering	……..	f
g	Understand **laws, regulations and standards** associated with civil engineering	……..	g
h	Understand the principles of **management and business** associated with civil engineering	……..	h
i	Understand **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	……..	i

Please rank from 1-9 the following skill attributes, which you expect to demonstrate when you perform the job. Number 1 indicates your most highly ranked skill attribute.

	Skills	**Rank**	
	I should be able to:		
a	Apply **in-depth technical skills** in at least one civil engineering discipline	……..	a
b	Use **technologies** appropriately	……..	b
c	Access, evaluate and synthesise **information**	……..	c
d	**Communicate** effectively not only with engineers but also with the community at large	……..	d
e	Function effectively as **an individual**	……..	e
f	Function effectively in multi-disciplinary or multi-cultural **teams**	……..	f
g	Function effectively in teams with the capacity to be **a member**	……..	g
h	Function effectively in teams with the capacity to be **a manager**	……..	h
i	Function effectively in teams with the capacity to be **a leader**	……..	i

Please rank from 1-9 the following attitude attributes, which you expect to demonstrate when you perform the job. Number 1 indicates your most highly ranked attitude attribute.

	Attitudes	**Rank**	
	I should be:		
a	Able to **think** critically, creatively, reflectively in their work	……..	a
b	Committed to undertake **lifelong learning**	……..	b
c	Committed to meeting **ethical** responsibilities in their work	……..	c
d	Committed to meeting **environmental** responsibilities in their work	……..	d
e	Able to work with **international** and **global perspectives**	……..	e
f	Committed to developing further my **professional skills**	……..	f
g	Committed to working effectively with different **cultural groups**	……..	g
h	Committed to using effective **group skills** in my workplace	……..	h
i	Committed to develop effective **interpersonal skills** in my workplace	……..	i

Please make any further comments if you wish.
………
………

Please indicate your email address if you wish the information contained in this questionnaire to be supplied to you: …………………………………………………

Appendix C. The questionnaire set for academicians

Code: 13………

ATTRIBUTES, JOB PERFORMANCE, SATISFACTION AND EXPECTATION OF CIVIL ENGINEERING GRADUATES

CIVIL ENGINEERING EDUCATOR/ SUPERVISOR QUESTIONNAIRE

2006

Dear Respondent

Thank you for agreeing to participate in this questionnaire. As part of my PhD studies, I am conducting a survey to identify the attributes of 4-year civil engineering education graduates, their job performance, the satisfaction of stakeholders with graduates' capabilities, and to identify the expectations with civil engineering graduates. The objective of the study is to produce a model that links graduate attributes, potential job performance, and stakeholder satisfaction with graduate capabilities to inform various communities associated with civil engineering education.

The purpose of this questionnaire is to gather information from you as an educator (or supervisor) in civil engineering education about the existing attributes of recent graduates you have come into contact with and your expectations of graduates of civil engineering education. For the purpose of this survey, a graduate is defined as a fresh graduate who has completed a 4-year civil engineering degree within the past three years, i.e. 2003, 2004, 2005, and 2006.

Your responses about each question will be valuable. Information provided in this questionnaire by you and others will be collated and reported to you by email. Your individual answers will be kept strictly confidential and your anonymity is guaranteed in any written reports. The identification code on this questionnaire is for my purposes in administration of the survey. Furthermore, this survey has been approved by the Human Research Ethics Committee of Curtin University of Technology with the number **SMEC 20060017**.

This questionnaire will take approximately **15 minutes** to complete. While I realise I am taking much of your valuable time, the information gathered from the questionnaire will be helpful to civil engineering education, industry and professional associations. Thank you for your cooperation and assistance in completing this questionnaire.

Perth, 1 October 2006

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PLEASE RETURN THE QUESTIONNAIRE IN THE REPLY PAID ENVELOPE AS SOON AS POSSIBLE.

Indicate your response for each question either by ticking one box or providing details.

	RESPONDENT DETAILS
1	Are you male or female? ☐ Male ☐ Female
2	Indicate the city where you work: …………………………
3	What is your association with the graduates? ☐ Educator ☐ Supervisor ☐ Other, specify: ……………..
4	How long have you been in this position? ☐ Up to 1 year ☐ 2 years ☐ 3 years ☐ More than 3 years

	GRADUATES DETAILS
5	Indicate the institution where the 4-year civil engineering graduates, with whom you are associated with, study (OPTIONAL): …………………………..
6	Indicate the year(s) when the graduates completed the 4-year civil engineering education? ☐ 2003 ☐ 2004 ☐ 2005 ☐ 2006 ☐ Other, specify…………

EXISTING GRADUATES ATTRIBUTES

The following statements are associated with identifying the existing attributes of the graduates. Please circle the number of the response that expresses your assessment about the statement.

1 STRONGLY DISAGREE	2 DISAGREE	3 NOT SURE	4 AGREE	5 STRONGLY AGREE

	Assessment about knowledge **I believe that the graduates:**					
1	Understand **principles** and **concepts** associated with civil engineering	1	2	3	4	5
2	Understand **basic science** and **engineering fundamentals** associated with civil engineering	1	2	3	4	5
3	Understand **in-depth technical knowledge** in at least one civil engineering discipline	1	2	3	4	5
4	Understand **problem identification, formulation** and **solution** associated with civil engineering	1	2	3	4	5
5	Understand to utilise a **systems approach** to design and operational performance associated with civil engineering	1	2	3	4	5
6	Understand the principles of **sustainable design** and **development** associated with civil engineering	1	2	3	4	5
7	Understand **laws, regulations and standards** associated with civil engineering	1	2	3	4	5
8	Understand the principles of **management and business** associated with civil engineering	1	2	3	4	5
9	Understand **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	1	2	3	4	5

	Assessment about skills **I believe that the graduates are able to:**					
10	Apply **in-depth technical skills** in at least one civil engineering discipline	1	2	3	4	5
11	Use **technologies** appropriately	1	2	3	4	5
12	Access, evaluate and synthesise **information**	1	2	3	4	5
13	**Communicate** effectively not only with engineers but also with the community at large	1	2	3	4	5
14	Function effectively as **an individual**	1	2	3	4	5
15	Function effectively in **multi-disciplinary** or **multi-cultural teams**	1	2	3	4	5
16	Function effectively in teams with the capacity to be **a member**	1	2	3	4	5
17	Function effectively in teams with the capacity to be **a manager**	1	2	3	4	5
18	Function effectively in teams with the capacity to be **a leader**	1	2	3	4	5

	Assessment about attitudes **I believe that the graduates are able to:**					
19	T**hink** critically, creatively, reflectively in their work	1	2	3	4	5
20	Committed to undertake **lifelong learning**	1	2	3	4	5
21	Committed to meeting **ethical** responsibilities in their work	1	2	3	4	5
22	Committed to meeting **environmental** responsibilities in their work	1	2	3	4	5
23	Work with **international** and **global perspectives**	1	2	3	4	5
24	Committed to developing further their **professional skills**	1	2	3	4	5
25	Committed to working effectively with different **cultural groups**	1	2	3	4	5
26	Committed to using effective **group skills** in their workplace	1	2	3	4	5
27	Committed to develop effective **interpersonal skills** in their workplace	1	2	3	4	5

EXPECTATION

Please rank from 1-9 the following knowledge attributes which you expect of graduates from a 4-year civil engineering degree to demonstrate when they move into the workforce. Number 1 indicates your most highly ranked knowledge attribute.

	Knowledge **The graduates should be:**	**Rank**	
a	Understand **principles** and **concepts** associated with civil engineering	……..	a
b	Understand **basic science** and **engineering fundamentals** associated with civil engineering	……..	b
c	Understand **in-depth technical knowledge** in at least one civil engineering discipline	……..	c
d	Understand **problem identification, formulation** and **solution** associated with civil engineering	……..	d
e	Understand to utilise a **systems approach** to design and operational performance associated with civil engineering	……..	e
f	Understand the principles of **sustainable design** and **development** associated with civil engineering	……..	f
g	Understand **laws, regulations and standards** associated with civil engineering	……..	g
h	Understand the principles of **management and business** associated with civil engineering	……..	h
i	Understand **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	……..	i

Please rank from 1-9 the following skill attributes, which you expect of graduates from a 4-year civil engineering degree when they move into the workforce. Number 1 indicates your most highly ranked skill attribute.

	Skills **The graduates should be able to:**	**Rank**	
a	Apply **in-depth technical skills** in at least one civil engineering discipline	……..	a
b	Use **technologies** appropriately	……..	b
c	Access, evaluate and synthesise **information**	……..	c
d	**Communicate** effectively not only with engineers but also with the community at large	……..	d
e	Function effectively as **an individual**	……..	e
f	Function effectively in multi-disciplinary or multi-cultural **teams**	……..	f
g	Function effectively in teams with the capacity to be **a member**	……..	g
h	Function effectively in teams with the capacity to be **a manager**	……..	h
i	Function effectively in teams with the capacity to be **a leader**	……..	i

Please rank from 1-9 the following attitude attributes, which you expect for the graduates of 4-year civil engineering degree to demonstrate when they move into the workforce. Number 1 indicates your most highly ranked attitude attribute.

	Attitudes **The graduates should be:**	**Rank**	
a	Able to t**hink** critically, creatively, reflectively in their work	……..	a
b	Committed to undertake **lifelong learning**	……..	b
c	Committed to meeting **ethical** responsibilities in their work	……..	c
d	Committed to meeting **environmental** responsibilities in their work	……..	d
e	Able to work with **international** and **global perspectives**	……..	e
f	Committed to developing further their **professional skills**	……..	f
g	Committed to working effectively with different **cultural groups**	……..	g
h	Committed to using effective **group skills** in their workplace	……..	h
i	Committed to develop effective **interpersonal skills** in their workplace	……..	i

Please make any further comments if you wish.

………
………
………

Please indicate your email address if you wish the information contained in this questionnaire to be supplied to you: …………………………………………………

Appendix D. The questionnaire set for professionals

Code: 14……….

ATTRIBUTES, JOB PERFORMANCE, SATISFACTION AND EXPECTATION OF CIVIL ENGINEERING GRADUATES

EXPERT IN PROFESSIONAL ORGANISATION QUESTIONNAIRE

2006

Dear Respondent

Thank you for agreeing to participate in this questionnaire. As part of my PhD studies, I am conducting a survey to identify the attributes of 4-year civil engineering education graduates, their job performance, the satisfaction of stakeholders with graduates' capabilities, and to identify the expectations with civil engineering graduates. The objective of the study is to produce a model that links graduate attributes, potential job performance, and stakeholder satisfaction with graduate capabilities to inform various communities associated with civil engineering education.

The purpose of this questionnaire is to gather information from you as an expert in a professional organisation about the existing attributes of recent civil engineering graduates you have come into contact with and your expectations of graduates. For the purpose of this survey, a graduate is defined as a person who has completed a 4-year civil engineering degree within the past three years, i.e. 2003, 2004, 2005, and 2006.

Your responses about each question will be valuable. Information provided in this questionnaire by you and others will be collated and reported to you by email. Your individual answers will be kept strictly confidential and your anonymity is guaranteed in any written reports. The identification code on this questionnaire is for my purposes in administration of the survey. Furthermore, this survey has been approved by the Human Research Ethics Committee of Curtin University of Technology with the number **SMEC 20060017**.

This questionnaire will take approximately **15 minutes** to complete. While I realise I am taking much of your valuable time, the information gathered from the questionnaire will be helpful to civil engineering education, industry and professional associations. Thank you for your cooperation and assistance in completing this questionnaire.

Perth, 1 October 2006

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PLEASE RETURN THE QUESTIONNAIRE IN THE REPLY PAID ENVELOPE AS SOON AS POSSIBLE.

Indicate your response for each question either by ticking one box or providing details.

	RESPONDENT DETAILS
1	Are you male or female? ☐ Male ☐ Female
2	Indicate the city where you work: …………………………
3	What is your association with graduate civil engineers? ☐ Researcher ☐ Practitioner ☐ Other, specify ……………..
4	How long have you been in this position? ☐ Up to 1 year ☐ 2 years ☐ 3 years ☐ More than 3 years

	GRADUATES DETAILS
5	Please indicate the institutions where 4-year civil engineering graduates with whom you have been associated with have studied: ………………………….. ………………………….. ………………………….. ………………………….. ………………………….. ………………………… ………………………….. ………………………….. ………………………….. ………………………….. ………………………….. …………………………..
6	Indicate the year(s) when the graduates completed the 4-year civil engineering education? ☐ 2003 ☐ 2004 ☐ 2005 ☐ 2006 ☐ Other, specify…………

EXISTING GRADUATE ATTRIBUTES

The following statements are associated with identifying the existing attributes of the graduates. Please circle the number of the response that expresses your assessment of the statement.

1	2	3	4	5
STRONGLY DISAGREE	DISAGREE	NOT SURE	AGREE	STRONGLY AGREE

	Assessment about knowledge					
	I believe that the graduates:					
1	Understand **principles** and **concepts** associated with civil engineering	1	2	3	4	5
2	Understand **basic science** and **engineering fundamentals** associated with civil engineering	1	2	3	4	5
3	Understand **in-depth technical knowledge** in at least one civil engineering discipline	1	2	3	4	5
4	Understand **problem identification, formulation** and **solution** associated with civil engineering	1	2	3	4	5
5	Understand to utilise a **systems approach** to design and operational performance associated with civil engineering	1	2	3	4	5
6	Understand the principles of **sustainable design** and **development** associated with civil engineering	1	2	3	4	5
7	Understand **laws, regulations and standards** associated with civil engineering	1	2	3	4	5
8	Understand the principles of **management and business** associated with civil engineering	1	2	3	4	5
9	Understand **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	1	2	3	4	5

	Assessment about skills					
	I believe that the graduates are able to:					
10	Apply **in-depth technical skills** in at least one civil engineering discipline	1	2	3	4	5
11	Use **technologies** appropriately	1	2	3	4	5
12	Access, evaluate and synthesise **information**	1	2	3	4	5
13	**Communicate** effectively not only with engineers but also with the community at large	1	2	3	4	5
14	Function effectively as **an individual**	1	2	3	4	5
15	Function effectively in **multi-disciplinary** or **multi-cultural teams**	1	2	3	4	5
16	Function effectively in teams with the capacity to be **a member**	1	2	3	4	5
17	Function effectively in teams with the capacity to be **a manager**	1	2	3	4	5
18	Function effectively in teams with the capacity to be **a leader**	1	2	3	4	5

	Assessment about attitude					
	I believe that the graduates are able to:					
19	T**hink** critically, creatively, reflectively in their work	1	2	3	4	5
20	Committed to undertake **lifelong learning**	1	2	3	4	5
21	Committed to meeting **ethical** responsibilities in their work	1	2	3	4	5
22	Committed to meeting **environmental** responsibilities in their work	1	2	3	4	5
23	Work with **international** and **global perspectives**	1	2	3	4	5
24	Committed to developing further their **professional skills**	1	2	3	4	5
25	Committed to working effectively with different **cultural groups**	1	2	3	4	5
26	Committed to using effective **group skills** in their workplace	1	2	3	4	5
27	Committed to develop effective **interpersonal skills** in their workplace	1	2	3	4	5

EXPECTATION

Please rank from 1-9 the following knowledge attributes which you expect for the graduates of 4-year civil engineering degree to demonstrate when they perform the job. Number 1 indicates your most highly ranked knowledge attribute.

	Knowledge **The graduates should be:**	**Rank**	
a	Understand **principles** and **concepts** associated with civil engineering	……..	a
b	Understand **basic science** and **engineering fundamentals** associated with civil engineering	……..	b
c	Understand **in-depth technical knowledge** in at least one civil engineering discipline	……..	c
d	Understand **problem identification, formulation** and **solution** associated with civil engineering	……..	d
e	Understand to utilise a **systems approach** to design and operational performance associated with civil engineering	……..	e
f	Understand the principles of **sustainable design** and **development** associated with civil engineering	……..	f
g	Understand **laws, regulations and standards** associated with civil engineering	……..	g
h	Understand the principles of **management and business** associated with civil engineering	……..	h
i	Understand **other disciplines** associated with civil engineering i.e. electrical, mechanical, architectural or urban planning fundamentals	……..	i

Please rank from 1-9 the following skill attributes which you expect for the graduates of 4-year civil engineering degree to demonstrate when they perform the job. Number 1 indicates your most highly ranked skill attribute.

	Skills **The graduates should be able to:**	**Rank**	
a	Apply **in-depth technical skills** in at least one civil engineering discipline	……..	a
b	Use **technologies** appropriately	……..	b
c	Access, evaluate and synthesise **information**	……..	c
d	**Communicate** effectively not only with engineers but also with the community at large	……..	d
e	Function effectively as **an individual**	……..	e
f	Function effectively in multi-disciplinary or multi-cultural **teams**	……..	f
g	Function effectively in teams with the capacity to be **a member**	……..	g
h	Function effectively in teams with the capacity to be **a manager**	……..	h
i	Function effectively in teams with the capacity to be **a leader**	……..	i

Please rank from 1-9 the following attitude attributes which you expect for the graduates of 4-year civil engineering degree to demonstrate when they perform the job. Number 1 indicates your most highly ranked attitude attribute.

	Attitudes **The graduates should be:**	**Rank**	
a	Able to t**hink** critically, creatively, reflectively in their work	……..	a
b	Committed to undertake **lifelong learning**	……..	b
c	Committed to meeting **ethical** responsibilities in their work	……..	c
d	Committed to meeting **environmental** responsibilities in their work	……..	d
e	Able to work with **international** and **global perspectives**	……..	e
f	Committed to developing further their **professional skills**	……..	f
g	Committed to working effectively with different **cultural groups**	……..	g
h	Committed to using effective **group skills** in their workplace	……..	h
i	Committed to develop effective **interpersonal skills** in their workplace	……..	i

Please make any further comments if you wish.
……
……
……

Please indicate your email address if you wish the information contained in this questionnaire to be supplied to you: …………………………………………………

Appendix E. The request letters for employers

Perth, 12 December 2006

No : ………..
Subject : Request for responding the questionnaire
Enclosure : 1 Questionnaire
1 Reply postpaid envelop
1 Information sheet
Dear ………..

The education of engineering students is an expensive exercise – it costs a lot of money, time and effort. It is important that we get it right. However there are many different views on what an engineering graduate should be. Employers, Engineers Australia, individual professionals and indeed the graduates themselves all have a picture of the 'ideal graduate'.

The department is undertaking an extensive review of our Civil and Construction Engineering course, the attributes of our graduates, the course learning outcomes, the expectations of employers, professionals and the graduates. The overall objective is to develop a picture of a course, its content and outcomes that most closely matches the wishes and ideals of those involved. Having done this we, and other universities, will be able to better match our course as closely as possible with these expectations.

Rather than rely solely upon the formalised procedures of accreditation and unrelated surveys, we have structured and planned this review as a comprehensive project that will incorporate representative comment and observations for the four main sectors involved; professional engineers, engineering academics, employers and graduates. These will be integrated with studies of course learning outcomes carried out on our behalf by professional engineers as well as governments and university generic course reviews.

I realise that requests for information roll in with alarming frequency. However, I am asking you to give us your opinion not only for this department but for all of those who will ultimately benefit, including yourself and colleagues and future graduates.

We believe that you have been in a position to observe the knowledge, skills, attitudes and performance of Civil Engineering graduates recruited by your organisation. I would be extremely grateful if you would to respond to the questionnaires enclosed. A reply paid addressed envelope is enclosed. If you are not in a position to respond to the questionnaire, please pass the questionnaire and other documents to another person who is in a position to observe the knowledge, skills, attitude and performance of Civil Engineering graduates.

Findings from this project will be distributed to respondents and their institutions by email. The data collection and the publication method of this study have been approved by Human Research Ethic Committee of Curtin University of Technology. The approval number is SMEC 20060017. The rights of respondents and confidentiality are mentioned in Information Sheet for the Respondent.

If you need any more information or have any concerns about the study, please contact me.
Thank you in anticipation of your cooperation.

Kind Regards
David Scott
Professor and Head, Department of Civil Engineering,
Curtin University of Technology,
GPO Box U1987, Perth, 6845, Australia
Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au
CRICOS provider code 00301

Perth, 10 November 2006

No : ………..
Subject : Reminder: Employer questionnaire from Curtin University of Technology
Enclosure : 1 Questionnaire
1 Reply postpaid envelop
1 Information sheet

Dear…
I am writing to you to ensure that you have received a letter from the Department of Civil Engineering, Curtin University of Technology, with a request to respond to a questionnaire. The letter was sent several weeks ago. To anticipate any problems that may have been experienced with the original letter, I again enclosure the questionnaire, the information sheet, and the reply postpaid envelope for your consideration.

I believe that you are in a position to observe the knowledge, skills, attitudes and performance of Civil Engineering graduates recruited by your organization. Your opinions will be highly valued by me and I would appreciate any time that you can take to complete the questionnaire. If you are not in the position to respond the questionnaire, please send the questionnaire set to an eligible person.

As Head of the Civil Engineering Department, I am overseeing an extensive review of our Civil and Construction Engineering course, the attributes of our graduates, the course learning outcomes, the expectations of employers, professionals and the graduates. The overall objective is to develop a picture of a course, its content and outcomes that most closely match the wishes and ideals of people like you who have an interest in the future needs in the industry and the graduates we produce. Having completed this review with your help we, and other universities, will be able to better match our course as closely as possible with these expectations.

If you need any more information or have any concerns about the study, please contact me.

I thank you in advance for your cooperation and support of our course.

Yours sincerely

David Scott
Professor and Head, Department of Civil Engineering,
Curtin University of Technology,
GPO Box U1987, Perth, 6845, Australia
Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au

Perth, 18 January 2007

No : (..*Code of Respondent…*)
Subject : Request for responding the questionnaire
Enclosure : 1 Questionnaire
1 Reply postpaid envelop
1 Information sheet

Dear *(…Title… Family Name…)*

The education of engineering students is an expensive exercise – it costs a lot of money, time and effort. It is important that we get it right. However there are many different views on what an engineering graduate should be. Employers, Engineers Australia, individual professionals and indeed the graduates themselves all have a picture of the 'ideal graduate'.

The department is undertaking an extensive review of our Civil and Construction Engineering course, the attributes of our graduates, the course learning outcomes, the expectations of employers, professionals and the graduates. The overall objective is to develop a picture of a course, its content and outcomes that most closely matches the wishes and ideals of those involved. Having done this we, and other universities, will be able to better match our course as closely as possible with these expectations.

Rather than rely solely upon the formalised procedures of accreditation and unrelated surveys, we have structured and planned this review as a comprehensive project that will incorporate representative comment and observations for the four main sectors involved; professional engineers, engineering academics, employers and graduates. These will be integrated with studies of course learning outcomes carried out on our behalf by professional engineers as well as governments and university generic course reviews.

I realise that requests for information roll in with alarming frequency. However, I am asking you to give us your opinion not only for this department but for all of those who will ultimately benefit, including yourself and colleagues and future graduates.

We believe that you have been in a position to observe the knowledge, skills, attitudes and performance of Civil Engineering graduates recruited by your organisation. I would be extremely grateful if you would to respond to the questionnaires enclosed. A reply paid addressed envelope is enclosed. If you are not in a position to respond to the questionnaire, please pass the questionnaire and other documents to another person who is in a position to observe the knowledge, skills, attitude and performance of Civil Engineering graduates.

Findings from this project will be distributed to respondents and their institutions by email. The data collection and the publication method of this study have been approved by Human Research Ethic Committee of Curtin University of Technology. The approval number is SMEC 20060017. The rights of respondents and confidentiality are mentioned in Information Sheet for the Respondent.

If you need any more information or have any concerns about the study, please contact me.
Thank you in anticipation of your cooperation.

Kind Regards
David Scott
Professor and Head, Department of Civil Engineering,
Curtin University of Technology,
GPO Box U1987, Perth, 6845, Australia
Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au
CRICOS provider code 00301

Appendix F. The request letters for graduates

Perth, 1 October 2006

No : ………..
Subject : Request for responding the questionnaire
Enclosure : 3 Questionnaires
3 Reply postpaid envelops
3 Information sheets
Dear …………

The education of engineering students is an expensive exercise – it costs a lot of money, time and effort. It is important that we get it right. However there are many different views on what an engineering graduate should be. Employers, Engineers Australia, individual professionals and indeed the graduates themselves all have a picture of the 'ideal graduate'.

The department is undertaking an extensive review of our Civil and Construction Engineering course, the attributes of our graduates, the course learning outcomes, the expectations of employers, professionals and the graduates. The overall objective is to develop a picture of a course, its content and outcomes that most closely matches the wishes and ideals of those involved. Having done this we, and other universities, will be able to better match our course as closely as possible with these expectations.

Rather than rely solely upon the formalised procedures of accreditation and unrelated surveys, we have structured and planned this review as a comprehensive project that will incorporate representative comment and observations for the four main sectors involved; professional engineers, engineering academics, employers and graduates. These will be integrated with studies of course learning outcomes carried out on our behalf by professional engineers as well as governments and university generic course reviews.

I realise that requests for information roll in with alarming frequency. However, I am asking you to give us your opinion not only for this department but for all of those who will ultimately benefit, including yourself and colleagues and future graduates.

We believe that you are a Civil Engineering graduate with not more than 3 years of work experience in the construction industry. I would be extremely grateful if you and two other colleagues who are recent graduates would to respond to the questionnaires enclosed. (One questionnaire set is enclosed for each respondent). Every questionnaire set has been provided by reply paid addressed envelope.

Findings from this project will be distributed to respondents and their institutions by email. The data collection and the publication method of this study have been approved by Human Research Ethic Committee of Curtin University of Technology. The approval number is SMEC 20060017. The rights of respondents and confidentiality are mentioned in Information Sheet for the Respondent.

If you need any more information or have any concerns about the study, please contact me.

Thank you in anticipation of your cooperation.

Kind Regards
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GPO Box U1987, Perth, 6845, Australia
Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au
CRICOS provider code 00301

Perth, 10 November 2006

No : ………..
Subject : Reminder: Employer questionnaire from Curtin University of Technology
Enclosure : 1 Questionnaire
1 Reply postpaid envelop
1 Information sheet

Dear…
I am writing to you to ensure that you have received a letter from the Department of Civil Engineering, Curtin University of Technology, with a request to respond to a questionnaire. The letter was sent several weeks ago. To anticipate any problems that may have been experienced with the original letter, I again enclosure the questionnaire, the information sheet, and the reply postpaid envelope for your consideration.

I believe that you are a Civil Engineering graduate with not more than 3 years of work experience in the construction industry. Your opinions will be highly valued by me and I would appreciate any time that you can take to complete the questionnaire.

As Head of the Civil Engineering Department, I am overseeing an extensive review of our Civil and Construction Engineering course, the attributes of our graduates, the course learning outcomes, the expectations of employers, professionals and the graduates. The overall objective is to develop a picture of a course, its content and outcomes that most closely match the wishes and ideals of people like you who have an interest in the future needs in the industry and the graduates we produce. Having completed this review with your help we, and other universities, will be able to better match our course as closely as possible with these expectations.

If you need any more information or have any concerns about the study, please contact me.

I thank you in advance for your cooperation and support of our course.

Yours sincerely

David Scott
Professor and Head, Department of Civil Engineering,
Curtin University of Technology,
GPO Box U1987, Perth, 6845, Australia
Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au

Appendix G. The request letters for academicians

Perth, 1 October 2006

No : ………..
Subject : Request for responding the questionnaire
Enclosure : 3 Questionnaires
3 Reply postpaid envelops
3 Information sheets
Dear …………

The education of engineering students is an expensive exercise – it costs a lot of money, time and effort. It is important that we get it right. However there are many different views on what an engineering graduate should be. Employers, Engineers Australia, individual professionals and indeed the graduates themselves all have a picture of the 'ideal graduate'.

The department is undertaking an extensive review of our Civil and Construction Engineering course, the attributes of our graduates, the course learning outcomes, the expectations of employers, professionals and the graduates. The overall objective is to develop a picture of a course, its content and outcomes that most closely matches the wishes and ideals of those involved. Having done this we, and other universities, will be able to better match our course as closely as possible with these expectations.

Rather than rely solely upon the formalised procedures of accreditation and unrelated surveys, we have structured and planned this review as a comprehensive project that will incorporate representative comment and observations for the four main sectors involved; professional engineers, engineering academics, employers and graduates. These will be integrated with studies of course learning outcomes carried out on our behalf by professional engineers as well as governments and university generic course reviews.

I realise that requests for information roll in with alarming frequency. However, I am asking you to give us your opinion not only for this department but for all of those who will ultimately benefit, including yourself and colleagues and future graduates.

We believe that you have experience of teaching students in a Bachelor of Civil Engineering course. I would be extremely grateful if you and two other colleagues with lecturing experience would to respond to the questionnaires enclosed. (One questionnaire set is enclosed for each respondent). Every questionnaire set has been provided by reply paid addressed envelope.

Findings from this project will be distributed to respondents and their institutions by email. The data collection and the publication method of this study have been approved by Human Research Ethic Committee of Curtin University of Technology. The approval number is SMEC 20060017. The rights of respondents and confidentiality are mentioned in Information Sheet for the Respondent.

If you need any more information or have any concerns about the study, please contact me.

Thank you in anticipation of your cooperation.

Kind Regards
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Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au
CRICOS provider code 00301

Perth, 10 November 2006

No : ………..
Subject : Reminder: Employer questionnaire from Curtin University of Technology
Enclosure : 1 Questionnaire
1 Reply postpaid envelop
1 Information sheet

Dear…
I am writing to you to ensure that you have received a letter from the Department of Civil Engineering, Curtin University of Technology, with a request to respond to a questionnaire. The letter was sent several weeks ago. To anticipate any problems that may have been experienced with the original letter, I again enclosure the questionnaire, the information sheet, and the reply postpaid envelope for your consideration.

I believe that you have experience of teaching students in a Bachelor of Civil Engineering course. Your opinions will be highly valued by me and I would appreciate any time that you can take to complete the questionnaire.

As Head of the Civil Engineering Department, I am overseeing an extensive review of our Civil and Construction Engineering course, the attributes of our graduates, the course learning outcomes, the expectations of employers, professionals and the graduates. The overall objective is to develop a picture of a course, its content and outcomes that most closely match the wishes and ideals of people like you who have an interest in the future needs in the industry and the graduates we produce. Having completed this review with your help we, and other universities, will be able to better match our course as closely as possible with these expectations.

If you need any more information or have any concerns about the study, please contact me.

I thank you in advance for your cooperation and support of our course.

Yours sincerely

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Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au

Appendix H. The request letters for professionals

Perth, 1 October 2006

No : ………..
Subject : Request for responding the questionnaire
Enclosure : 3 Questionnaires
3 Reply postpaid envelops
3 Information sheets
Dear …………

The education of engineering students is an expensive exercise – it costs a lot of money, time and effort. It is important that we get it right. However there are many different views on what an engineering graduate should be. Employers, Engineers Australia, individual professionals and indeed the graduates themselves all have a picture of the 'ideal graduate'.

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I realise that requests for information roll in with alarming frequency. However, I am asking you to give us your opinion not only for this department but for all of those who will ultimately benefit, including yourself and colleagues and future graduates.

We believe that you and your organisation has experience of observing or supervising Civil Engineering graduates in their early years working in the construction industry. I would be extremely grateful if you and two other colleagues with supervision experience would to respond to the questionnaires enclosed. (One questionnaire set is enclosed for each respondent). Every questionnaire set has been provided by reply paid addressed envelope.

Findings from this project will be distributed to respondents and their institutions by email. The data collection and the publication method of this study have been approved by Human Research Ethic Committee of Curtin University of Technology. The approval number is SMEC 20060017. The rights of respondents and confidentiality are mentioned in Information Sheet for the Respondent.

If you need any more information or have any concerns about the study, please contact me.

Thank you in anticipation of your cooperation.

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GPO Box U1987, Perth, 6845, Australia
Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au
CRICOS provider code 00301

Perth, 10 November 2006

No : ………..
Subject : Reminder: Profession questionnaire from Curtin University of Technology
Enclosure : 1 Questionnaire
1 Reply postpaid envelop
1 Information sheet

Dear…
I am writing to you to ensure that you have received a letter from the Department of Civil Engineering, Curtin University of Technology, with a request to respond to a questionnaire. The letter was sent several weeks ago. To anticipate any problems that may have been experienced with the original letter, I again enclosure the questionnaire, the information sheet, and the reply postpaid envelope for your consideration.

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If you need any more information or have any concerns about the study, please contact me.

I thank you in advance for your cooperation and support of our course.

Yours sincerely

David Scott
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Curtin University of Technology,
GPO Box U1987, Perth, 6845, Australia
Phone +61 8 9266 7573 Fax +61 8 9266 2681
Email davidscott@vesta.curtin.edu.au

Perth, 18 January 2007

No : (..*Code of Respondent…*)
Subject : Request for responding the questionnaire
Enclosure : 1 Questionnaire
1 Reply postpaid envelop
1 Information sheet

Dear *(…Title… Family Name…)*

The education of engineering students is an expensive exercise – it costs a lot of money, time and effort. It is important that we get it right. However there are many different views on what an engineering graduate should be. Employers, Engineers Australia, individual professionals and indeed the graduates themselves all have a picture of the 'ideal graduate'.

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CRICOS provider code 00301

Appendix I. Information sheet for participants

STAKEHOLDERS' SATISFACTION WITH CIVIL ENGINEERING GRADUATES

General information

Objectives of the research

1. To explore the expectations of various stakeholder groups of civil engineering graduates.
2. To create a model which explains the links between civil engineering graduate attributes, their job performance and stakeholder satisfaction with civil engineering education.

Benefit of the research

The model will guide civil engineering educators about the curriculum they should be delivering.

Investigator: Albani Musyafa; *Co supervisor:* Dr. Joan Gribble; *Supervisor:* Prof. David Scott
Institution : Department of Civil Engineering, Curtin University of Technology, GPO Box U1987, Perth, 6845, Australia, Phone +61 8 9266 7573, Fax +61 8 9266 268,1 Email davidscott@vesta.curtin.edu.au

Data collecting

Schedule	*1 October to 31 December 2006*
Method	*Survey of various stakeholder groups and consultation/interview with a purposeful sample of these groups.*
Instruments	*Questionnaires and consultation protocol*
Kinds of participants	*Educators, employers, and graduates of civil engineering education; and experts in professional organizations*
Location of participants	*Australia and Indonesia*

Rights and obligation

Rights of the participants:

3. Targeted participants have a voluntary choice to participate or not to in this research.
4. Targeted participants may refuse to participate in this research and need give no reasons or justification for that decision.
5. Participants who have provided informed consent to take part in the research are free at any time to withdraw their consent to be further involved in this research.
6. Participants will be provided the opportunity to receive a report of the data analysis.

Obligations of the researcher:

1. The researcher will ensure that the rights of participants are upheld.
2. The researcher will respect and regard the welfare, rights, beliefs, perceptions, customs and cultural heritage of persons involved in this research.
3. The researcher will ensure that the individual information provided by participants will remain confidential.
4. The researcher will guarantee anonymity of the participants.
5. The researcher will ensure that data collected from participant will be used only for the purpose of this study.

Confidentiality

1. Data will be stored in a secure location i.e. Curtin University of Technology for 5 years.
2. Access to data will be restricted to me as the researcher, my co supervisor, and my supervisor.
3. Data will be used for purposes as stated in the research objectives.
4. Data will be published in format which could not identify individual participants in the study.

Should any participant have any concerns or complaints with the conduct of this study, please contact:

Human Research Ethic Committee

Telephone	: 9266 2784
Fax	: 9266 3793
Email	: hrec@curtin.edu.au

The ethics approval number for this research is SMEC 20060017.