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Employability and Skill Set of Newly Graduated Engineers in India

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Abstract

Skill shortage remains one of the major constraints to continued growth of the Indian economy. This employer survey seeks to address this knowledge-gap by answering three questions: (i) Which skills do employers consider important when hiring new engineering graduates? (ii) How satisfied are employers with the skills of engineering graduates? and (iii) In which important skills are the engineers falling short? The results confirm a widespread dissatisfaction with the current graduates—64 percent of employers hiring fresh engineering graduates are only somewhat satisfied with the quality of the new hires or worse. After classifying all skills by factor analysis, the authors find that employers perceive *Soft Skills* (*Core Employability Skills* and *Communication Skills*) to be very important. Skill gaps are particularly severe in the higher-order thinking skills ranked according to Bloom's taxonomy. In contrast, communication in English has the smallest skill gap, but remains one of the most demanded skills by the employers. Although employers across India asks for the same set of soft skills, their skill demands differ for *Professional Skills* across economic sectors, company sizes, and regions. These findings suggest that engineering education institutions should: (i) seek to improve the skill set of graduates; (ii) recognize the importance of *Soft Skills,* (iii) refocus the assessments, teaching-learning process, and curricula away from lower-order thinking skills, such as remembering and understanding, toward higher-order skills, such as analyzing and solving engineering problems, as well as creativity; and (iv) interact more with employers to understand the particular demand for skills in that region and sector.

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Employability and Skill Set of Newly Graduated Engineers in India[1]

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1. Introduction

Insufficient supply of quality skills is one of the main impediments to further economic growth in India. The Indian economy grew more than 8% on average over the past 5 years, including the year of the unprecedented financial crisis in 2009. However, the skill shortage is still one of the major constraints in most industries in India (World Bank, 2009b).

IT, infrastructure and power sectors where engineers play a critical role are particularly in difficult situations when it comes to unmet demand for skills. For instance, the exporting IT sector reported lack of skills as the most serious obstacle for growth, and salaries rose 15% annually from 2003 to 2006 mainly due to the shortages of qualified workforce (World Bank, 2009). The road sector also faces severe shortages of qualified manpower. The sector needs to increase its hiring by at least 2-3 times of the 2008 level where 6,000 – 7,000 fresh engineers and diploma holders joined the road sector workforce (World Bank, 2008). In the power sector, the focus is also on shortages of qualified engineers. The sector needs more skills and knowledge at all levels of the workforce, particularly considering the growing concerns over environmental degradation and depletion of conventional energy sources (Ministry of Power, 2007). According to the widely quoted report by the National Association of Software and Services Companies (NASSCOM) and McKinsey in 2005, only 25% of the engineering education graduates are employable by a multinational company. Many employers give concrete examples on the lack of skills of the newly graduated hires, which the employers link to shortcomings in the education system. Box 1 provides one such case from a large ITES company.

The higher education system has responded to the increased demand for engineers by massively expanding production of engineers. The number of students enrolled increased 800 percent from 1998 to 2008, (MHRD, 2009). This quantitative expansion is widely perceived to have led to an average decline in the quality of the students entering, the teaching and, consequently, the quality of the graduating engineers (Jha et al. 2009).

Despite the gravity of the situation, little research has been conducted to identify the kinds of skills demanded by employers and measure in which skills graduates meet employers' expectation. There is an increasing demand for such information from teachers, administrators, and policy makers. For example, Government of India is implementing a program with World Bank co-finance, to improve quality of engineering education and increase learning outcomes of engineering education graduates. For this program and for other initiatives, it is critical to identify specific bottlenecks in skills demanded by employers, and provide detailed information and practical suggestions to overcome the skill shortages.

With this aim, an Employer Satisfaction Survey was carried out from September to November 2009 as part of preparation of the Second Phase of Technical Education Quality Improvement Program (TEQIP-II) initiated by the Government of India and financially supported by the World Bank. The survey was implemented by a joint team of the National Project Implementation Unit (NPIU), the Federation of Indian Chambers of

Commerce and Industry (FICCI), and the World Bank in consultation with Ministry of Human Resource Development (MHRD), Government of India.

Box 1: A Typical Fresh Engineering Graduate Lacking Problem Solving Skill

To illustrate the typical skill gap we see in fresh engineers, let us take the case of Gopal, who after completing his Bachelor's degree in Computer Science and Engineering with a good academic track record has just joined an IT Services organization. Specifically, this group works on product engineering for a semiconductor vendor who is developing highly integrated silicon and supporting software for mobile devices. Gopal has undergone about 2 months of refresher training by the organization on software engineering before being assigned to the project.

The Project manager that he reports to is in charge of delivering the layer of platform software, which comprises of the Real Time Operating System and the Device Drivers for all the peripherals the mobile device will support, to the customer. The project manager assigns to Gopal the task of taking over the development of a device driver for one of the simpler peripherals on the device and points him to all the relevant information sources. The project manager expects Gopal to work quite independently on the same and complete it with minimal assistance given the fact that he has the necessary knowledge from his academic background, and the device driver is for the simplest peripheral on the chip.

On the job, however Gopal begins to flounder. He is first of all quite stymied by the amount of information he has to digest in a short span of time. He did not have the skill to filter out and read what was really required for the job. The second challenge was his unfamiliarity with handling a large volume of code. His academic projects had been quite small, a few hundred lines at most. He did not have the skill to abstract out the entire system, and only focus on the interfaces for the device driver he had to develop. The next challenge was on the design of the module. He had to pick a design which was not only efficient in the time but also efficient in use of system resources as the design is for a mobile device with typically limited memory. Last but not the least, the design had to be robust. When it was time to integrate and test the driver, he had to really grasp the complexities of debugging an embedded system. Though his own module was quite simple, he had to have the big picture of the system. He had to understand how to use the debugging tools and the features it provided, to probe the system at the appropriate level. He was once again felt wanting on the required problem solving skills to move ahead on the problems encountered.

If we reflect on this case, it is clear that the academic curriculum had the following lacunae:

- Had not trained Gopal sufficiently on key design skills, especially handling conflicting criteria to be met, and problem solving skills, and creative exploration for the same, and
- Had not trained him on handling complexity, and key abstraction skills required to handle it.

These problems can be traced to:

- Lack of imagination in the construction of laboratory experiments in the academic setting and also probably in the evaluation patterns followed,
- Few problem sets (examinations) for students to test design oriented problems which would have given students the chance to explore the design space and appreciate the challenges, and
- Little exposure to joint projects with industries to experience complexities in the actual work place and prepare students better for a career in the relevant industries.

General Manager, Project Delivery, in a large IT company in India

Specifically, the survey seeks answers the following three questions:

(i) Which skills do employers consider important when hiring new engineering graduates?
(ii) How satisfied are employers with the skills of engineering graduates?
(iii) In which important skills are the engineers falling short?

The paper is organized as follows. The next section briefly summarizes similar studies. Section 3 describes the methodology of the data collection. Section 4 shows descriptive statistics of survey respondents. Section 5 presents major findings with analysis of the collected data. Finally, Section 6 summarizes and discusses implications for education provision and education policy in order to increase employability of engineering graduates.

2. Previous Employer Surveys and Related Literature on Skills

This section reviews a selected set of previous employer surveys and related literature on skills that guided the design of this employer survey. A number of employer surveys have been conducted for graduates of different academic disciplines, e.g., business administration, education, economics, psychology, etc. Many of these surveys aim to identify which skills are demanded by employers and to examine how the supply of skills matches labor market demand.[3]

Noel-Levitz (a higher education consulting firm) and Utah State University developed a comprehensive and well designed instrument for employer satisfaction surveys. The objective of the survey was to measure the employer satisfaction for benchmarking purposes (Kleinke, 2006). Seventeen universities participated in the survey in 2004. A survey instrument was mailed to 297 employers of the graduates, of which 112 employers responded (38% response rate). The questionnaire focused on graduates' knowledge and understanding within: the field of the graduates' major, general skills, and specialized skills. Employers rated graduates' knowledge and skills on a five-point scale in two aspects: satisfaction with the specific skills of the graduate and the importance of each of those skills. The survey found that employers were on average "*very satisfied*" with the knowledge and skills of the graduates (average rating of 4.0 on a five point scale). The survey instrument was found useful especially in that it asked both importance and satisfaction levels of knowledge and skills. This structure was incorporated in our survey instrument.

Lattuca, Terenzini, and Volkwein, 2006, assessed the impact of accreditation based upon student learning outcomes as introduced by the Accreditation Board for Engineering and Technology (ABET) in the mid-1990s. The expected student learning outcomes of both ABET and the National Board of Accreditation (NBA) in India are similar due to common membership of the so-called Washington Accord, which mutually recognizes engineering degrees across 12 member-countries, (Washington Accord, 2007). Since many questions in our employer survey were drawn from the NBA's learning outcomes, our survey results are to some extent comparable with the above study's outcomes. Lattuca, Terenzini and Volkwein surveyed 1,622 employers. The employers were asked information on their characteristics and three basic issues: (i) the preparation of recent engineering graduates, (ii) whether or not the skills of the graduates had increased, and (iii) the importance employers attach to each of the 11 EC2000 learning outcomes. The study found that the majority of employers agreed that, overall, graduates were adequately or well prepared for

[3] In this paper, we use the term "skills" in the broadest interpretation. Hence, it is not limited to skills of a routine nature related to a specific trade, but covers broadly and includes what some studies labels competences, personal attributes, personal characteristics and abilities of both cognitive and affective/interpersonal nature.

the profession. Further, many employers reported that the skill set of the recently hired graduates had improved compared to those in 1990s, in particular for so-called soft skills.

Academy for Education Development (AED) carried out an employer survey in Egypt, with the objective of providing recommendations to the Ministry of Higher Education on how to improve the quality of Middle Technical Colleges graduates (AED, 2008). A sample of 240 companies was selected based on stratified sampling technique (by size: small, medium, and large). AED sent surveyors to companies for personal interviews. 92 companies fully completed the survey questionnaire (38% response rate). The survey found that the level of skills demanded by employers had increased, mainly because: (i) higher levels of technology, (ii) increasing competition, and (iii) increasing concerns about quality of products. The survey also indicated that companies prioritize "soft skills" including personality (honesty, punctuality, etc) and what they labeled "basic skills" (literacy, problem solving, management, etc). The AED's employer survey was especially helpful for our employer satisfaction survey to determine relevant questions of employer characteristics. Data availability on employers' characteristics enabled us to scrutinize the survey results disaggregated by employers' characteristics.

In addition to the survey instruments above, we refer to several papers applying different analytical tools on data from employer surveys. Paranto and Kelker (1999) analyzed employers' satisfaction with job skills of business college graduates in a regional university in the US. They examined which skills employers perceived important when hiring business graduates. 346 employers were identified for the survey by the university's placement office. They are mostly in rural areas in the upper Midwest of the US, and hired business graduates during the 1990-94 period. 136 employers responded (39% response rates). By using factor analysis, 18 variables (skills) were reduced to four major factors, namely specific skills, core skills, personal characteristics, and communication skills (See Table 1).

Table 1: Skills under Four Factors

Specific Skills	Core Skills	Personal Characteristics	Communication Skills
• Database knowledge • Spreadsheet knowledge • Word processing knowledge • Ability to adapt to changing technology • Technical skills • Mathematical skills	• Self confidence • Critical thinking • Creative thinking • Interpersonal skills • Leadership skills • Experience with real world problems	• Business ethics • Professionalism	• Listening skills • Speaking skills • Written communication

A t-test revealed that the mean importance rating of the "Core Skills" is statistically significantly higher than that of "Specific Skills". In addition, analysis of variance showed that there is no statistically significant difference in the importance of "core skills" among employers of different size and different economic sectors. Hence, the survey shows that the importance of "Core Skills" cuts across all participating firms. Paranto and Kelker recommended business schools that they should improve effectiveness of business programs, by putting more emphasis on "Core Skills".

Hill and Petty (1995) conducted a similar analysis but focused on occupational work ethics. By using factor analysis, forty eight skills were grouped into four factors: interpersonal skills, initiative, being dependable, and "reversed items on instrument" (See Table 2). The last factor was interpreted as negative perceptions, in which there are (lack of) skills such as *irresponsible*, *careless*, *selfish*, etc. The study recommended that school curriculum should address the four factors to make student skills more relevant to the workplace.

Table 2: Work Ethics under Four Factors

Factor 1: Interpersonal Skills	Factor 2: Initiative	Factor 3: Being Dependable	Factor 4: Reversed Items
• Courteous	• perceptive	• following directions	• hostile
• friendly	• productive	• following regulations	• rude
• cheerful	• resourceful	• dependable	• selfish
• considerate	• initiating	• reliable	• devious
• pleasant	• ambitious	• careful	• irresponsible
• cooperative	• efficient	• honest	• careless
• helpful	• effective	• punctual	• negligent
• likeable	• enthusiastic		• depressed
• devoted	• dedicated		• tardy
• loyal	• persistent		• apathetic
• well groomed	• accurate		
• patient	• conscientious		
• appreciative	• independent		
• hard working	• adaptable		
• modest	• persevering		
• emotionally stable	• orderly		
• stubborn			

These prior works guided us in developing the survey methodology analysis for this employer survey in India.

3. Survey Methodology

FICCI and World Bank conducted an on-line employer satisfaction survey from September to November, 2009. 157 employers across sectors and regions in India fully completed the questionnaire. The questionnaire (Annex 3) has a list of skills that engineering graduates are typically expected to possess at graduation. Employers were requested to rate on a scale from 1 (not at all) to 5 (extremely) how important each skill is for an engineering graduate to be an effective employee, (Importance Level). The survey also asked employers to rate their satisfaction level with regard to each of the skills, (Satisfaction Level).

3.1 Sample Size and Sampling Strategy

Originally, a stratified random sampling from FICCI's member database of over 3,000 firms was considered for the Employer Satisfaction Survey. Sample size was calculated based on the following formula.

$$n = \frac{z^2 pq}{e^2}$$

where *n* is the sample size. A 90% confidence interval with margin of error 0.05 was applied. *z* is the abscissa of the normal curve that cuts off at a given significance level, i.e., 1.65, *p* (in this case 0.6) is the estimated proportion of an attribute that is present in the population, *q* is 1-*p*, and *e* is the desired level of precision, i.e., 0.05. Using this formula, the originally estimated sample size was about 260, and it was further proportionately allocated to FICCI's classification of 17 economic sectors.

There were several difficulties in sampling. First, although the sampling method was originally a stratified random sampling, some member companies were directly contacted to participate in the survey, due to a low response rate (convenience sampling). This may have introduced a bias in the representativeness of the sample. Second, the web-based survey was opened in the last few weeks of the survey to all companies that registered. This slightly increased the sample size. This self-selection could also have caused a selection bias. Third, the sample size was not large enough to meet a 90% confidence interval. Due to time constraints, it was reduced from 260 to 157 companies, i.e., an 80% confidence interval with a margin of error of 0.05.

Despite these shortcomings, the study brings value since it is the first of its kind in India. Further, the participation number of 157 is comparable to other employer satisfaction surveys. The employer satisfaction survey is expected to be conducted every two years. Therefore, the sampling methodologies and the survey design are expected to improve in future rounds, and the quality of the data will be further enhanced over time.

3.2 Survey Design (Preparation and Implementation of the Survey)

NPIU, FICCI and World Bank held a series of interviews with employers. Suggestions provided by employers were incorporated into the questionnaire. As a result, the overall survey design and instrument were improved over the course of pilot surveys.

During the pilot surveys, the employers were asked four specific questions to improve the survey questionnaires and implementation. The four questions were:

First, "*Who will evaluate employer's satisfaction"?* (Human resource department, supervisors of newly hired, or a third person). Presumably, employers are in the best position to identify appropriate evaluator of the fresh engineering hires. Therefore, the survey invitation was sent to the human resource department which decided the responsibility to complete the survey.

Second, "*Who will be evaluated"?* (A fresh class of graduates or those who have already a few years' experiences). Given the fact that many fresh engineers change jobs within a year or so, external effects such as in-house training should be removed as much as possible in order to assess learning outcomes at institutions. It was therefore decided that the target population would be the fresh graduates from technical and engineering institutions for whom this was their first job. Hence, employers were asked not to consider engineers for whom this was not their first job after graduation.

Third, "*At what level should the employers evaluate?* (At individual level, at institutional level such as Indian Institutes of Technology, National Institutes of Technology, institutions that participated in the Technical Education Quality Improvement Program, etc, or by overall average of all fresh hires)". It was decided to send one single questionnaire to each company due to the administrative burden to deal with multiple questionnaires per different graduate group. Employers then evaluated all first-time-employed engineers hired over the previous four years together as one group.

Fourth, "*How will the questionnaires be distributed to companies?* (Online survey, email invitation, or paper-based questionnaire via physical mail)". The on-line survey was finally selected as the survey method because it is easy to manage and organize the data collected from employers. Further, on-line survey can be easily used again in the next round of the employer satisfaction survey in two years. FICCI randomly selected employers who were provided with a username and password. After logging into the survey, employers were asked to complete the survey and provide company characteristics.

3.3 Survey Instrument

The questionnaire design builds upon three sources: the expected learning outcomes used for accreditation by the National Board of Accreditation (NBA), previous employer surveys, and consultations with employers. The questionnaire is divided into three sections; (i) Overall satisfaction level, (ii) Importance and Satisfaction of 26 different skills, and (iii) Employer's characteristics.[4] Employers were asked to evaluate both the importance and satisfaction levels of each of the 26 skills on a five point scale.

The NBA, India's only official accreditation body for engineering education, has established 11 Program Outcomes. NBA is a provisional member of the Washington Accord—an international agreement between accreditation agencies for engineering education for 18 countries. Therefore, NBA's program outcomes (expected learning outcomes for graduates) are based upon the internationally agreed set of the skills and knowledge that graduates are expected to possess at the time of graduation.[5] The NBA criteria are:

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[4] The survey questionnaire is attached in Annex 3. The questionnaire asks about importance and satisfaction for 26 skills divided into two overall groups: General and Specific skills. The General skill referred mainly to personal characteristics while Specific skills mainly referred to those skills directly related to technical and engineering professions as well as communication and computer skills. The categorization of skills into General and Specific Skills was conducted in an a-priori manner following consultations with government officials, employers, and academia. Section 5 will go in detail more systematic and empirically-based categorization. The survey questionnaire is attached in Annex 3.

[5] The NBA learning outcomes and the ABET learning outcomes are very similar, but do have a few important differences. For example, the NBA criterion (e) asks for the graduates to "demonstrate an ability to

(a) Graduates will demonstrate knowledge of mathematics, science and engineering.

(b) Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

(c) Graduates will demonstrate an ability to design and conduct experiments, analyze and interpret data.

(d) Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.

(e) Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.

(f) Graduate will demonstrate skills to use modern engineering tools, techware and equipment to analyze problems.

(g) Graduates will demonstrate knowledge of professional and ethical responsibilities.

(h) Graduate will be able to communicate effectively in both verbal and written form.

(i) Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.

(j) Graduate will develop confidence for self-education and ability for life-long learning.

(k) Graduate who can participate and succeed in competitive examinations.

Ten out of the 11 NBA Program Outcomes were included in the questions (some in an abbreviated form). Thirteen skills from previous employer surveys, notably from (Kleinke, 2006) were added. These were in particular skills often referred to as soft skills or core skills or employability skills, such as integrity, self-motivation, team skills etc. Further three specific skills were added, namely "Basic computer", "Advanced Computer", and "Customer Service Skills". Lastly, another three skills "Technical Skills (programming)" "Communication in English" and "Entrepreneurship Skills", were included as per request of employers.

Definition of skills and a common understanding of what a skill is, poses a problem for comparability and interpretation. Given the survey has to be relatively short to ensure an acceptable response rate, the questionnaire did not define each skill. In most instances, an additional explanation of example is provided in parenthesis. However, it is possibly that employers may have perceived the meaning of the skills differently. In addition, some of the skills are overlapping in the sense if a person possess skill a, then they are strongly expected also to possess an element of skill b. One such example is "*Self-motivated*" and "*Self-discipline*". However, there is no widely accepted categorization of skills that are exhaustive and non-overlapping. Hence, an overlap is unavoidable in our view.

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work on multidisciplinary tasks", while the ABET criteria (d) asks for the graduates to "function on multi-disciplinary teams". Although, the difference is subtle, the ABET criterion directly asks for team-skills, while the NBA does not.

Obviously, each employer has different perceptions and expectations toward engineering graduate skills. The respondents' perceptions and expectations may arbitrarily influence the ratings of the satisfaction and importance levels because of, for instance, wording and orderings of questions. Therefore, many economists are skeptical about the meaningfulness of the answers from so-called "subjective questions". We acknowledge this subjective element of this analysis. However a growing literature within different strands of economics, such as happiness and competitiveness use subjective survey data for econometric and/or psychometric analysis. In addition, management and marketing professionals employ a battery of satisfaction surveys, e.g., employee satisfaction surveys, customer satisfaction surveys, etc. to inform key decisions. We therefore follow the advice of Bertrand and Mullainathan (2001) who argues that subjective measures may be helpful as explanatory variables with due diligence to the interpretation of the results.

4. Characteristics of Respondents

This section shows descriptive statistics of the respondents (employers). The surveyed employers are those that hire engineering graduates. The summary of descriptive statistics of 157 employers is presented in Table A2-1 in Annex 2.

Size: Half of respondents are large companies with more than 500 employees, while the other half is equally divided into medium (with between 100 and 500 employees) and small employers (with less than 100 employees). Given that a half of the employers in our sample are large companies with more than 500 employees, we may have oversampled large companies. As a result, the outcomes of the survey may reflect more views of the larger companies.

Location: More than 40% of the responding employers are from the North region where Delhi is located, and 27% and 19% are from West and South regions, respectively. State-wise, Delhi dominates the sample (27%), and Maharashtra where Mumbai is located accounts for 19%. Other major states have a share of 38% in total; Uttar Pradesh 8.9% (the most populous state), Gujarat 8.9% (one of the fastest economically growing states), Haryana 8.3% (a large area of the state is included in the National Capital Region), Karnataka 7.0% (one of the economically progressive states), and Andhra Pradesh 5.1% (one of the top IT exporting states).

Sector: The survey covers almost 20 sectors of industries. As discussed in the Introduction, IT, Infrastructure, and Power sectors show increasing demand of qualified engineering graduates. These sectors have the highest share of employers in the sample after "Other". One third of the companies answered that their sectors do not belong to any of the listed sectors in the questionnaire and selected "Other". This "Other" is further disaggregated into mining, other service activities, and professional, scientific and technical activities by using the responses from another question "*Please specify the major economic activity of your firm*".

Foreign Capital: Twenty percent of the responding firms were established with foreign capital.

Respondents: Half of the respondents are a head/manager of a human resource department. About 18% are a manager of engineering graduates' department. Approximately 15% are a business owner or partner. The large share of head/manager of human resource department could have been a potential problem if the survey evaluated individual skill sets. However, the survey rated a group of new hires across the company. Therefore, the human resources department would be best placed to assess skills of newly hired engineers as a group.

Consequently, the sample covered a wide range of employers across sectors, regions, size of companies, etc. This suggests that the results are relatively representative. However, the sample may not fully represent the true population, i.e., the total number of the employers that hire engineering graduates in India. Since we do not have detailed enterprise level data on who hires engineers, we cannot compare our sample with the true population.

5. Findings

This section presents the major findings. First the section presents the results of a factor analysis of the 25 skills rated by the employers. [6] Based on the skill groups, detail analysis is further conducted to respond to the three research questions raised in the introduction: (i) How satisfied are employers with the skills of engineering graduates? (ii) Which skills do employers consider important when hiring new engineering graduates? and (iii) In which important skills are the engineers falling short?

5.1 Grouping Skills

We conduct a factor analysis of the 25 individual skills to group the individual skills into a small number of skill groups (factors).

We group the skills because it is plausible that a common latent factor (skill/ability) partially drives the importance and satisfaction ratings of a group of individual abilities. For instance, employers and HR-staff often talk about the importance of "soft skills". There is hence a notion that a set of interpersonal skills are related into one group and that this group of skills is important. However, "soft skills" are often neither well defined nor backed-up by empirical evidence that the individual skills referred to as soft skills form one group. Factor analysis is one of the ways to test this notion of soft skills and empirically define the individual skills that make up "soft skills". Further, the identification of a small number of factors allow us to identify commonalities in demand and supply for skills, and structures the findings and provides a limit set of overall findings.

Factor analysis fits exactly the above goal of reducing the number of variables into overall groups. It is a statistical procedure to find the latent variables that explain attributes of common variables in the observed variables. Factor analysis is widely used in social science, especially in psychological researches and business surveys. Psychologists, for instance, conduct empirical researches on the relationship between personality traits and job performance. They examine numerous personal traits and categorize them into five

[6] A skill, "*Accepts responsibility for consequences of actions*" is dropped from the analysis since the skill is quite similar to "*Reliability*"

representative personal traits by using factor analysis. Those five personal traits are called "Big Five" that represents an overall pattern of all personality traits and recent papers have examined the link between these traits and income, (Borghans, Lex, Duckworth and Heckman 2008).

By using factor analysis, 26 skills listed in the questionnaire were grouped into three factors using the importance ratings. Table 3 below presents the resulting groups (factors) of skills generated by factor analysis. Skills emboldened in Table 3 are those with more than 0.55 of factor loadings.[7]

Table 3: Skills grouped into Three Factors

Factor 1 (Core Employability Skills)	Factor 2 (Professional Skills)	Factor 3 (Communication Skills)
• **Integrity** • **Self-discipline** • **Reliability** • **Self-motivated** • **Entrepreneurship Skills** • **Teamwork** • **Understands and takes directions for work assignments** • **Willingness to learn** • Flexibility • Empathy	• **Identify, formulate, and solve technical/engineering problems** • **Design a system, component, or process to meet desired needs** • **Use appropriate/modern tools, equipment, technologies** • **Apply knowledge of mathematics, science, engineering** • **Customer Service Skills** • Knowledge of contemporary issues • Creativity	• **Written communication** • **Design & conduct experiments, and analyze and interpret data** • **Reading** • **Communication in English** • Technical Skills • Verbal communication • Basic computer • Advanced computer

Table A2-2 in Annex 2 lists all skills with factor loadings that explain dimensions of each factor in more details. The three factors above account for more than 85% of the total variance.

The first factor predominantly consists of personal characteristics. The skills with high factor loading are "*Integrity*", "*Self-discipline*", "*Reliability*", "*Self-motivated*", "*Entrepreneurship Skills*", "*Teamwork*", "*Understands and takes directions for work assignments*", and "*Willingness to learn*". This factor is named ***Core Employability Skills***, since these skills are not occupation specific, but cuts across occupations. Other studies refer to this set of skills as generic, catalytic, core and/or employability.

The second factor is essentially comprised of engineering specific skills, of which the following are the skills with high loading; "*Identify, formulate, and solve technical/engineering problems*", "*Design a system, component, or process to meet desired needs*", "*Use appropriate/modern tools, equipment, technologies*", and "*Apply knowledge of mathematics, science, engineering*". Following the HR-literature and other employer surveys, we call this factor for "***Professional Skills***". In the engineering education literature, this set of skills is also referred to as technical skills.

[7] Factor loadings are the correlation coefficients between each variable and the factor. Items with higher load are more relevant to the respective factor. Based on the guidelines made by Comrey and Lee (1992), items (skills) that load more than 0.55 are considered "*very good*". TableA2-2 in Annex 2 shows the skills with the factor loadings.

The third factor mixes different types of skills, e.g., communication skills, cognitive skills, and computer skills. The high loading skills in the third factor include "*Written communication*", "*Design & conduct experiments, and analyze and interpret data*", "*Reading*", and "*Communication in English*". This factor includes skills which may not be directly relevant to communication, such as "*Design & conduct experiments, and analyze and interpret data*". However, Table 3 and Table A2-2 show that all communication skills fall in the third factor with relatively higher loadings. Therefore, the third factor is named *Communication Skill*.

The three names of the factors do not necessarily represent all skills in respective factors, but these three names do represent the majority of skills with high loadings. It should also be noted that naming factors is a mere poetic, theoretical, and inductive leap (Pett, Lackey, Sullivan, 2003). Therefore, it is important to look into the composition of these three factors and understand actual skills explaining each factor.

The three factors obtained from factor analysis are similar to other studies using factor analysis. For instance, as presented in Table 1 from Section 2, Paranto and Kelker (1999) grouped skills into four factors, Specific, Core, Personal Characteristics, and Communication Skills. The factor, *Core Employability Skills,* corresponds to Core and Personal skills, and *Professional Skills* to Specific skills, and *Communication Skills* to Communication Skills. This similarity with empirical findings from other employer surveys increases our confidence of the above categorization of skills.

The three skills group identified by the above factor analysis partly corroborates one of the most used learning classifications, the Bloom's taxonomy, (Bloom 1956). Bloom's taxonomy suggests the existence of three domains of learning. The term "learning" is synonymous to the term "skill" as used in this paper. The three domains are:

- <u>Cognitive skills</u> involve knowledge and the development of intellectual skills,
- <u>Affective skills</u> include the manner in which we deal with things emotionally, such as feeling, values, appreciation, enthusiasm, motivations, and attitudes, and
- <u>Psychomotor skills</u> encompass physical movements, coordination, and the use of motor-skill areas.

The types of skills that our factor analysis categorizes under the *Core Employability Skills* mostly belong to the Affective domain in Bloom's taxonomy (Integrity, self-discipline, reliability, and team-work). The types of skills categorized under the *Professional Skills* all belong to the Cognitive domain in Bloom's taxonomy (remembering knowledge, understanding, applying, analyzing, evaluating, and creating). The skills categorized under the third factor *Communication Skills* are a more mixed bag, as discussed above, and do not correspond to a specific domain in the Bloom's taxonomy. In Bloom's taxonomy communication skills are mostly classified as part of the Affective Domain. This partial match of our identified skills categories with the Bloom's taxonomy provides further confidence in the use of the three skills group in the rest of the paper.

Using these three categories of skills (*Core Employability, Professional Skills*, and *Communication Skills*), the remaining of this section responds to the three research questions on importance, satisfaction, and skill gaps.

5.2 Importance: Which Skills Do Employers Demand in Engineering Graduates?

The level of importance attached to each skill reveals employers' valuation of, and demand for, that skill. Table 4 below summarizes the importance level of each skill under the three factors as perceived by the employers. Standard deviations are presented in Table A2-3 in Annex 2 which also contains statistical tests for statistically significant differences in importance scores as discussed below. All skills are on average rated from 3.5 (half way between "Somewhat important" and "very important") to 4.5 (half way between "very important" and "extremely important"). Hence, all skills in the questionnaire are rated as important.

Core Employability Skills show the highest level of importance on average. The high importance level of reliability and teamwork is consistent with the qualitative feedback from employers received during the pilot surveys. Many employers specifically look for engineers who are reliable and can effectively work with team members.

Table 4: Importance Level by Three Factor Skills

Core Employability	Mean	Professional Skills	Mean	Communication Skills	Mean
Integrity	4.48	Use of modern tools	4.08	Communication in English	4.26
Reliability	4.42	Apply Math/Sci/Engg know.	4.07	Written Communication	4.07
Teamwork	4.41	Creativity	4.07	Reading	4.04
Willingness to learn	4.40	Problem solving	3.93	Technical Skills	4.02
Entrepreneurship	4.35	System design to needs	3.84	Experiments/data analysis	4.01
Self-discipline	4.26	Contemporary issues	3.83	Verbal Communication	4.00
Self-motivated	4.22	Customer Service	3.51	Basic computer	3.95
Flexibility	4.15			Advanced computer	3.71
Understand/take directions	4.14				
Empathy	3.92				
Average	**4.27**	**Average**	**3.91**	**Average**	**4.01**

Employers rated *Professional Skills* the lowest on average among the three factor skills. This may be partly because employers think that engineering related skills can be partly remedied through in-house training even after graduation while *Core Employability Skills* would require longer timeframe to be acquired.

Communication in English is ranked the most important skill under *Communication Skills*. This could be explained by English being the preferred language in many economic sectors and firms. Azam, Chin, and Prakash (2010) also find that employers demand English skills. Specifically, they estimate based upon a large household survey that English communication skills increase the hourly wages of men by a whopping 34%. The return mainly accrues to young highly educated workers (such as engineers). As Indian economic activities go global, better command of English language is desired. In addition, the high ranking of Communication in English could be partially attributed to the fact that there has been an increasing demand for Indian engineers in the software and information technology-enabled service (ITES) sectors that are provide services in English to customers in the United States and the United Kingdom (Ferrari and Dhingra, 2009). A one-way analysis of variance (ANOVA) was conducted to test whether the mean importance scores of Communication in English are equal between firm sizes, firms with/without foreign capital, and firms in difference economic sectors. Large firms consider Communication in English more important than medium and small firms. Firms with foreign capital have higher importance mean scores than those without foreign capital. The IT sector has relatively higher scores than other sectors. However, these results are not statistically significant. The results of analysis are presented in Table A2:4 - 6 of Annex 2.[8]

A similar employer survey undertaken in the US in 2004 equally asked for the importance level of skills of engineering bachelor graduates (Lattuca, Terenzini, Volkwein, 2006 study for ABET). The formulation of the skills is very similar if not identical for 10 *Professional Skills*.[9] The two surveys allow us to examine whether US employers demands the same skills as the Indian employers. In particular, we focus on whether the employers share the same prioritization of skills; i.e. is the ranking of the importance similar among the employers of the two countries? Table 5 ranks the importance of skills in each country based upon the percentage of employers responding "Very or Extremely Important" (the two highest responses on a five point scale). The picture is mixed. In general, employers in both countries rank team-work, applying math/science/engineering knowledge and communication skills high, while raking skills related to knowledge of contemporary issues, system design, and design of experiments low. However, some skills are ranked differently, such as lifelong learning (valued by Indian employers and less so by US employers). We cannot test whether the rankings are statistically significantly the same since we do not have the underlying data for the US employer survey.

Table 5 Ranking of Importance of Skills in India compared to the US

India		US	
% of employers respond "Very or Extremely Important"	Skill	Skill	% of employers respond "Very or Extremely Important"
94%	Lifelong-learning	Communicate effectively	91%
93%	Understand professional and ethical responsibilities	Engineering problem solving	86%

[8] Nevertheless, there is also the possibility that the formulation of the questionnaire in English implied that an English speaking person filled out the questionnaire. This could potentially have introduced a bias towards increased importance of English.

[9] There is a logical explanation why the two surveys asked feedback on a set of skills that were almost identically formulated. The US survey sought feedback on the ABET EC2000 (a)-(k) criteria. These criteria formed the basis for the formulation of the expected attributes and competences of an engineer graduate in the Washington Accord. The NBA criteria used in this Indian employer survey were formulated to be consistent with the Washington Accord.

93%	Teamwork	Teamwork	79%
85%	Apply math, science, and engineering know.	Apply math, science, and engineering know.	78%
84%	Communicate effectively	Use modern engineering tools	77%
83%	Use modern engineering tools	Understand professional and ethical responsibilities	73%
83%	Design and conduct experiments	Design a system to meet needs	66%
80%	Engineering problem solving	Lifelong-learning	60%
75%	Design a system to meet needs	Design and conduct experiments	59%
71%	Knowledge of Contemporary issues	Knowledge of Contemporary issues	25%

Source: Authors for India and Lattuca, Terenzini, Volkwein study for ABET 2006 for the US.

Note: Year of survey for the US was 2004 and 2009 for India. The both surveys asked employers to rate the importance on a five-point scale. The wording of the US scale differed marginally from the Indian survey. Whereas the top two most importance categories in the Indian scale was "Very or Extremely", the two highest importance levels were termed "Highly Important or Essential".

A similarity in the demand for skills would suggest that employers in India and the US share the same perception of skill set that an engineering graduate should learn.[10] This would support the value of having common standards in engineering education as sought by the accrediting bodies that are members of the Washington Accord. A similarity in demand would also suggest that the factors driving skill demand in the two countries: technologies, competitiveness, and composition of economic sectors are relatively similar in the two countries.

Soft Skills vs. Professional Skills (Importance): Many employers emphasized the importance of soft skills during interviews. Also other studies have discussed that many employers spend significant amount of resources to provide employees with training for improvement in not only technical but also soft skills, for example (Wadhwa, Kim de Vitton, Gereffi, 2008). Therefore, we test the importance of *Soft Skills* relative to *Professional Skills*. When discussing soft skills, communication skills are often part of soft skills. Therefore, a variable *Soft Skills* is created by combining *Core Employability Skills* with *Communication Skills* variables. Then, the following assumption is statistically tested: "*Employers perceive Soft Skills as more important than Professional Skills*". In order to verify the assumption above, a t-test is conducted with a null hypothesis that the mean of *Soft Skills* is the same as that of *Professional Skills* in terms of the importance level. In other words, do employers perceive that *Soft Skills* and *Professional Skills* are equally important? The result of the t-test in Table A2-8 in Annex 2 suggests that we reject the null hypothesis and shows that the mean of *Soft Skills* is significantly higher than that of *Professional Skills* in importance level. The mean of *Soft Skills* is 4.15 (0.03) while that of *Professional Skills* is 3.98 (0.05).[11] The probability of the null hypothesis is less

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[10] Although the two survey questionnaires are almost identical, the interfered comparison of skills demanded in the two countries may not be comparable. This is the case if the response on importance is influenced by the skill set of available engineers in each country. For instance, if a large share of Indian employers rate lifelong learning skills "very important" because that skill is in short supply; while a lower share of US employers rate lifelong learning skills "very important", because graduating engineers in the US possess this skills.

[11] The figures in the parentheses are standard deviations.

than 0.001. Therefore, our data provides support for the assumption above, "*Employers perceive soft skills as more important than Professional Skills*".

Further, a similar analysis is conducted to test whether *Core Employability Skills* are statistically different from *Professional Skills*, and similarly *Communication Skills* from *Professional Skills*. The results are the same as above. The means of *Core Employability Skills* and *Communication Skills* are 4.27 (0.04) and 4.01 (0.04), respectively. Both of them are significantly higher than the mean of *Professional Skills* with the *p*-value of less than 0.001 and 0.014 in *Core Employability Skills* and *Communication Skills*, respectively. Hence, employers perceive both *Core Employability Skills* and *Communication Skills* more important than *Professional Skills*. Table A2-9 and A2-10 in Annex 2 present the detailed test information.

The results of the analysis are consistent with the qualitative findings, which report that employers in India are trying to broaden the talent pool and develop a recruitment philosophy to hire for general ability and attitude rather than specialized domain and professional skills (Wadhwa, Kim de Vitton, Gereffi, 2008). The National Knowledge Commission report (2008) also emphasizes the importance of soft skills as one of the survival skills for individuals. One of the reasons that employers perceive *Soft Skills* more important than *Professional Skills* might be that stronger *Soft Skills*, such as willingness to learn, lead to continuous improvement of *Professional Skills.*

There is a discussion to which extent institutions and teachers should aim for improved *Core Employability* (Integrity, Reliability, Teamwork, Willingness to learn etc.) and *Communication Skills* and to which extent that they can be held accountable for the graduates' skills in these skill categories, given these are to a degree acquired prior to higher education. Nevertheless, it is critical that engineering institutions recognize the importance of *Soft Skills*. Based upon the importance of these skill sets, it is our view that education institutions should actively foster the learning of *Soft Skills*. This would add to the professional skills of graduate and increase their employability and trainability.

Does demand for skills vary between Economic Sectors, Firm sizes, and regions?

The analysis so far is conducted at national level. This section analyzes the data disaggregated by sector, firm size and regional levels. In order to assess whether or not employer's characteristics have an impact on their perceptions of the level of importance in Soft and Professional Skills, the Kendall's rank correlation coefficient is used to determine whether the orderings of importance level in skills differ across sectors, size, and regions.

The Kendall's rank correlation analysis is helpful when comparing the orderings of two or more groups. It is a non-parametric measure assessing the degree of correspondence between sets of rakings. A pair of variables needs to transform one rank order into the other. Depending on the degree of correspondence between the set of rankings, the Kendall's rank correlation coefficient lies between -1 and 1. If the value is 1, the agreement between two rankings is perfect (same orderings). If the value is -1, the ranking order is completely reversed. If the value is 0, the ordering of the two variables are independent. For our dataset, if the orderings of the importance level differ across sectors, sizes, and regions, then skill demand depends upon the employer's characteristics (sector, size, and region).

First, we test whether the orderings of importance level in soft and Professional Skills differ across sectors. Because there are some sectors that do not have sufficient sample size, the test takes into account only the following sectors, which have relatively larger samples; Automobiles, IT, Infrastructure, Mining, Oil & Gas, Other Service Sectors, and Power. The null hypothesis of the test is that the orderings of the importance level in skills in sector X and Y are different (independent). In soft skills, 18 out of 28 sector pairs with asterisks indicate that orderings in the level of importance are not statistically different from zero (Table A2-14 in Annex 2). In Professional Skills, only 4 sector pairs show that they are not different (Table A2-15 in Annex 2). In other words, most sectors have a common perception about which soft skills are important, while they value different kinds of Professional Skills.

For instance, infrastructure sector, which is one of the sectors facing serious skill gaps, shows that the ordering of the importance level in *Soft Skills* does not differ from the other sectors, except from that of the Power sector. As for *Professional Skills* of Infrastructure, the ordering of the importance level statistically significantly differs from the ordering of other sectors (with exception of the Power and Oil&Gas sectors). For example while infrastructure emphasizes the importance of knowledge of math/science/engineering and ability to use modern tools, IT prioritizes creativity the highest. This result indicates that the Infrastructure sector tends to demand similar *Soft Skills* as other sectors. In contrast, the priority in *Professional Skills* tends to be more unique to the sector.

Secondly, a similar test is conducted for firm size. The null hypothesis of the test is that the orderings of the importance level in skills are different by size of company. Table A2-16 in Annex 2 shows that the orderings of the importance level of *Soft Skills* do not differ across small, medium, and large firms. Therefore, like the analysis conducted across sectors, employers tend to consider the same *Soft Skills* important, irrespective of firm size.

However, the similar analysis for *Professional Skills* shows a different picture (Table A2-17 in Annex 2). Firm size matters when it comes to demand for *Professional Skills*. Large companies with more than 500 employees ask for different *Professional Skills* compared to both medium and small firms. For instance, while large companies demand creativity the most, small companies look for ability to use modern tools, knowledge of math/science/engineering, and problem solving skills. Small and medium companies seem to demand the same set of skills, since there is no statistically significant difference in the ordering of importance level of *Professional Skills*.

Finally, another similar test was conducted by region. The results are similar to the analyses above. The important *Soft Skills* are common to most regions while many regions tend to consider different priorities in *Professional Skills*. Table A2-18 in Annex 2 shows that only one pair, Central and West, indicates that the order of importance level in *Soft Skills* are not the same. All the other pairs show that the regions tend to consider similar *Soft Skills* important. As for *Professional Skills*, the order of importance differs across regions (Table A2-19). For instance, problem solving skill in North is considered relatively more important than other *Professional Skills* (ranked 3rd among 7 *Professional Skills*), but that in South problem-solving is only ranked 6th.

To summarize, we find that similar *Soft Skills* are considered important across sectors, regions, and firm sizes. The analysis also shows that employers tend to have different priorities in *Professional Skills* depending upon their characteristics.

5.3 Satisfaction: To What Extent Does the Skill Set of Engineering Graduates Meet Demand?

Overall, 64% of employers are only somewhat satisfied or worse with the quality of engineering graduates' skills. 3.9% of employers rate the skills as "Not at all satisfied", 16.1% as "Not very satisfied", and 43.9% as "Somewhat satisfied". The average rating on "*overall are you satisfied with the newly graduated engineer that you have hired over the last 4 years?*" is only 3.15. That is slight above "*somewhat satisfied*". The mean of the average satisfaction rating of each of the 26 skills is similar: 3.19, which indicates that the employers have responded fairly consistently on the dis-satisfaction level for both the overall level compared to each of the specific skills. It is noteworthy that none of the skills listed in the questionnaire are on average rated above 4.0, "Very Satisfied", which means that no skill satisfies employers at the "very" or "extremely" level. Given that this is the first survey one cannot compare with either previous surveys to evaluate whether satisfaction has decreased over the last decade as a consequence of the massive expansion (800% from 1998 to 2008). This (dis-)satisfaction level is corroborated by other studies on skills of the Indian engineering graduates. For instance, the NASSCOM and McKinsey report (2005) finds that 75% of engineering graduates are not employable by multinational companies.

Obviously, this (dis-)satisfaction level is an average. There is no doubt that India produces a large number of exceptionally bright engineers, as can be seen in the importance of high-tech entrepreneurs in the US that are of Indian origin, (Wadhwa, Rissing, Saxenian, and Gereffi, 2007) and the share of international publications that come from Indian engineering education Institutions. Also, it could be that employers have unrealistically high expectations regarding the potential skill level of graduates. In the US survey of engineering graduates, the average satisfaction rate was 4.01 equivalent to "very satisfied". While the Indo-US difference is likely to reflect a difference in the quality of the graduates' skills, it could also stem from more reasonable expectations from employers or a generally more positive attitude of US employers. One should be cautious in directly comparing subjective surveys internationally.[12]

[12] Satisfaction level of employers toward graduates' skills is not always pessimistic, at least in other countries. Several similar employer surveys in the US, for instance, show that employers are satisfied, in some cases very satisfied, with graduates' skills. The employer survey conducted by Noel-Levitz and Utah State University shows that employers are very satisfied with the graduates from Utah State University. They show the interest to continue to hire the graduates. Another employer survey conducted by the University of Texas-Pan American also shows that very few employers are dissatisfied with graduates' skills. Given the different contexts between the US and India, satisfaction level cannot be simply comparable between the two countries. However, employers do not always unrealistically evaluate their satisfaction level toward graduates' skills.

The dissatisfaction level of employers toward engineering graduates' skills confirms that a significant share of graduating engineers does not meet employers' expected standards. Even if employers demanded unrealistically high skills from graduates, there is a substantial quality gap between institutions (the producers) and employers (the consumers). This quality gap needs to be addressed.

Table 6 below presents the satisfaction level of each skill under the three factors. The level of *Core Employability Skills* is relatively more satisfying than the other two skill factors. It can be also seen that employers are most satisfied with Communication in English. Further, knowledge of math/science/ engineering and basic computer are at the highest level of satisfaction in *Professional Skills*. This intuitively makes sense as these skills were some of the main vehicles for the initial success of the India's offshore IT business.

In contract, satisfaction of higher-order thinking skills such as problem solving, system design, and experiments/data analysis is at an alarming level—only "*somewhat satisfied"* on average. This result reflects the views from many, if not most, firms. During a series of interviews, employers pointed out that most engineering graduates lack these higher order thinking skills, especially problem solving. More detail information of satisfaction level is presented in Table A2-7 in Annex 2.

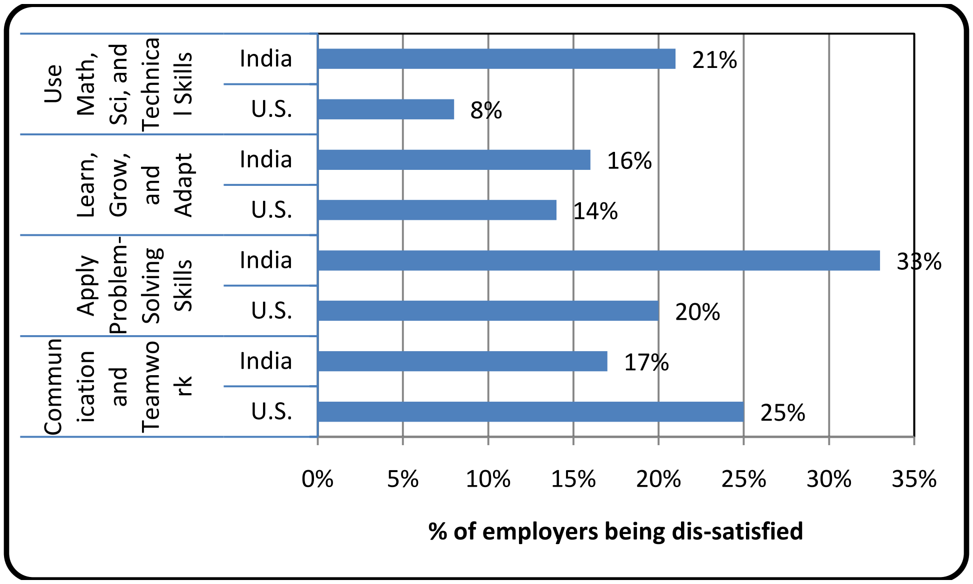
Table 6: Satisfaction Level by Three Factors

Core Employability	**Mean**	**Professional Skills**	**Mean**	**Communication Skills**	**Mean**
Integrity	3.50	Apply Math/Sci/Engg know.	3.23	Communication in English	3.95
Teamwork	3.46	Use of modern tools	3.15	Basic computer	3.34
Entrepreneurship	3.44	Creativity	3.08	Written Communication	3.22
Self-discipline	3.37	System design to needs	2.95	Verbal Communication	3.17
Willingness to learn	3.37	Contemporary issues	2.95	Technical Skills	3.13
Flexibility	3.29	Problem solving	2.87	Reading	3.08
Reliability	3.20	Customer Service	2.65	Advanced computer	3.03
Empathy	3.15			Experiments/data analysis	3.02
Self-motivated	3.12				
Understand/take directions	3.12				
Average	**3.30**	**Average**	**2.98**	**Average**	**3.24**

We compare the satisfaction levels with findings from a US employer survey of engineering graduates. The results of the two surveys should be interpreted with caution, for two main reasons: (i) The survey questionnaires differed slightly. The US employers were asked to rate five combined types of skills on a three point scale, while the Indian employers were rating using a five point scale on a series of individual skills (these differences were not present for the importance questions analyzed above); (ii) satisfaction rates depend critically upon the respondent's expectations. For example, it may be that the competences of the Indian and the US graduates are identical, but the Indian employers have high expectations than the US employers, and the former is therefore less satisfied.

The results tentatively suggest that Indian employers are less satisfied with their graduates compared to the US employers' assessment of their graduates. The Indian employers are less satisfied than their US peers on three out of the four types of skills; notably on "*Use of Math, Science, and Engineering knowledge*", "*Applying Problem Solving skills*", and "*Learn, Grow and Adapt*".

Figure 1 Dissatisfaction Levels between Indian and US Employers



Source: Authors for India and Lattuca, Terenzini, Volkwein study for ABET 2006 for the US.
Note: Year of survey for the US was 2004 and 2009 for India.

Soft Skills vs. Professional Skills (Satisfaction): As in the case of importance level, satisfaction level of both *Soft and Professional Skills* is analyzed to see how well (or unwell) engineering graduates meet employers' expectation for *Soft and Professional Skills*.

A t-test is conducted with a following null hypothesis: "the mean of *Soft Skills* is the same as that of *Professional Skills* in terms of the satisfaction level". The mean satisfaction score of *Soft Skills* is 3.27 (0.05), and that of *Professional Skills* is 2.98 (0.06). The mean satisfaction score of *Soft Skills* is statistically significantly higher than that of *Professional Skills*. Hence, the result suggests that the null hypothesis be rejected (See Table A2-11), and indicates that employers are more satisfied with *Soft Skills* than *Professional Skills*.

We also independently tested for the two soft skill factors (*Core Employability Skills* and *Communication Skills*) compared to *Professional Skills*. The null hypotheses are; (i) the mean of *Core Employability Skills* is the same as that of *Professional Skills*, and (ii) the mean of *Communication Skills* is the same as that of *Professional Skills*. The mean scores of *Core Employability Skills* and *Communication Skills* are 3.30 (0.05) and 3.24(0.05), respectively, compared to 2.98(0.06) for *Professional Skills*. Both mean scores are significantly higher than *Professional Skills'* scores of 2.98, and the result of the two t-tests suggests that we reject both hypotheses (See Table A2-12 and A2-13). Hence, the results of analysis show that employers are more satisfied with both *Core Employability Skills* and *Communication Skills* than *Professional Skills*.

As the satisfaction level of *Soft Skills* is considered higher than that of *Professional Skills* among employers, engineering graduates seem to respond relatively better to the demand of *Soft Skills*, compared to that of *Professional Skills.* However, as shown earlier, the overall satisfaction level for *Soft Skills* remains quite low; only slightly above "somewhat satisfied".

5.4 Skill Gaps

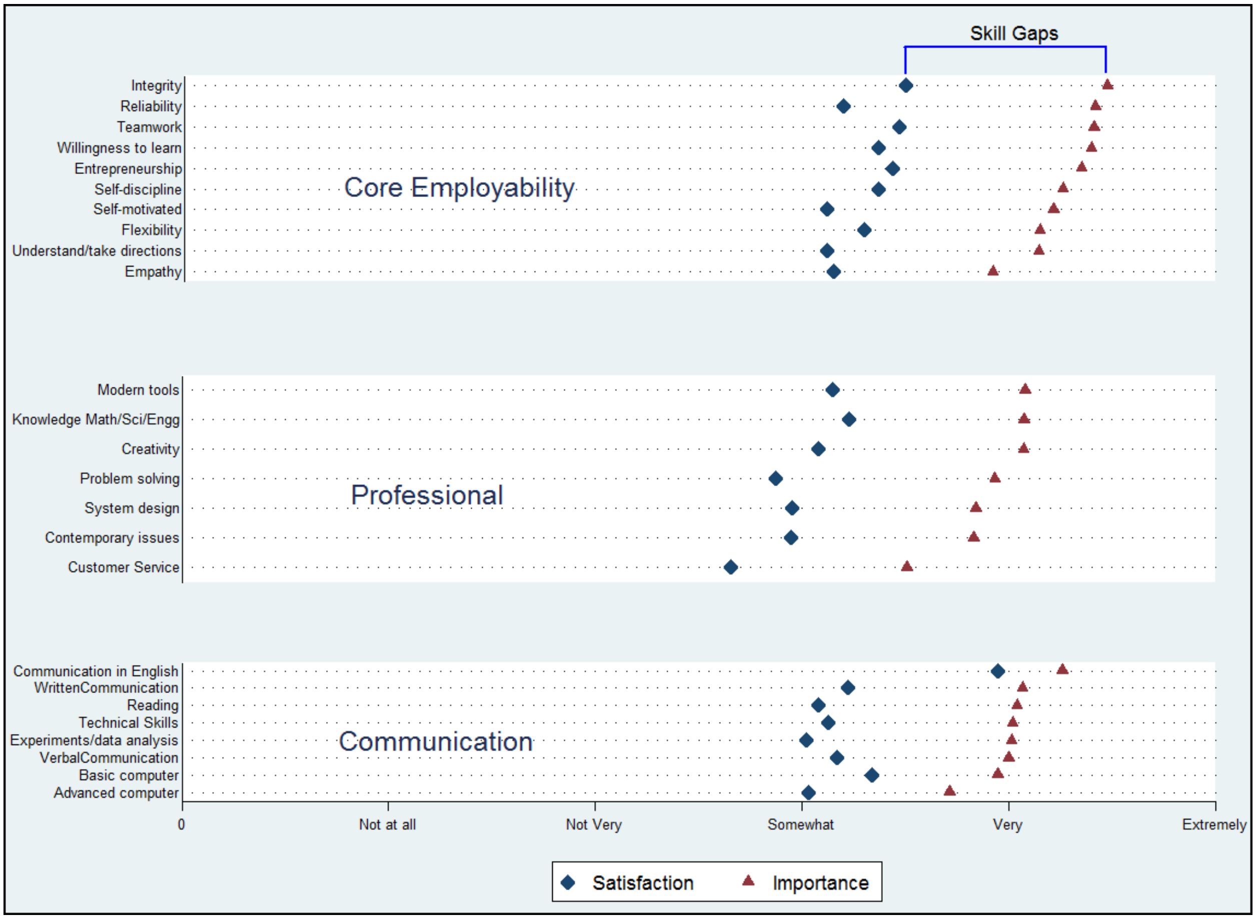
This section responds to the third question, "In which important skills are the engineers falling short?" This section combines the analysis of the importance ratings and the satisfaction ratings to identify the specific skills that are in high demand (high importance), but satisfaction rates are low. These are the skills gaps that are most urgent to address.

We calculate the skill gap as the difference between the importance level and the satisfaction level. A high skill gap signals that the skill is important and that the graduates do not meet expectations. Table 7 presents the skill gaps by skill factor, while Figure 2 displays the skill gap sorted by mean scores of importance level in descending order.

Table 7: Skills Gaps by Three Factor Skills

Core Employability	Mean	Professional Skills	Mean	Communication Skills	Mean
Reliability	1.22	Problem solving	1.06	Experiments/data analysis	0.99
Self-motivated	1.10	Creativity	0.99	Reading	0.96
Willingness to learn	1.03	Use of modern tools	0.93	Technical Skills	0.89
Understand/take directions	1.03	System design to needs	0.89	Written Communication	0.85
Integrity	0.98	Contemporary issues	0.88	Verbal Communication	0.83
Teamwork	0.95	Apply Math/Sci/Engg know.	0.85	Advanced computer	0.68
Entrepreneurship	0.91	Customer Service	0.85	Basic computer	0.61
Self-discipline	0.90			Communication in English	0.31
Flexibility	0.86				
Empathy	0.77				
Average	**0.98**	**Average**	**0.92**	**Average**	**0.77**

Figure 2: Skill Gaps



There are skill gaps across the three skill factors. On average, *Core Employability Skills* contain a higher level of skills gap (0.98) compared to *Professional Skills* (0.92) and to *Communication Skills* (0.77). Only the skill gap for *Communication Skills* is statistically significantly different from the two others. Nevertheless, there are important skills gaps in all three skill groups. Hence, there is no overall skill category where the graduates particularly fall short. Employers ask for skill improvements across the gamut of skills.

Core Employability Skills remains the factor with the largest skill gap. The importance of *Core Employability Skills* outweighs the higher satisfaction level, resulting in a higher skill gap in this group of skills. In particular, the largest skill gaps are Reliability (1.22) and Self-Motivated (1.10). We do not have a particular explanation why these two skills display the highest level of skills gap.

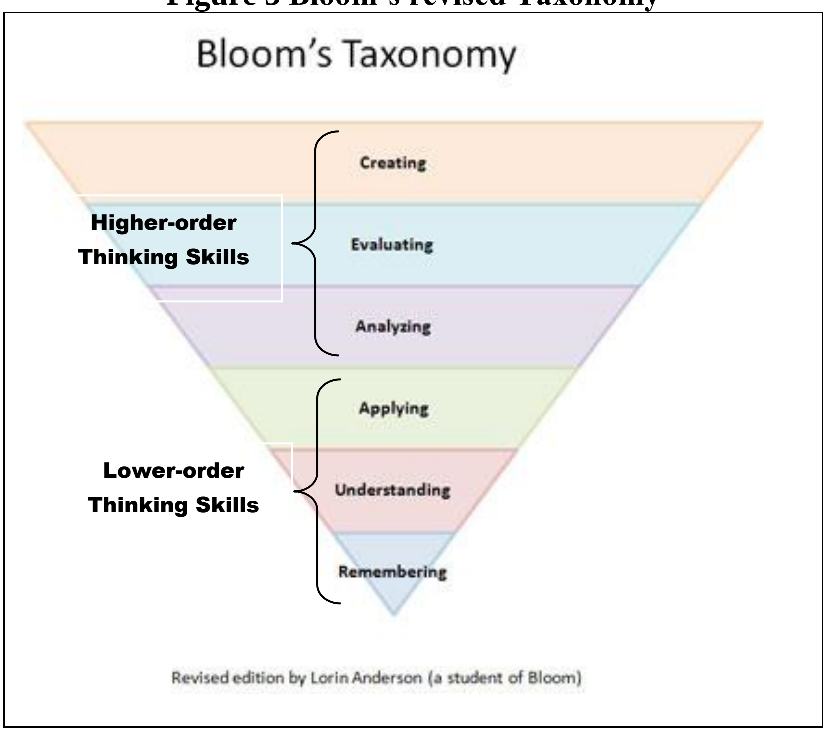
Skill Gaps: Graduates Possess Strong English Communication Skills

The survey finds that institutions are doing very well meeting the demand for English skills and that English communication is a crucially demanded skill. The skill gap in English communication is by far the smallest among all the skills (0.31) (Table 7 and Figure 2).However, the absence of skill gap does not mean that institutions should not focus on English. The high importance of English imply that engineering education institutions need to continue equipping graduates with a good command of the English language. The importance of English communication for employability should be taken into account when discussing language of instruction. Several States are discussing the benefits of local language instruction. The government of Tamil Nadu, for instance, has recently introduced Tamil as a medium of instruction in civic and mechanical engineering courses. Further, students in some government colleges are allowed to take examinations either in Tamil or in English or in both. The use of local language will remove an important barrier for learning, since poor command of English is a barrier for many students, in particular from rural areas, World Bank (forthcoming). However, the importance that employers attach to English when hiring such should also be taken into account, so that the engineering graduates will be employable upon graduation. In addition, the critical comparative advantage of Indian engineers should not be lost during the course of educational reforms at institutions because the importance of the good command in English has been increasing in both the domestic and international markets.

Skill Gaps: Higher-Order Thinking Skills Are lagging

A closer assessment of the skill gaps tentatively suggests that the skill gaps are largest within higher-order thinking skills, and smallest among the lower-order thinking skills. To arrive at this finding, we map the Professional (cognitive) Skill into the Bloom's revised taxonomy of cognitive skills. This taxonomy hieratically orders the level of cognitive skills (Anderson and Krathwohl, 2001).

Figure 3 Bloom's revised Taxonomy



Using the McBearth action verbs that have been ascribed to each thinking level, we classify the *Professional Skills* and the Engineering-related skills that fit poorly in the *Communication Skills*-factor into either higher-order thinking skills (the top three cognitive skills in the revised Bloom's taxonomy: analyzing, evaluation, and creating) or the lower-order thinking skills (the bottom-three cognitive skills in the revised Bloom's taxonomy:

remembering, understanding and applying).[13] Table 8 presents the classified skills and the importance and the skill gap as revealed by the employers.

Table 8 Importance and Skill gap for Higher-Order and Lower-Order Thinking Skills

Higher-Order Skills	**Importance**	**Skill Gap**
Identify, formulate, and solve technical/engineering problems	3.93	1.08
Design a system, component, or process to meet desired needs	3.84	0.89
Use appropriate/modern tools, equipment, technologies to the specific job	4.08	0.93
Creativity	4.07	0.99
Design & conduct experiments, and analyze and interpret data	4.01	0.99
Average Higher-Order Skills	**3.98**	**0.97**
Lower-Order skills	**Importance**	**Skill Gap**
Apply knowledge of mathematics, science, engineering	4.07	0.85
Knowledge of contemporary issues	3.83	0.88
Technical Skills (e.g. programming)	4.02	0.89
Basic computer (e.g. word processing)	3.95	0.68
Advanced computer (e.g. spreadsheets and databases)	3.71	0.69
Average Lower-Order skills	**3.90**	**0.77**

Source: authors' calculation

The average skill gap for higher-order thinking skills is substantially higher 0.97 compared to 0.77 for lower-order skills, a statistically significant difference at the 1% level. Further, the importance level is higher 3.98 compared to 3.90 (also statistically significant at the 1% level). This simple analysis shows that Indian employers demand higher-order thinking skills. It also indicates that the graduates are better at meeting the demand for lower-order thinking skills, but they fall short in meeting the demand for higher-order thinking skills. The reasons for demanding higher-order thinking skills are likely to be a result of increased international and national competition, the pervasiveness of technologies in today's world, the focus on increased quality products and innovation. As skills acquired in school and workplace become obsolete more quickly in the globalization era, higher order thinking skills and an ability to learn new and more complex skills are indispensible to respond to accelerating technological change (Riboud and Tan, 2009).

While the above is only an indicative results, it is the first empirically-based evidence that the Engineering education institutions and system does an inadequate job of developing analytical, evaluating and creative engineers. The above result highlights a crucial question for Indian engineering education; does the typical Indian engineering graduate sufficiently learn higher-order thinking skills? Or does the education model (curriculum, teaching-learning process and assessment) predominantly build lower-order thinking skills, such as

[13] Besterfiled-Sacre et al, 2000, shows how each EC2000 criteria can be dissected into skill elements that belong to different levels of thinking orders. By using such a detailed mapping, a more detailed approximation of the thinking-level of each required engineering skill could be established and the above analysis would rest upon a more detailed analytical foundation. However, this dissection of each EC2000 criteria goes beyond the scope of this paper.

remembering and understanding? Answering these questions require a larger employer survey and possibly a competence assessment of engineering graduates. [14]

Summary Analysis of Skill Gaps: The previous sections show that employers are likely to perceive *Soft Skills* more important than *Professional Skills*. However, engineering graduates with limited and weak *Professional Skills* are undesirable for employers. The survey results, for instance, show a clear signal to the Problem Solving that is under *Professional Skills*. As shown earlier, Problem Solving has the largest gap in *Professional Skills* and the second least satisfying skill of all skills.

Wide gaps can be observed among almost all skills. This is more obvious for higher order skills, such as Problem Solving that falls in *Professional Skills*. Further, the mean scores of skill gaps in *Professional Skills* are higher than those in *Soft Skills*, which are 0.91 and 0.88 points, respectively. Therefore, the importance of *Professional Skills* should not be disparaged.

6. Summary Findings and Policy Implications

Educating engineers with a comprehensive and deep set of skills that are in demand would be of tremendous importance for the employability of individual engineers and for the country's development. Large economic sectors, such as IT, infrastructure, power and water, rely critically upon engineering skills and technologies. This employer survey provides important new insight on which specific skills are important for employers and where the graduates currently fall short. In what follows, we present the main findings and the policy implications that we draw from each finding. However, it is important to keep three caveats in mind: (i) the quality improvements in education lie squarely within the scope of pedagogy, education policy and education management, which is outside of the scope of this paper; (ii) the engineers evaluated by employers should be seen as the end product of the entire education system, not just engineering education. The engineering colleges receive graduates from the secondary education system with a set of skills upon which they add. In particular, the *Soft Skills* are influenced by a prior schooling and the family setting; and (iii) although the sample size is fairly large compared to similar surveys, it is relatively small compared to the large population of Indian firms. Further, the survey may be biased due to a small size of convenience sampling and a possible over-sampling of large firms. Keeping these important caveats in mind, we limit the recommendations to a set of broad actions within engineering education to improve the skill set of future engineers.

There is substantial dissatisfaction with the quality of graduates. 64% of employers are only somewhat satisfied or worse with the current engineering graduate skills. This confirms the finding of a number of other surveys showing that the skills set of fresh engineers is inadequate. Although, there are always caveats when comparing satisfaction surveys internationally, we find that Indian employers are less satisfied with their engineers compared to US employers. Obviously, the dissatisfaction suggests that renewed

[14] The same question should be posed as to graduates of other stream of higher education in India and to to other levels of the education system. Clark, 2001 examines the culture of pedagogy in the primary and secondary education system. She finds a pervasive focus of teaching and learning in India on lower order thinking-typified by repetition and memorization-and the lack of attention given to the development of higher-order thinking.

efforts are necessary to raise the skill set of engineering graduates in India through an improvement in the quality of engineering education. We particularly recommend that each engineering program explicitly states and measures the desired learning outcomes (the skill set of their graduate). The accreditation agency, NBA, in particular could have a tremendously important impact if it increased the weight of graduates' learning outcomes compared to other input-oriented accreditation criteria (such as classroom and curricula). Also, while the results may appear gloomy, reforms and quality improvements programs have successfully taken place at individual state and institutional level. There are several success stories, see Annex 4 for the Technical Education Quality Improvement Programme. What is required is a scale-up of the reforms and investments at the national level addressing the shortcomings in the skill set of engineers.

The skills set of engineers can be characterized by three overall skills factors:

(i) *Core Employability Skills* (which cover generic attitudinal and affective skills, such as reliability and team-work);

(ii) *Communication Skills* (such as English skills, written and verbal communication), and

(iii) *Professional Skills* (which generally covers cognitive skills related to the engineering professions, such as ability to apply engineering knowledge; as well as design and conduct experiments and related data analyze and interpretation).

These skill factors are similar to findings from other employer surveys. *Core Employability Skills* and *Communications Skills* are often referred to as soft skills. The factors also have important similarities with theoretical skill domains developed in the educational literature. These three skill factors are therefore appropriate to use for further analysis.

All three skills factors are important- *Core Employability Skills*, *Communication Skills* and *Professional Skills* are important. Engineers that are in high demand possess all three skills sets. Engineering education programs therefore have to put in place a comprehensive quality upgrade of their programs.

However, while *Professional Skills* remain important**, employers consider *Soft Skills* (*Core Employability Skills* and *Communication Skills*) the most important skills.** Employers look for engineering graduates who show integrity, are reliable, can work well in teams and are willing to learn.

Further, employers across India ask for a similar set of soft skills. Irrespective of the size of the company, the economic sector, or the region, the above *Soft Skills* (integrity, reliability, teamwork and willingness to learn) remain the important ones.

The policy implication is the need to improve the *Soft Skills* of graduates. This could come about by: (i) Colleges and teachers recognizing that *Soft Skills* are important and include soft skills as part of the desired learning objectives that teachers should foster in their students. Technical knowledge and applicability are fundamental to engineering education; however, they are not all. Student's soft skills need to be honed as well; (ii) The National Accreditation Board could enhance the importance given to soft skills in the Program Outcomes; For example, NBA does not explicitly include "team working skills" as an expected skill for an engineering graduate; (iii) The teaching-learning process could be adjusted to include more project-work in teams and possibly received grades as a team; and (iv) Introduce or scale-up specific courses providing students with opportunities to enhance their English skills, communication skills or other forms of *Soft Skills*, for example through finishing schools (courses for graduating students focusing on specific skills in high demand).

The survey finds that colleges are doing very well meeting the demand for English skills, since the graduates are rated in English. The skill gap in English communication is the smallest among all the skills. Yet English communication is rated as the most important communication skill and higher than any technical skill. Although we understand the advantages of teaching in a local language, we recommend caution when considering changing the language of instruction from English to a regional language, because the change may put graduates from local language programs at a significant disadvantage at the job-interview.

Graduates seem to lack higher-order thinking skills (analyzing, evaluating and creating). The employers think that graduates are relatively strong in lower-order thinking skills (knowledge and understanding), but fall short when it comes to the more complex tasks such as application of appropriate tools to solve a problem, and analysis and interpretation. Employers are less than "*Somewhat satisfied*" with these skills. Further, these higher-order thinking skills are the most important *Professional Skills*. In short, memorizing textbooks for examinations is not a skill appreciated by the employers. This raises a question of fundamental importance, whether the Indian engineering education system overly trains students to memorize science and engineering knowledge, without adequately emphasizing the applicability, analysis and out-of-the-box thinking that employers look for. The Indian engineering firms increasingly require more analytical, adaptive, and creative engineers to upgrade the country's infrastructure, to respond to climate change and compete for higher value-added IT-orders on the global market.

Our recommendations to improve higher-order thinking skills are following. First of all, we recommend that the question be further examined and debated given the importance. Secondly, if the finding is true, which several qualitative studies suggest, major initiatives are required to reform the system: (i) reshape assessment methods, especially exams at the large affiliating universities, to assess higher-order thinking skills and not measure memorized knowledge. This would require institutions to focus on learning rather than memorization and mere understanding. In order to do so, curricula should be designed in a way where students learn how to abstract out complex and practical issues within limited time; (ii) reform curricula to increase the share of tasks where the student or a team of students lead their own problem identification, experimenting, and solving using engineering knowledge and methodologies; (iii) promote teaching-learning sessions where students are actively learning and developing their own analytical and evaluating skills as compared to simply listing and taking notes. This would most likely require significantly increased academic autonomy of institutions, substantial professional development of the teacher force and recruitment, and attention to instructional skills when recruiting teachers.

Employers ask for different *Professional Skills* depending upon their economic sectors, the firm size and the region. To illustrate, IT companies, in general, demand creativity and strong system design skills while the knowledge of mathematics, science, and engineering are less important. On the other hand, the infrastructure firms prioritize graduates with strong ability to use modern tools and the knowledge of mathematics, science, and engineering, but focus less on creativity and system design skills.

This leaves an important role for institutions to prepare their graduates to meet the demand for skills from different sectors. Institutions therefore have to increase their interaction with various kinds of employers. Hence, the institutions should customize program outcomes to meet the specific demand. Further, extra-curriculum activities such as internships and involvement of institutions with community would also help students to deepen the understanding of demanded skills and respond well to particular demanded skills.

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Annex 1: Procedures of Factor Analysis

1. Introduction

Factor analysis is a statistical procedure to find the latent variables (or factors) that explains attributes underlying common variables in the matrix. In other words, it is "*to identify the interrelationships among a large set of observed variables and then, through data reduction, to group a smaller set of these variables into dimensions or factors that have common characteristics (Nunnally & Bernstein, 1994)".[15]* Therefore, it is sometimes used as a data reduction technique.

Factor analysis is widely used in social science, especially in psychological researches and business surveys. For instance, it has been used by personality psychologists to find out major dimensions of people's personality that defines human personality. The most prominent is probably the "Big Five" personality inventory. The Big Five factors are Openness, Conscientiousness, Extroversion, Agreeableness, and Neuroticism (OCEAN). The Big Five model has been developed over the past 50 years in personality psychology, and a strong consensus that these five factors represent an overall pattern of all personality traits has emerged since early 1990s. Factor analysis is also extensively used in business surveys, from employee/employer satisfaction surveys to customer satisfaction surveys, to marketing research, and to analysis of stock market.

There are basically two types of factor analysis: exploratory and confirmatory. Exploratory factor analysis "*is used when the researcher does not know how many factors are necessary to explain the interrelationships among a set of characteristics, indicators, or items (Gorsuch, 1983; Pedhazur & Schmelkin, 1991; Tabachnick & Fidell, 2001)*"[16] Confirmatory factor analysis, on the other hand, is used when the researcher has a defined idea of the structure or the number of dimensions underlying a set of variables. Given that employer satisfaction survey is probably the first attempt in India, exploratory factor analysis was applied for the data analysis. Since this paper discusses only exploratory factor analysis, it will henceforth simply be named factor analysis.

Factor analysis normally takes three basic steps, preparing the relevant covariance matrix, extracting initial factors, and rotating to a terminal solution (Kim and Mueller, 1978). Therefore, the rest of this annex proceeds in the following way. Section 2 examines the quality of correlation matrix and determines if it is factorable. Section 3 presents the extraction method conducted. Section 4 discusses the selection of rotation methods of the factor analysis. Section 5 briefly examines the internal consistency of the instrument by using Cronbach's Coeeficient alpha. Section 6 discusses naming and interpreting the factors and their limitations. Section 7 presents composition of factor scores.

2. Examine Correlation Matrix

Reviewing elementary characteristics of correlation matrices is critical for factor analysis because the quality of matrices determines whether or not the matrices are factorable.

[15] Marjorie A. Pett, Nancy R. Lackey, John J. Sullivan, 2003. *Making Sense of Factor Analysis*.
[16] Ibid

Bartlett's Test of Sphericity and Kaiser-Meyer-Olkin Test (KMO) were used to evaluate the strength of the liner association among 25 items in the correlation matrix.[17]

a) Bartlett's Test of Sphericity: This is to test the null hypothesis that correlation matrix is an identity matrix. An identity matrix is a matrix with 0's on the off-diagonal and a completely noncollinear, which is not factorable. The formula of the test is following;

$$x^2 = -\left[(N-1) - \left(\frac{2k+5}{6}\right)\right] \log_e |R| \quad \ldots\ldots (1)$$

where

x^2=calculated chi-square value for Bartlett's test
N=sample size
k=number of items or variables in the matrix
log e=natural logarithm
|R|=determinant of the correlation matrix

The outcome below suggests that we reject the hypothesis above and conclude that our correlation matrix is not an identity matrix.

```
 Bartlett test of sphericity
Chi-square         =        1875.263
Degrees of freedom =             300
p-value            =           0.000
 H0: variables are not intercorrelated
```

b) Kaiser-Meyer-Olkin Test (KMO): KMO is a measurement of sampling adequacy that compares the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients.

$$KMO = \frac{\sum_{i\neq j}\sum r_{ij}^2}{\sum_{i\neq j}\sum r_{ij}^2 + \sum_{i\neq j}\sum a_{ij}^2} \quad \ldots\ldots (2)$$

where

$\sum\sum$ = sum over all items in the matrix when Item $i \neq$ Item j
r_{ij} = Pearsoncorrelation betwen Items i and j
a_{ij} = pertial correlation betwen Items i and j

```
Kaiser-Meyer-Olkin Measure of Sampling Adequacy
KMO = 0.860
```

Evaluation of the size of KMO is characterized by Kaizer, Meyer, and Olkin as following:

[17] A skill, "*Accepts responsibility for consequences of actions*", is dropped from the correlation matrix before factor analysis proceeds since the skill is quite similar to "*Reliability*".

- Above .90 is “Marvelous”
- In the .80s is “Meritorious”
- In the .70s is “Middling”
- In the .60s is “Mediocre”
- In the .50s is “Miserable”
- Less than .40s is “Don’t Factor”

According to Bartlett’s test, the test is significant ($x^2 = 1875.263, p = .000$), which indicates that the correlation matrix is not an identity matrix. The result of KMO statistics (.86) is “Meritorious” according to Kaizer’s criteria, suggesting that we have a sufficient sample size relative to the number of items in our scale. Given the results of the two tests above, the correlation matrix appears to be factorable.

3. Extraction Method and Selection of the Number of Factors to Retain

The main objective of the extraction in factor analysis is to determine the minimum number of common factors that would satisfactorily produce the correlations among the observed variables (Kim and Mueller, 1978). There are about 7 extraction methods; Principal Component Analysis (PCA), Principal Axis Factoring (PAF), Maximum Likelihood Methods, Unweighted Least Squares, Generalized Least Squares, Alpha Factoring, Image Factoring, etc. The first two methods, PCA and PAF, are served as base models of factor analysis and most commonly used in factor analysis. Therefore, we will focus on these two extraction methods, discuss differences of the two models, and then finally decide which method is appropriate for our analysis.

Both methods are based on assumption that initial factors to be extracted from the specified matrix are orthogonal or uncorrelated with one another (Pett, Lackey, Sullivan, 2003), and therefore they are a multivariate linear model.

The model of PCA is defined by the following equation:

$$z_k = a_{k1}PC_1 + a_{k2}PC_2 + \ldots + a_{kj}PC_j \quad \ldots\ldots (3)$$

where

z_k = standardized observed variable for k
a_{kj} = factor loadings (or standardized regression coefficient) of k on PC_j
PC_j = jth common factors

The model of PAF is slightly different from PCA, and it is defined by the following equation:

$$z_k = a_{k1}F_1 + a_{k2}F_2 + \ldots + a_{kj}F_j + u_kY_k \quad \ldots\ldots (4)$$

where

z_k = standardized observed variable for k

a_{kj} = factor loadings (or standardized regression coefficient) of k on F_j
F_j = jth common factors
$u_k Y_k$ = factor loading of k on its unique factor Y_k

As the formulas above show, the major difference between PCA and PAF is their approaches to deal with the variances. While PAF includes all variances; common variance, specific variance, and error variance, PCA partitions variances into shared variance and unique variance, which is composed of specific and error variance.

There is no agreement among researches on which extraction method is better, and therefore selection of extracting method in factor analysis is not easy. Both PCA and PAF have advantages and disadvantages. While PCA is more commonly used by researchers and useful especially when reducing a number of variables with a smaller number of components (or factors), PAF provides a better estimate of correlations by separating out error variances. (Pett, Lackey, and Sullivan, 2003) As a result, PCA tends to show the estimate of correlations slightly higher than that of PAF. Because we do not know how significant error of measurement from shared variance play a role in this exercise, it would be safer to take into account (separate out) the error variance. Thus, PAF is selected as extraction method.[18] Table A1-1 below shows the result of the extraction.

Table A1- 1: Factor loadings (pattern matrix) and unique variances (PAF)

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	8.059	5.610	0.577	0.577
Factor2	2.449	1.069	0.175	0.753
Factor3	1.379	0.485	0.099	0.851
Factor4	0.894	0.285	0.064	0.915
Factor5	0.609	0.090	0.044	0.959
Factor6	0.519	0.092	0.037	0.996
Factor7	0.427	0.090	0.031	1.027
Factor8	0.337	0.062	0.024	1.051
Factor9	0.275	0.067	0.020	1.071
Factor10	0.208	0.078	0.015	1.086
Factor11	0.130	0.033	0.009	1.095
Factor12	0.097	0.040	0.007	1.102
Factor13	0.057	0.062	0.004	1.106
Factor14	-0.004	0.009	0.000	1.106
Factor15	-0.013	0.034	-0.001	1.105
Factor16	-0.047	0.006	-0.003	1.101
Factor17	-0.053	0.027	-0.004	1.098
Factor18	-0.080	0.031	-0.006	1.092
Factor19	-0.110	0.013	-0.008	1.084
Factor20	-0.123	0.033	-0.009	1.075
Factor21	-0.156	0.020	-0.011	1.064
Factor22	-0.176	0.004	-0.013	1.051
Factor23	-0.180	0.079	-0.013	1.038
Factor24	-0.260	0.016	-0.019	1.020
Factor25	-0.276	.	-0.020	1.000

Var	Fctr1	Fctr2	Fctr3	Fctr4	Fctr5	Fctr6	Fctr7	Fctr8	Fctr9	Fctr10	Fctr11	Fctr12	Fctr13	Uniqueness
gi21	0.524	-0.223	-0.160	0.125	-0.159	-0.034	0.035	-0.157	0.016	0.026	-0.137	0.146	0.042	0.540
gi22	0.678	-0.058	-0.188	0.201	-0.221	0.211	-0.016	-0.023	0.021	0.031	-0.158	-0.051	-0.014	0.337

[18] PCA was also tried out. However, the factors extracted by PCA seemed mixing soft and Professional Skills, and it was difficult to intuitively interpret the results, which is one of the important assessments of the extracted factors.

gi23	0.635	-0.002	-0.072	0.299	-0.130	0.095	-0.210	-0.150	-0.041	0.092	0.088	-0.052	0.008	0.388
gi24	0.598	-0.445	0.023	-0.217	-0.145	0.012	0.142	0.111	0.206	0.022	-0.001	0.023	-0.005	0.300
gi25	0.596	-0.510	0.019	-0.105	-0.174	0.088	0.133	-0.053	0.016	0.085	0.073	-0.017	-0.041	0.300
gi26	0.532	-0.486	0.170	-0.113	-0.093	-0.068	-0.103	0.135	0.200	-0.022	0.075	-0.039	0.043	0.347
gi27	0.649	-0.398	-0.012	0.104	-0.007	-0.002	0.008	0.229	-0.201	0.050	-0.048	-0.028	0.065	0.307
gi28	0.602	-0.062	-0.245	0.142	0.065	-0.201	-0.089	0.113	-0.131	0.153	0.059	0.111	-0.043	0.429
gi29	0.685	-0.264	0.113	-0.013	0.165	0.091	-0.050	0.024	-0.016	-0.109	-0.067	-0.088	-0.120	0.371
gi210	0.545	-0.298	-0.077	0.044	0.157	0.194	0.058	0.009	-0.145	-0.168	0.056	0.080	-0.019	0.482
gi211	0.623	-0.266	-0.014	0.139	0.180	-0.238	0.067	-0.134	0.065	-0.022	0.111	0.008	-0.005	0.394
si31	0.534	0.235	-0.323	-0.394	0.034	0.168	0.073	-0.093	-0.036	-0.003	0.020	-0.004	0.094	0.346
si32	0.531	0.213	-0.394	-0.446	0.075	0.037	-0.105	0.000	-0.075	0.050	-0.011	-0.076	-0.040	0.285
si33	0.561	0.341	-0.377	-0.119	0.106	-0.165	0.175	0.087	0.064	-0.025	0.006	0.026	0.022	0.330
si34	0.609	0.415	-0.291	0.187	-0.071	0.109	-0.002	0.043	0.072	-0.045	0.055	-0.001	-0.030	0.308
si35	0.642	0.259	0.378	-0.138	-0.238	-0.067	0.003	-0.035	-0.208	-0.039	0.078	-0.002	0.017	0.246
si36	0.609	0.199	0.434	-0.152	-0.116	-0.196	-0.033	-0.079	-0.073	0.034	-0.035	-0.059	0.031	0.307
si37	0.533	0.302	0.092	-0.064	0.125	0.083	-0.402	0.070	0.142	0.033	0.029	0.067	0.003	0.397
si38	0.576	0.319	0.359	-0.112	-0.075	0.012	-0.016	0.133	-0.015	-0.161	-0.066	0.116	-0.033	0.357
si39	0.263	0.193	0.404	-0.058	0.205	0.223	0.045	-0.045	0.081	0.208	-0.043	0.055	0.016	0.577
si310	0.354	0.120	0.243	0.098	0.294	0.073	0.229	0.104	-0.046	0.158	-0.006	-0.033	-0.016	0.609
si311	0.352	0.448	0.066	0.349	-0.035	0.176	0.127	0.130	0.061	-0.085	0.080	-0.049	0.072	0.459
si312	0.646	0.339	0.115	0.039	-0.010	-0.040	0.153	-0.253	0.072	-0.021	0.025	0.012	-0.058	0.354
si313	0.566	0.349	-0.084	0.156	0.017	-0.319	0.008	0.068	0.071	0.002	-0.114	-0.073	-0.002	0.397
si314	0.527	-0.365	0.067	0.057	0.354	-0.035	-0.102	-0.160	0.002	-0.115	-0.063	-0.032	0.087	0.393

After determining the extraction method, the number of factors to retain should be decided. There are mainly three approaches:

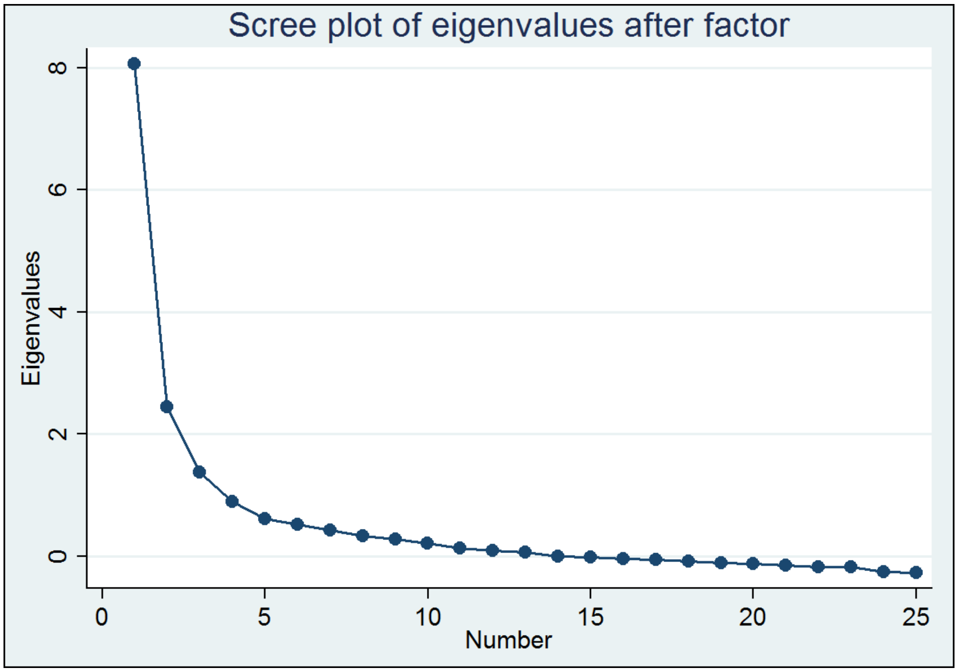
Eigenvalues[19] with more than 1.0. One of the ways to determine the number of factors to retain is to select factors whose eigenvalues are more than 1.00 (Kaiser-Guttman rule). Given this rule, it suggests that Factor 1, 2, and 3 in the Table A1-1 should be selected.

Percent of Variance Extracted. Another way is to examine the cumulative figures (the last column of the top table in Table A1-1) and set a threshold where the figures reach between 75 – 80%. The figures are accumulation of "proportion" (next column on the left of "cumulative"). The figures in proportion are calculated by dividing eigenvalue in a given factor by the summation of the eigenvalues (13.962). For instance, the first proportion 0.5772 is computed as following: 8.05851/13.962=0.5772 (rounded). This suggests retaining the first two factors (Factor 1 and 2).

Scree Plot. The third method for determining the number of factors to retain is the Scree Plot. This is visualization of the first method (eigenvalues), and Cattell (1966) suggests retaining factors whose dropping level of eigenvalues is higher than that of going across in the Scree Plot. In Figure A1-1 below, the first three factors show significant drops compared to others which are more or less flat. Therefore, this method also recommends retaining the first three factors. Given these three methods, it is determined that our factor analysis model will keep three factors (Factor 1, 2, and 3) for further analysis.

[19] Eigenvalue is the amount of variance explained by each factor.

Figure A1- 1: Scree Plot of Eigenvalues



4. Rotating Methods

Unrotated factors, e.g., Table A1-1 are often very difficult to have meaningful interpretations. In order to make the unrotated factors more interpretable, those factors are usually rotated for further analysis. Therefore, rotating factor is the next step after determining the number of factors to be retained. Detail explanations of rotation are beyond the scope of this paper, but the paper briefly explains the method applied for the analysis and the reason why the method was selected.

There are basically two rotating methods, orthogonal and oblique factor rotations. While the former is assumed that the generated factors are independent of each other (uncorrelated), the latter is supposed to have some correlations between the factors. (Pett, Lackey, and Sullivan, 2003) Especially in social science, it is unrealistic to assume that the generated factors are completely independent. For instance in our study, Factor 1 has higher correlations with core employability skills, Factor 2 shows more correlations with Professional Skills, and Factor 3 is more related to communication skills.[20] It intuitively makes sense to assume that these three generated factors in our analysis (Core Employability Skills, Professional Skills, and Communication Skills) may have some

[20] Table A1-1 does not clearly show this result. This is precisely why rotation is needed. Table 6 in Annex 2 shows more meaningful and interpretable results.

correlations, however little. Therefore, the oblique factor rotation method was selected for our analysis.[21]

5. Interpreting and naming Factors

The amount of the factor loadings for each skill is helpful for interpreting factors. It is widely accepted that factor loadings less than 0.40 can be disregarded for interpretation of the factors. Therefore, Table A2-2 in Annex 2 shows the rotated factors which are sorted from highest to lowest and more than 0.40 in factor loadings.

The highest and the majority of factor loadings in Factor 1 are skills that are related to core employability skills e.g., integrity, self-discipline, reliability, etc. Factor 2, on the other hand, is dominated by Professional Skills with a few core employability skills whose factor loading is relatively low. All three communication skills fall in Factor 3, and there are skills related to the cognitive ability such as reading and analyzing and interpreting data.

Taking into account these interpretations of the factors, each factor is named as follows: Core employability skills (Factor 1), Professional Skills (Factor 2), and Communication Skills (Factor 3).

However, as briefly described in the main text, naming factors requires careful thoughts. It should be noted that the extracted factors do not necessarily truly exist in the real world, and they are hypothetically created. Therefore, the names of factors subjectively describe the multi dimensions of each factor.

6. Evaluation of the Internal Consistency of the Instrument (Cronbach's Coefficient Alpha)

Before fully completing the factor analysis, it is important to assess the internal consistency of the instrument. Cronbach's coefficient alpha is commonly used to measure reliability of the instrument, and the formula is given as follows:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_x^2}\right)$$

where

α = coefficient alpha
k = number of items in the scale
$\sum \sigma_i^2$ = sum of the variances of the items
σ_x^2 =variance of the scales' composite score

[21] There are several different rotating methods under the oblique method. Promax is used for rotating factors. It is one of the representative oblique methods and is widely used in social surveys. It is especially helpful for large data sets.

Table A1-2 below presents alpha coefficients for the twenty five skills of the employer satisfaction survey. The reliability estimates presented in the last column ranged from .911 to .918 with a total scale coefficient alpha equal to .916. Since an α>.8 is considered good reliability, the result of evaluating the internal consistency shows that our instrument is reliable enough.

Table A1- 2: Internal Consistency (Cronbach's Coefficient)

Skills	Obs	Sign	item-test correlation	item-rest correlation	average inter-item covariance	alpha
Flexibility	153	+	0.532	0.483	0.165	0.914
Creativity	153	+	0.669	0.624	0.159	0.911
Empathy	153	+	0.651	0.606	0.160	0.911
Reliability	153	+	0.602	0.557	0.162	0.913
Integrity	153	+	0.587	0.544	0.163	0.913
Self-discipline	153	+	0.535	0.485	0.164	0.914
Self-motivated	153	+	0.665	0.626	0.161	0.912
Knowledge of contemporary issues	153	+	0.596	0.542	0.161	0.913
Teamwork	153	+	0.696	0.660	0.161	0.911
Willingness to learn	153	+	0.578	0.535	0.164	0.914
Understands and takes directions for work assignments	153	+	0.653	0.608	0.160	0.912
Apply knowledge of mathematics, science, engineering	150	+	0.577	0.525	0.162	0.913
Use appropriate/modern tools, equipment, technologies	150	+	0.551	0.499	0.163	0.914
Identify, formulate, and solve technical/engineering problems	150	+	0.613	0.561	0.160	0.913
Design a system, component, or process to meet desired needs	150	+	0.649	0.600	0.159	0.912
Design & conduct experiments, and analyze and interpret data	150	+	0.665	0.626	0.161	0.912
Written communication	150	+	0.629	0.588	0.162	0.912
Verbal communication	150	+	0.548	0.500	0.164	0.914
Reading	150	+	0.606	0.559	0.162	0.913
Communication in English	150	+	0.308	0.253	0.171	0.917
Basic computer	150	+	0.432	0.374	0.167	0.916
Advanced computer	150	+	0.407	0.332	0.166	0.918
Technical Skills	150	+	0.683	0.640	0.158	0.911
Customer Service Skills	150	+	0.607	0.549	0.159	0.913
Entrepreneurship Skills	151	+	0.541	0.499	0.166	0.914
Test scale					**0.162**	**0.916**

Annex 2: Tables and Figures

Table A2- 1: Descriptive Statistics of Companies by Size, Region, States, Sector, and Respondents

Variable	N	%
Size		
Large (Over 500 employees)	79	50.3
Medium (Between 100 and 500 employees)	37	23.6
Small (Under 100 employees)	39	24.8
No response	2	1.3
Total	157	100
Region [a]		
Central	6	3.8
East	12	7.6
North	66	42.0
South	30	19.1
West	43	27.4
Total	157	100
States [b]		
Andhra Pradesh	8	5.1
Bihar	1	0.6
Goa	1	0.6
Gujarat	14	8.9
Haryana	13	8.3
Jharkhand	2	1.3
Karnataka	11	7.0
Maharashtra	29	18.5
New Delhi	43	27.4
Orissa	1	0.6
Rajasthan	3	1.9
Tamil Nadu	6	3.8
Uttar Pradesh	14	8.9
West Bengal	7	4.5
No response	4	2.6
Total	157	100
Sector		
Automobiles	7	4.5
Biotech	4	2.6
Cement	1	0.6
Food Processing	6	3.8
IT	16	10.2
Industrial Electronics	6	3.8
Infrastructure	11	7.0

Irrigation, Diary, Fertilizer, Agriculture	2	1.3
Oil & Gas	7	4.5
Other	53	33.8
Paper	3	1.9
Pharmaceutical	3	1.9
Power	20	12.7
Real Estate	2	1.3
Refinery, Chemicals	6	3.8
Steel	5	3.2
Telecom	3	1.9
Textile	2	1.3
Total	157	100
Firm Established with Foreign Capital		
Yes	31	19.8
No	112	71.3
Don't know	10	6.4
No response	4	2.6
Total	157	100
Respondents		
Board Member	5	3.2
Business owner/partner	23	14.6
Colleagues of graduate's department	1	0.6
GM - communications	2	1.3
Head/Manager of Human Resource departme	79	50.3
Manger of graduate`s department	28	17.8
President/V. President/Executives	13	8.3
Other	2	1.3
No response	4	2.5
Total	157	100

a. Regions where headquarters locate
b. States where headquarters locate

Table A2- 2: Factor Pattern Matrix for Skills

Skills	Core Employability Skills (Factor 1)	Professional Skills (Factor 2)	Communication (Factor 3)	Uniqueness[22]
Integrity	0.83			0.38
Self-discipline	0.78			0.45
Reliability	0.76			0.44
Self-motivated	0.74			0.42
Entrepreneurship Skills	0.65			0.58
Teamwork	0.63			0.45
Understands and takes directions for work assignments	0.59			0.54
Willingness to learn	0.58			0.61
Flexibility	0.49			0.65
Empathy	0.33			0.59
Identify, formulate, and solve technical/engineering problems		0.80		0.43
Design a system, component, or process to meet desired needs		0.77		0.37
Use appropriate/modern tools, equipment, technologies		0.73		0.52
Apply knowledge of mathematics, science, engineering		0.67		0.55
Customer Service Skills		0.51		0.55
Knowledge of contemporary issues		0.45		0.57
Creativity		0.42		0.50
Written communication			0.74	0.40
Design & conduct experiments, and analyze and interpret data			0.73	0.38
Reading			0.72	0.44
Communication in English			0.59	0.73
Technical Skills			0.50	0.45
Verbal communication			0.42	0.62
Basic computer			0.42	0.80
Advanced computer			0.41	0.67

Extracted Method: Principle Axis Factoring
Rotation Method: Promax

Table A2- 3: Importance Level

Skills	*N*	*Mean*	*Std. Dev.*
Integrity	153	4.48	0.66
Reliability	153	4.42	0.69
Teamwork	153	4.41	0.66
Willingness to learn	153	4.40	0.64
Entrepreneurship	151	4.35	0.59
Self-discipline	153	4.26	0.71
Communication in English	150	4.26	0.62
Self-motivated	153	4.22	0.69
Flexibility	153	4.15	0.68
Understand/take directions	153	4.14	0.77
Responsibility	150	4.11	0.68

[22] "Uniqueness is the variance that is 'unique' to the variable and not shared with other variables." (Torres-Reyna)

Use of modern tools	150	4.08	0.74
Apply Knowledge Math/Sci/Engg	150	4.07	0.76
Creativity	153	4.07	0.77
Written Communication	150	4.07	0.67
Reading	150	4.04	0.72
Technical Skills	150	4.02	0.79
Experiments/data analysis	150	4.01	0.69
Verbal Communication	150	4.00	0.68
Basic computer	150	3.95	0.71
Problem solving	150	3.93	0.81
Empathy	153	3.92	0.75
System design	150	3.84	0.82
Contemporary issues	153	3.83	0.76
Advanced computer	150	3.71	0.89
Customer Service	150	3.51	0.89

Table A2- 4: ANOVA – Importance Mean Scores of Communication in English (Company Size)

```
            |          Summary of simean
company_size|        Mean   Std. Dev.       Freq.
------------+------------------------------------
      Large |   4.3506494   .57961498          77
     Medium |   4.0833333   .73192505          36
      Small |   4.2571429   .56061191          35
------------+------------------------------------
      Total |   4.2635135   .62118481         148

                        Analysis of Variance
    Source              SS         df       MS            F     Prob > F
------------------------------------------------------------------------
Between groups      1.75479115      2   .877395577      2.31     0.1025
 Within groups      54.9681818    145   .379090909
------------------------------------------------------------------------
    Total            56.722973    147   .385870564

Bartlett's test for equal variances:  chi2(2) =   3.4147  Prob>chi2 = 0.181
```

Table A2- 5: ANOVA – Importance Mean Scores of Communication in English (Foreign Capital)

```
foreign_cap |          Summary of simean
       ital |        Mean   Std. Dev.       Freq.
------------+------------------------------------
  Dont know |           4   .81649658          10
         No |   4.2641509   .62185417         106
        Yes |   4.3666667   .55605342          30
------------+------------------------------------
      Total |   4.2671233   .62467753         146

                        Analysis of Variance
    Source              SS         df       MS            F     Prob > F
------------------------------------------------------------------------
Between groups      1.01175153      2   .505875765      1.30     0.2753
 Within groups      55.5704403    143   .388604477
```

Total	56.5821918	145	.390222012

Bartlett's test for equal variances: chi2(2) = 2.2316 Prob>chi2 = 0.328

Table A2- 6: ANOVA – Importance Mean Scores of Communication in English (Sector)

sector2	Summary of simean Mean	Std. Dev.	Freq.
Automobiles	4	.57735027	7
IT	4.3333333	.48795004	15
Industrial Electronics	4.5	.54772256	6
Infrastructure	3.9090909	.53935989	11
Mining and quarrying Manufacturin	4.3571429	.49724516	14
Oil & Gas	4.2857143	.75592895	7
Other service activities	4.0714286	.61572793	14
Power	4.3888889	.60768499	18
Total	4.2391304	.58119931	92

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	3.14749984	7	.449642835	1.37	0.2292
Within groups	27.5916306	84	.328471793		
Total	30.7391304	91	.337792642		

Bartlett's test for equal variances: chi2(7) = 2.4924 Prob>chi2 = 0.928

Table A2- 7: Satisfaction Level

Skills	***N***	***Mean***	***Std. Dev.***
Communication in English	150	3.95	0.68
Integrity	153	3.50	0.88
Teamwork	153	3.46	0.81
Entrepreneurship	151	3.44	0.72
Self-discipline	153	3.37	0.86
Willingness to learn	153	3.37	0.91
Basic computer	150	3.34	0.95
Flexibility	153	3.29	0.77
Responsibility	150	3.25	0.88
Apply knowledge Math/Sci/Engg	150	3.23	0.84
Written Communication	150	3.22	0.89
Reliability	153	3.20	0.93
Verbal Communication	150	3.17	0.83
Empathy	153	3.15	0.81
Use of modern tools	150	3.15	0.85
Technical Skills	150	3.13	0.82
Self-motivated	153	3.12	0.79
Understand/take directions	153	3.12	0.95
Reading	150	3.08	0.92
Creativity	153	3.08	0.92

Advanced computer	150	3.03	0.93
Experiments/data analysis	150	3.02	0.90
System design	150	2.95	0.96
Contemporary issues	153	2.95	0.86
Problem solving	150	2.87	0.96
Customer Service	150	2.65	0.93

Table A2- 8: T-test for differences in importance means of Soft and Professional Skills

```
Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
meansoft |     153    4.154193    .0344562    .4261991    4.086118    4.222268
meantech |     153    3.894958    .0469839    .5811589    3.802132    3.987784
---------+--------------------------------------------------------------------
    diff |     153    .2592348    .0366064    .4527964    .1869118    .3315579
------------------------------------------------------------------------------
     mean(diff) = mean(meansoft - meantech)                       t =   7.0817
 Ho: mean(diff) = 0                              degrees of freedom =      152

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Note: *meansoft* refers to the mean of soft skills in importance level while *meantech* refers to that of Professional Skills.

Table A2- 9: T-test for differences in importance means of Core Employability Skills and Professional Skills

```
Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
meancore |     153    4.274437    .0398547    .4929755    4.195696    4.353178
meantech |     153    3.894958    .0469839    .5811589    3.802132    3.987784
---------+--------------------------------------------------------------------
    diff |     153    .3794792    .0423813    .5242274    .2957468    .4632116
------------------------------------------------------------------------------
     mean(diff) = mean(meancore - meantech1)                    t =   8.9539
 Ho: mean(diff) = 0                              degrees of freedom =      152

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Note: *meancore* refers to the mean of Core Employability Skills in importance level while *meantech* refers to that of Professional Skills.

Table A2- 10: T-test for differences in importance means of Communication and Professional Skills

```
Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
meancomm |     150      4.0075    .0394174    .4827629    3.929611    4.085389
```

```
meantech |     150    3.909524    .0466064     .570809    3.817429    4.001619
---------+--------------------------------------------------------------------
    diff |     150    .0979762    .0396727     .485889    .0195825    .1763699
------------------------------------------------------------------------------
     mean(diff) = mean(meancomm - meantech1)                      t =   2.4696
 Ho: mean(diff) = 0                              degrees of freedom =      149

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 0.9927         Pr(|T| > |t|) = 0.0147          Pr(T > t) = 0.0073
```

Note: *meancomm* refers to the mean of Communication in importance level while *meantech* refers to that of Professional Skills.

Table A2- 11: T-test for differences in satisfaction means of Soft and Professional Skills

```
Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
meansoft |     153    3.271729     .046479     .574914      3.1799    3.363557
meantech |     153    2.980859     .057682    .7134867    2.866897    3.094821
---------+--------------------------------------------------------------------
    diff |     153    .2908698    .0299241    .3701408    .2317489    .3499907
------------------------------------------------------------------------------
     mean(diff) = mean(meansoft - meantech)                       t =   9.7202
 Ho: mean(diff) = 0                              degrees of freedom =      152

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Note: *meansoft* refers to the mean of soft skills in satisfaction level while *meantech* refers to that of Professional Skills.

Table A2- 12: T-test for differences in satisfaction means of Core Employability Skills and Professional Skills

```
Paired t test
------------------------------------------------------------------------------
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
meancore |     153    3.301017    .0495818    .6132927    3.203058    3.398975
meantech |     153    2.980859     .057682    .7134867    2.866897    3.094821
---------+--------------------------------------------------------------------
    diff |     153    .3201577    .0331495     .410037    .2546644     .385651
------------------------------------------------------------------------------
     mean(diff) = mean(meancore - meantech)                     t =   9.6580
 Ho: mean(diff) = 0                              degrees of freedom =      152

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Note: *meancore* refers to the mean of Core Employability Skills in satisfaction level while *meantech* refers to that of Professional Skills

Table A2- 13: T-test for differences in importance means of Communication and Professional Skills

```
Paired t test
------------------------------------------------------------------------------
```

```
Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
meancomm |     150    3.241667    .0506069     .619805    3.141667    3.341667
meantech |     150     2.98381    .0583687    .7148678    2.868472    3.099147
---------+--------------------------------------------------------------------
    diff |     150    .2578571    .0373474    .4574104    .1840582    .3316561
------------------------------------------------------------------------------
     mean(diff) = mean(meancomm - meantech)                       t =   6.9043
 Ho: mean(diff) = 0                              degrees of freedom =      149

 Ha: mean(diff) < 0           Ha: mean(diff) != 0           Ha: mean(diff) > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0
```

Note: *meancomm* refers to the mean of Communication in satisfaction level while *meantech* refers to that of Professional Skills.

Table A2- 14: Kendall's Rank Correlation by Sector (Soft Skills)

	ITsoft	Powersoft	Autosoft	IEsoft	Infsoft	OGsoft	MMsoft	OSsoft
ITsoft	1							
Powersoft	0.3754*	1						
	0.0387							
Autosoft	0.2204	0.118	1					
	0.2533	0.5541						
IEsoft	0.2196	0.5361*	0.3715	1				
	0.2549	0.0047	0.0631					
Infsoft	0.4055*	0.3104	0.7053*	0.3919*	1			
	0.0261	0.0911	0.0002	0.0406				
OGsoft	0.4188*	0.3918*	0.4140*	0.3360	0.4088*	1		
	0.0247	0.0363	0.0346	0.0876	0.0297			
MMsoft	0.3643*	0.2966	0.3935*	0.3106	0.4097*	0.3873*	1	
	0.0463	0.1071	0.0401	0.1068	0.0258	0.0398		
OSsoft	0.3089	0.2959	0.7811*	0.5363*	0.5746*	0.4909*	0.5178*	1
	0.097	0.1131	0.0001	0.0056	0.002	0.0099	0.0054	

Upper row: tau-B, Lower row: *p*-value of z scores
*Significant at 5%

ITsoft: IT, Powersoft: Power, Autosoft: Automobiles, IEsoft: Industrial Electronics, Infsoft: Infrastructure, OGsoft: Oil&Gas, MMsoft: Mining and quarrying Manufacturing, OSsoft: Other service activities.

Table A2- 15: Kendall's Rank Correlation by Sector (Professional Skills)

	ITtech	Powert~h	Autotech	IEtech	Inftech	OGtech	MMtech	OStech
ITtech	1							
Powertech	0.1952	1						
	0.6486							
Autotech	0.2712	0.0529	1					
	0.5211	1						
IEtech	0.5590	0.6547	0.0606	1				
	0.1438	0.0769	1					

Inftech	0.1952	0.8095*	0.0529	0.6547	1			
	0.6486	0.0163	1	0.0769				
OGtech	0.3904	0.7143*	0.0529	0.8729*	0.7143*	1		
	0.2876	0.0355	1	0.0159	0.0355			
MMtech	0.5798	0.2057	0.2858	0.4125	0.3086	0.3086	1	
	0.113	0.638	0.5084	0.3155	0.433	0.433		
OStech	0.5500	0.1952	0.4339	0.5590	0.1952	0.4880	0.0527	1
	0.1245	0.6486	0.2615	0.1438	0.6486	0.1716	1	

Upper row: tau-B, Lower row: *p*-value of z scores
*Significant at 5%

ITtech: IT, Powertech: Power, Autotech: Automobiles, IEtech: Industrial Electronics, Inftech: Infrastructure, OGtech: Oil&Gas, MMtech: Mining and quarrying Manufacturing, OStech: Other service activities.

Table A2- 16: Kendall's Rank Correlation by Size of Company (Soft Skills)

	Ssoft	Msoft	Lsoft
Ssoft	1.0000		
Msoft	0.5533*	1.0000	
	0.0018		
Lsoft	0.5762*	0.6821*	1.0000
	0.0011	0.0001	

Upper row: tau-B, Lower row: *p*-value of z scores
*Significant at 5%

Ssoft: Small Company, Msoft: Medium Company, Lsoft: Large Company.

Table A2- 17: Kendall's Rank Correlation by Size of Company (Professional Skills)

	Stech	Mtech	Ltech
Stech	1.0000		
Mtech	0.8230*	1.0000	
	0.0187		
Ltech	0.3086	0.4286	1.0000
	0.4330	0.2296	

Upper row: tau-B, Lower row: *p*-value of z scores
*Significant at 5%

Stech: Small Company, Mtech: Medium Company, Ltech: Large Company.

Table A2- 18: Kendall's Rank Correlation by Region (Soft Skills)

	Csoft	Esoft	Nsoft	Ssoft	Wsoft
Csoft	1.0000				
Esoft	0.4678*	1.0000			
	0.0135				

Nsoft	0.4624*	0.6421*	1.0000		
	0.0126	0.0003			
Ssoft	0.4512*	0.5171*	0.6954*	1.0000	
	0.0155	0.0041	0.0001		
Wsoft	0.3497	0.5900*	0.6865*	0.5449*	1.0000
	0.0612	0.0010	0.0001	0.0021	

Upper row: tau-B, Lower row: *p*-value of z scores
*Significant at 5%
Csoft: Central, Esoft: East, Nsoft: North, Ssoft: South, Wsoft: West

Table A2- 19: Kendall's Rank Correlation by Region (Professional Skills)

	Ctech	Etech	Ntech	Stech	Wtech
Ctech	1.0000				
Etech	0.6928	1.0000			
	0.0678				
Ntech	0.5071	0.7807*	1.0000		
	0.1884	0.0227			
Stech	0.5774	0.4500	0.3904	1.0000	
	0.1352	0.2191	0.2876		
Wtech	0.5071	0.7807*	0.6190	0.5855	1.0000
	0.1884	0.0227	0.0715	0.0947	

Upper row: tau-B, Lower row: *p*-value of z scores
*Significant at 5%
Ctech: Central, Etech: East, Ntech: North, Stech: South, Wtech: West

Annex 3: Employer Satisfaction Questionnaire

Questionnaires for Employer Satisfaction Survey

1. OVERALL SATISFACTION

	Extremely	Very	Somewhat	Not Very	Not at all
Overall, are you satisfied with the newly graduated engineers that you have hired in the last 4 years *(only consider hires for whom this was their first job after graduation)*					

2. GENERAL SKILLS

Rate **IMPORTANCE** for successful performance of the job					**CRITERIA**	Rate **SATISFACTION** with this employee's qualities				
Extremely	Very	Somewhat	Not Very	Not at all		Extremely	Very	Somewhat	Not Very	Not at all
					Flexibility (responds well to change)					
					Creativity (identifies new approaches to problems)					
					Empathy (understands the situations, feelings, or motives of others)					
					Reliability (can be depended on to complete work assignments)					
					Integrity (understands/applies professional and ethical principles to decisions)					
					Self-discipline (exhibits control of personal behavior)					
					Self-motivated					
					Knowledge of contemporary issues					
					Teamwork (interpersonal relationships)					
					Willingness to learn (Life-long learning)					
					Understands and takes directions for work assignments					
					Accepts responsibility for consequences of actions					

COMMENTS

3. SPECIFIC SKILLS

Rate **IMPORTANCE** for successful performance of the job					**CRITERIA**	Rate **SATISFACTION** with this employee's general skills				
Extremely	Very	Somewhat	Not Very	Not at all		Extremely	Very	Somewhat	Not Very	Not at all
					Ability to apply knowledge of mathematics, science, engineering					
					Ability to use appropriate and modern tools, equipment, and technologies specific to their jobs (other than computers)					
					Ability to identify, formulate, and solve technical/engineering problems					
					Ability to design a system, component, or process to meet desired needs					
					Ability to design and conduct experiments, as well as to analyze and interpret data					
					Written communication					
					Verbal communication					
					Reading					
					Communication in English					
					Basic computer (e.g., word-processing)					
					Advanced computer (e.g., spreadsheets, databases)					
					Technical Skills (e.g., programming)					
					Customer Service Skills					
					Entrepreneurship Skills					

COMMENTS

4. CHARACTERISTIC OF EMPLOYER

A. What is the legal status of the firm?

1. Joint Stock Company
2. Joint stock company with state participation
3. Corporation represented in stock exchange
4. Limited liability partnership LLP
5. Production Cooperative
6. Private entrepreneur/family business
7. State enterprise (various types)
8. Other (Specify)_____________

B. Was your firm established with participation of foreign capital?

1. Yes
2. No
3. Don't know

C. What is the approximate size of your company?

1. Large (over 500 employees)
2. Medium (between 100 and 500 employees)
3. Small (under 100 employees)

D. Which states/union territories does your headquarter locate? (the biggest branch for multinational companies)

E. What is your job title?

1. Board member
2. Manger of graduate's department
3. Supervisor of graduate's department
4. Colleagues of graduate's department
5. Head/Manager of Human Resource department
6. Business owner/partner
7. Other (please specify)

F. How many employees were hired last year?

G. Please specify the major economic activity of your firm

1. Agriculture, forestry and fishing
2. Mining and quarrying Manufacturing
3. Electricity, gas, steam and air conditioning supply
4. Water supply; sewerage, waste management and remediation activities
5. Construction
6. Wholesale and retail trade; repair of motor vehicles and motorcycles
7. Transportation and storage
8. Accommodation and food service activities
9. Information and communication
10. Financial and insurance activities
11. Real estate activities
12. Professional, scientific and technical activities
13. Administrative and support service activities
14. Public administration and defense; compulsory social security
15. Education
16. Human health and social work activities
17. Arts, entertainment and recreation
18. Other service activities
19. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
20. Activities of extraterritorial organizations and bodies

H. Which sector does your company belong to

1. Oil & Gas
2. Power
3. Automobiles
4. Steel
5. Pharma
6. Industrial Electronics
7. IT
8. Infrastructure
9. Food Processing
10. Cement
11. Biotech
12. Paper
13. Real Estate
14. Telecom
15. Irrigation, Dairy
16. Refinery, Chemicals
17. Other

I. What is the annual turnover of your company in Rs crores?

1. Less than 100 cr
2. Between 100-500 cr
3. 500-1000 cr

J. Which region does your company fall in

1. East
2. West
3. Central
4. North
5. South

Annex 4. TEQIP Institutions as Leaders in Technical Education

Some of the survey results may look gloomy. However, reforms and investment into quality, learning outcomes, and employability have been implemented successfully at the state and institutional level. One such example is the Technical Education Quality Improvement Program (TEQIP). This employer survey was conducted as part of the preparation process for the second phase of TEQIP (TEQIP-II). The authors of this Working Paper are the Task Team Leader and a team member of TEQIP-II.

TEQIP is a national program of the Government of India (GoI) with co-financing from the World Bank and a key part of the 11th Five-Year Plan of the GoI. It envisages a long-term (about 10-12 years) development of the technical education in the country and implements in three phases for transformation of the technical education system.

To spearhead a set of reforms and investments, Government of India competitively selected 127 promising institutions as future leaders of the technical/engineering sector in the country, in addition to India Institutes of Technology. This first phase of TEQIP was successfully completed in 2009 with strong results in improved employability of students and quality of education:

a) More than 40 of the supported institution gained academic autonomy which allowed them to continuously improve curriculum, teaching and assessment according to demand for skills and newest research,
b) Campus placement rates nearly doubled for undergraduate students from 41% to76% and more than doubled from 25% to 56% for post-graduate students,
c) Course offerings were restructured, modernized and vastly expanded in line with employer expectations.
d) Ninety-three percent of 811 Bachelor courses were accredited or in the process of accreditation
e) 220,000 students from disadvantaged backgrounds were assisted through provision of remedial teaching, workshops and establishment of "book banks."
f) Enrolment in Master and PhD programs increased 50% and 69% respectively from 2002,
g) 30,000 faculty and 13,000 staff underwent training and professional development.
h) Professional publications increased from 3,800 to 6,328 per year,
i) Patents obtained and applied for increased from 22 to 34 per year, and 86 per year,
j) More than 1,887 programs were conducted to support the local community and workers benefitting nearly 180,000 people and transferring 1,228 technologies to the community.

Given the success, a second phase of TEQIP was launched in 2010 to scale-up reforms and investments. About 120 new institutions to the program will be competitively selected to improve learning outcomes and employability of graduates taking into account the findings of this paper as well as feedback from local employers and strategic institutional development plans. Further, approximately 80 institutions will be competitively selected to scale-up post-graduate education and improving research, development, and innovation.

When implemented broadly and consistently across the country, the above reforms and other government initiatives will improve upon the skills gaps identified in this employer survey. Further, the TEQIP program will continue to monitor employer satisfaction in order to track employer satisfaction and ensure feedback into the engineering education system.