THE INSTITUTION OF ENGINEERS, MALAYSIA

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POSITION PAPER

BENCHMARKING THE QUALITY OF ENGINEERS

Approved by IEM Council at 395th meeting on 19 January 2015

Note: This IEM Position Statement is approved by the IEM Council and it expresses the views of the IEM on 19 January 2015. The purpose of this statement is to provide objective, authoritative background information to persons interested in issues within IEM's expertise, particularly in areas where such information will be helpful in drafting sound public policies.

EXECUTIVE SUMMARY

The issue of the nation's quality of human capital especially in the engineering industry is critical for the country to attain the status of an advanced nation by 2020. To this end, Malaysia has been producing more than 10,000 engineers each year who had gone through accredited engineering programmes recognised by the advanced nations when Malaysia was accepted as a signatory of the Washington Accord in June 2009.

Despite such achievement, there remains a recurring concern about the quality of recent graduate engineers. In a national forum organised by IEM on 16 Jan 2012, participants from the industry and academia suggested that the quantity of supply of graduate engineers to the industry was not an issue. The major concern however, was on the quality and trainability of fresh graduate engineers produced by local institutions of higher learning (IHLs).

In response to this concern, an IEM Task Force was formed to gather information from the wider engineering population. An online survey had been conducted in July 2013 amongst members of IEM above 35 years old and other stakeholders such as FMM, MBAM, REHDA and MEF. The survey focused on the quality of graduate engineers who had graduated within 3 years from local IHLs. The items included in the survey covered various attributes ranging from communication skills to fundamental knowledge in engineering as well as the ability to solve problems.

Out of a scale of 1 to 5, the higher being the better, the average scores for various items from 1186 respondents ranged from 2.57 to 3.47, with standard deviations between 0.8 to 1.0. The score below 3 are related to the ability to propose solutions or to seek better ways to do things.

Based on the survey results and prior input from the forum, IEM opines that a combination of increasingly poor quality of incoming undergraduate students and the unbalanced priorities of academic practice at local IHLs may have contributed to the trend. The former is corroborated by the results of TIMSS and PISA whereby excellent results obtained through national high school examinations were not reflected. Increasing focus on research and publication instead of quality teaching and learning by the local IHLs further aggravates the problem.

IEM believes that the solution is multi-pronged and spans various time scales. Among others, teaching and assessment of science and mathematics must be more rigorous at pre-university levels. In engineering schools and faculties, industrial experience and involvement of industrial stakeholders in undergraduate teaching and learning should receive at least equal priority and intensity as academic research.

1. BACKGROUND

The Star Online dated 29 July 2011 raised concerns regarding the shortage of engineers in Malaysia. In response to this concern, IEM conducted a survey amongst members of the IEM Council to determine whether there was indeed a shortage of engineers in the industry. The feedback received however indicated that instead of the "shortage of engineers" as claimed, there was actually a "shortage of quality engineers"; here "quality" is reflected by the attributes listed in the subsequent survey done for the purpose of this position paper.

As the first survey was just indicative, involving 33 consulting firms, IEM decided to organize a National Forum on Benchmarking the Quality of Engineers on 16 January 2012. Various stakeholders such as academics, industry practitioners, employers of engineers as well as regulatory bodies attended the forum.

Several examples were cited with regard to the inadequate standard of graduate engineers entering the industry such as:

(i) Graduates in civil engineering with CGPA 3.5 and above were unable to sketch simple bending moment diagrams, shear forces and deflected shape, therefore illustrating their inability to visualise structural behaviour.
(ii) Electrical engineers cannot explain a simple fundamental question of why birds standing on live wires are not electrocuted.
(iii) Poor understanding of the fundamentals of engineering design.
(iv) Not able to apply engineering knowledge.

There were also complaints that many graduate engineers were "unfit" for industry and "untrainable". The consensus reached at the end of the forum was that:

(i) There is a need to raise the standard of engineering graduates.
(ii) Schools need to improve on the education delivery system especially in science and mathematics to ensure that quality students enter IHLs
(iii) IHLs must engage more practising engineers while lecturers should gain more industrial experience.

2. THE POSITION STATEMENT COMMITTEE

To delve further into this serious issue, IEM established a Task Force on 3 December 2012 to prepare a Position Paper on this matter. The Committee was chaired by Dato' Ir. Dr. Gue See Sew, IEM Past President and Fellow of the Academy of Sciences, Malaysia. Membership comprised representatives from universities, employers of engineers as well as representative of the government as listed in Appendix I. The Engineering Accreditation Council and the Council of Engineering Deans were invited, but declined to send any official representatives.

The committee decided to enhance the statistical significance of the background data by surveying a wider pool of stakeholders. Representatives of affiliated organizations helped to distribute the survey to their members.

3. EMPLOYER SURVEY

The survey was targeted at engineers who are most likely in positions capable of judging the quality of fresh graduates, i.e. those of 35 years of age or older. The subjects of the survey are the ***locally educated engineers*** with less than 3 years of working experience. The online survey was made accessible from 10 July 2013 to 15 October 2013. The questionnaire for the survey, as given in Appendix II, was categorized as follows:

i. Engineering Fundamentals
ii. Analytical Skills
iii. Communication Skills
iv. Team Player
v. Right Attitude

Each category included at least two questions to improve the validity of the outcome.

At the end of the survey period, 1186 responses were received. The results showed internal consistency, with a Cronbach alpha value of 0.96. The respondents came from all major sectors of engineering, as shown in Figure 1.

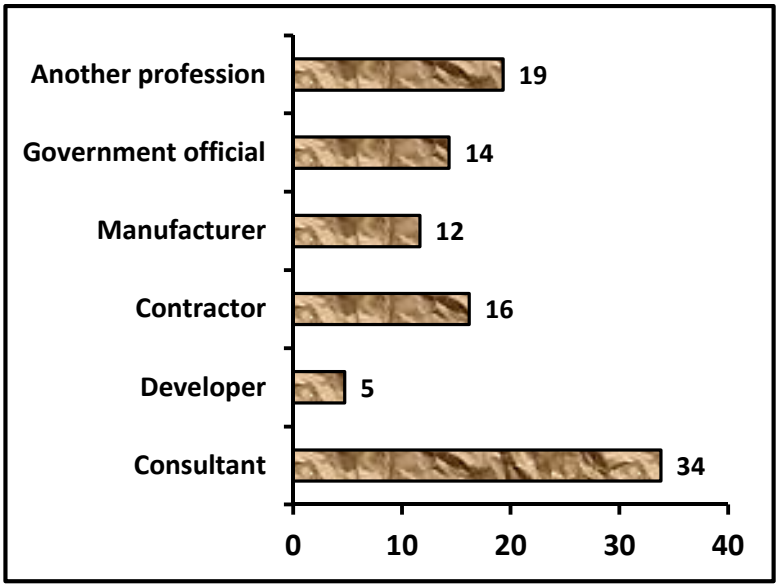


Figure 1: Distribution of respondents by sector (in percentage)

Based on the responses, the following observations closely related to the issues with regard to the technical knowledge and analytical skills of the graduates were found. Full details of the survey results can be found in Appendix III.

i. The average scores, based on the scale of 1 to 5, for knowledge of engineering fundamentals and the ability to apply the knowledge are 3.24 and 2.90 respectively (as shown in Figure 2). This result supports the general belief that the graduates have adequate knowledge of their disciplines but are less able in applying them. This could possibly be attributed to surface and rote learning.

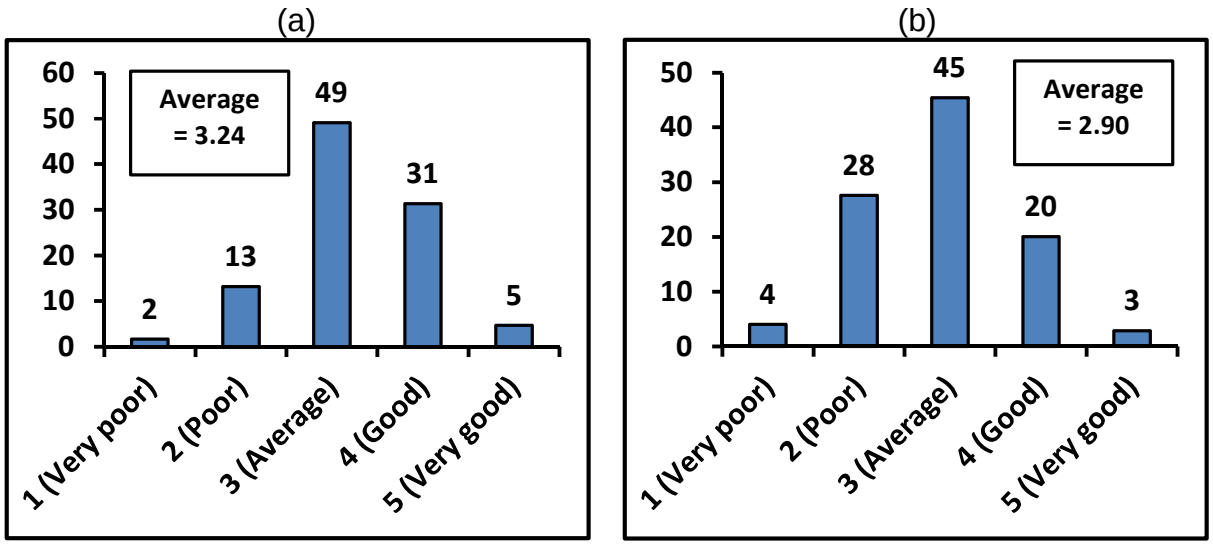


Figure 2: Percentage of respondents expressing the extent that the fresh local graduates have
(a) knowledge in Mathematics, Science, and Engineering;
(b) the ability to apply engineering fundamentals in solving engineering problems.

ii. Attributes associated with analytical skills yielded averages of 2.73 and 2.80 (Figure 3). However, the distributions are skewed towards the lower end. This suggests that the graduates had not been sufficiently exposed to think critically about problems posed, and how best to solve them.

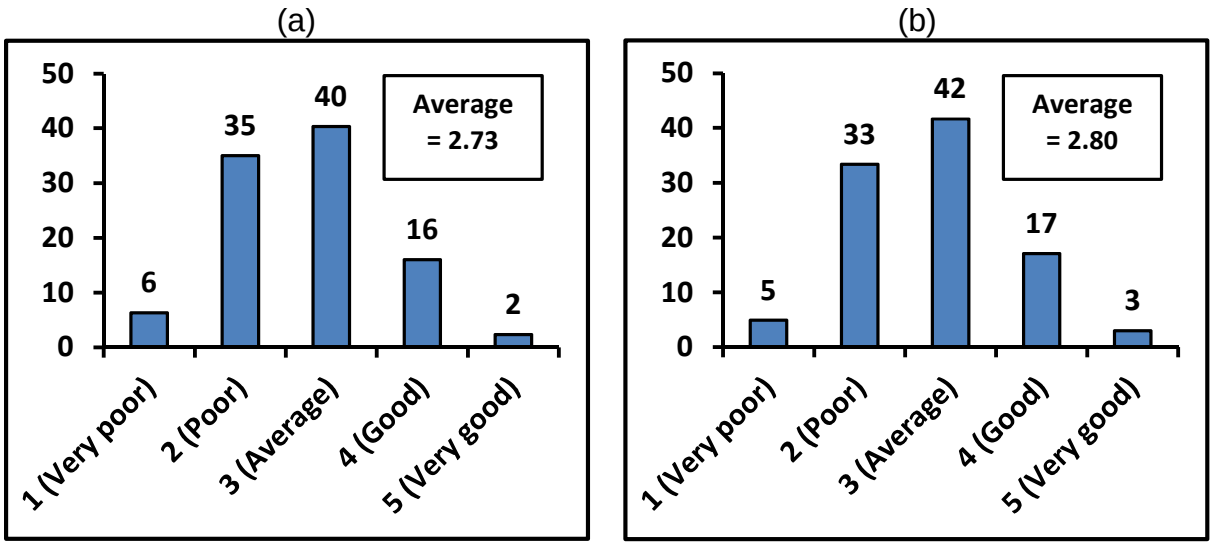


Figure 3: Percentage of respondents expressing the extent that the fresh local graduates have
(a) the ability to identify and investigate problems as well as propose solutions;
(b) the ability to seek ways of doing things for better results.

4. THE ISSUES

The survey results confirm the inadequacy in two main attributes of fresh graduate engineers i.e. firstly, the ability to apply knowledge of science and engineering and secondly, the ability to think analytically and critically. To assist the nation in this endeavour of further uplifting the quality of our locally educated graduate engineers, the Task Force believes that the root causes for the short-comings are the following:

4.1. Quality of Student Intake to the Universities

a) The poor performance of Malaysian secondary school students under TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment) is serious enough to raise doubts over the rigour and standards of our national examinations, which continuously produce batches of high passing percentages with many students obtaining full distinctions. In essence, Malaysia scored below average, and we not only fell behind Singapore, but also Vietnam.

b) If one were to contend that our students could not understand the test questions of TIMSS and PISA in view of the language, we would be conceding another point that the command of English amongst our students is below par. Indeed, Malaysia fared worse in the PISA reading score. In addition to the low competency in Science and Mathematics, poor command of languages and communication skills further jeopardise the ability of our students to cope in IHLs.

4.2. Quality of Engineering Education

a) Emphasis on memorising rather than understanding in our current education system gives rise to students who are not able to think or adapt to changes in the place of employment. More than one-third of the engineering graduates today are deemed to be below industry's expectation.

b) The curriculum is generally not strongly influenced by industrial needs. While stakeholders are consulted during each revision cycle as required by the Engineering Accreditation Council (EAC), the input from the industry is often cursory and not seriously taken up. Although the EAC does demand industrially relevant attributes from the graduates, the attainment during implementation is not easy to measure, and is open to interpretation.

c) The enrolment of poorly prepared students demands much greater efforts from academic staff to bring them up to speed. This has led to leniency in grading by academic staff to pass these students, which may have compromised standards. For example, 80% of graduates passed in the 1st and 2nd upper classes for some engineering programmes in an attempt to "make graduates more employable" besides meeting the associated KPI.

4.3 Performance of Academic Staff

The overemphasis of KPI towards research and publications amongst Research Universities has steered the IHLs in recruiting and retaining academic staff with much greater passion and acumen for research rather than teaching. It is generally not true that excellent researchers are themselves good undergraduate teachers. This is especially so in engineering as high-end research pursuits can be very remote and foreign from routine engineering as practised in the industry. Lecturing staff should in fact place more emphasis on teaching as compared to research.

5. RECOMMENDATIONS

5.1. Improve the Quality of Students Entering Institutions of Higher Learning

It is recommended that the following to be considered as possible solutions:

No.	Actions Recommended
1.	Improve the selection and nurturing of talent: • Raise the rigour of entrance examinations to IHLs, whether they are SPM, STPM or Matriculation. • Less academically-inclined students should be re-routed to vocational or skill-based courses where there is serious human resource shortage in this category for the industry.
2.	Improve the quality of the teaching and learning of science and mathematics in schools: • Provide sufficient incentives to science and mathematics graduates to become teachers, especially for posting to under-privileged regions. • Create exciting learning environments for the two subjects including encouraging innovations competitions involving science and mathematics to raise the general interest and competence amongst students. • Involve relevant industries and personalities in showcasing the application dimensions of science and mathematics.
3.	Improve Communication Skills and Command of Languages: • Provide school teachers with intensive structural training and follow-up in the teaching of languages and communication skills. • Acquire structured modules on teaching of languages and communication skills including online resources, videos and PowerPoint files and making them readily available. • Provide financial and facility resources for the establishment of (a) Drama Clubs (b) Communication skills enhancement clubs such as Toastmasters (c) Debating Clubs, etc.

5.2. Improve the Quality of Engineering Education

It is recommended that the following be considered as possible solutions:

Actions Recommended
Improve the curriculum and its delivery: • review the content and credit hours of EAC accredited programmes to strengthen industrial input and relevance. Credit hours allocated for non-technical subjects should be reduced. • develop a more holistic and realistic assessment of student attainment of the desired attributes prescribed by EAC. Do not prescribe rigid passing targets for courses. If students do not make the cut, they should simply repeat the course or drop out, rather than requiring the instructors to justify the failures. • increase the use of technology in teaching, especially slides, videos and websites to complement conventional lectures. The audio-visual aids should also be extended to some lengthy laboratory experiments. • develop and fund scheduled visits to sites of actual projects and companies. • monitor industrial training / attachment more closely to ensure mutually agreed exposure to professional engineering practice. • overhaul the tutorial system, for example insisting that they be separately scheduled in smaller classes with sufficient resources. Emphasis should be on: - polishing up the understanding of fundamentals - improving presentation / communication skills • organize structured annual project competitions within and among universities for every course to inculcate excellence, R&D, teamwork and ethics, to motivate undergraduates.

5.3 Improve the Performance of Academic Staff

Actions Recommended
Realign the priority and focus of academic staff: • increase the weightage for teaching to above 50%. • some staff could continue to be hired for their research prowess, but there should be two other parallel paths for practitioners and teachers. • the award system should be revamped to allow academic staff to advance their careers in their chosen paths. • to address the lack of industry experts in engineering education, practitioners should be allowed to compensate their lack of higher research degrees with professional practice and qualifications. • the salary structures should also be competitive enough to attract practitioners.

APPENDIX I

Members of IEM Task Force on Benchmarking the Quality of Engineers

Y.Bhg. Dato' Ir. Dr. Gue See Sew (Chairperson)	The Institution of Engineers, Malaysia (IEM)
Engr. Kwan Foh Kwai	Master Builders Association Malaysia (MBAM)
Mr. Chan Cheu Leong	Federation of Malaysian Manufacturers (FMM)
Dr. Aishah binti Abu Bakar	Jabatan Pendidikan Tinggi (JPT) / Universiti Malaya
En. Mohd. Arman bin Mohamed @ Abd Aziz	Jabatan Pendidikan Tinggi (JPT)
Ir. Ali Askar bin Sher Mohamad	Sustainable Energy Development Authority Malaysia (SEDA)
Ir. Dr. Ahmad Anuar bin Othman	Jabatan Pengairan dan Saliran (JPS)
Ir. Tar Singh	KTA Tenaga Consultant Sdn Bhd
Engr. Prof. Syed Abdul Kader bin Aljunid	Universiti Selangor (UNISEL)
Engr. Dr. Yeoh Hak Koon	Universiti Malaya

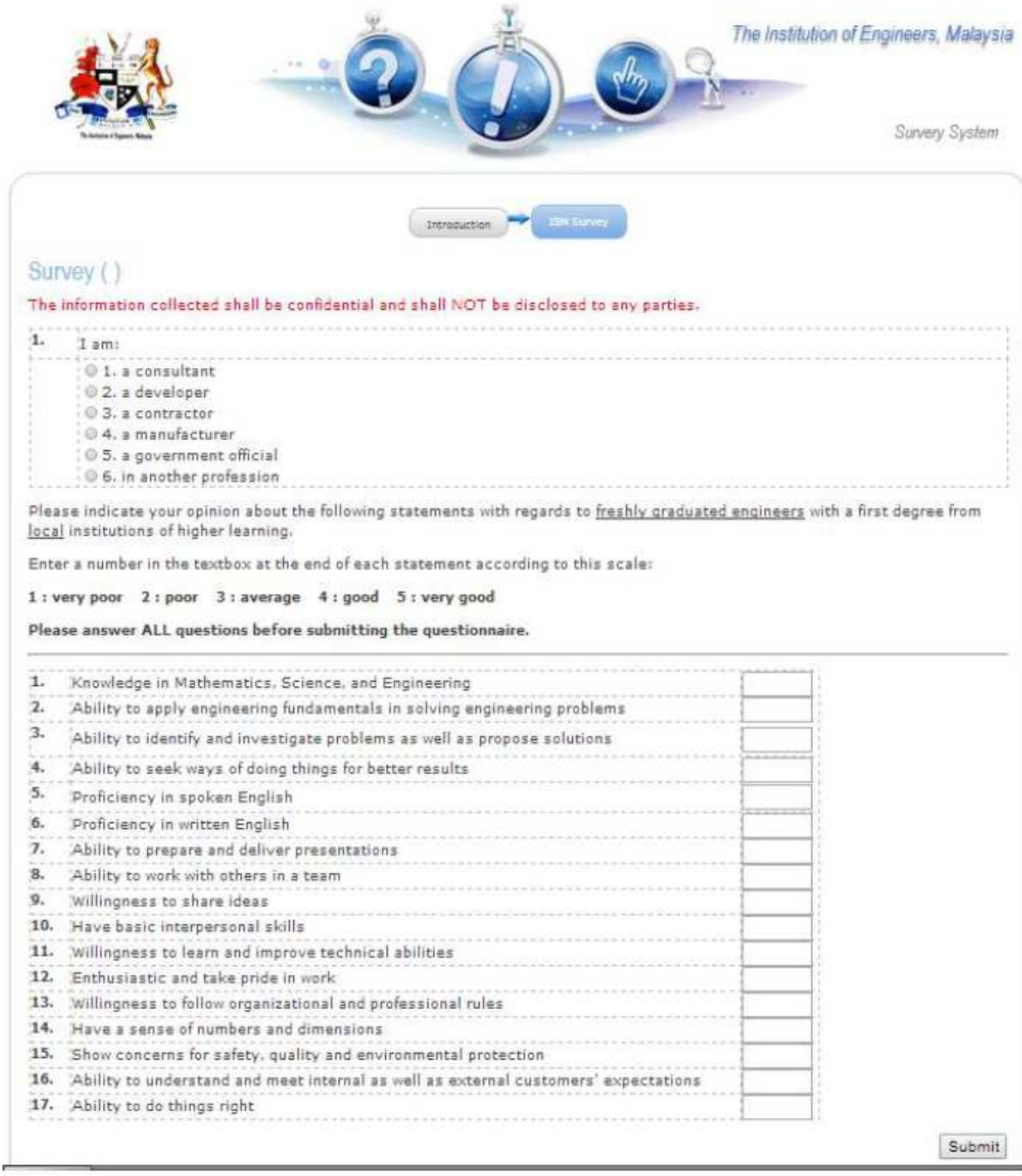
Secretarial support: Janet Lim, IEM.

Abbreviations

FMM	Federation of Malaysian Manufacturers
MBAM	Master Builders Association of Malaysia
MEF	Malaysian Employers Federation
REHDA	Real Estate and Housing Developers' Association

APPENDIX II

QUESTIONNAIRE OF THE SURVEY



APPENDIX III

DETAILED RESULTS OF THE SURVEY

i. The average scores, based on the scale of 1 to 5, for knowledge of engineering fundamentals and the ability to apply the knowledge are 3.24 and 2.90 respectively. This result supports the general belief that the graduates have adequate knowledge of their disciplines but are less able in applying them. This could possibly be attributed to surface and rote learning.

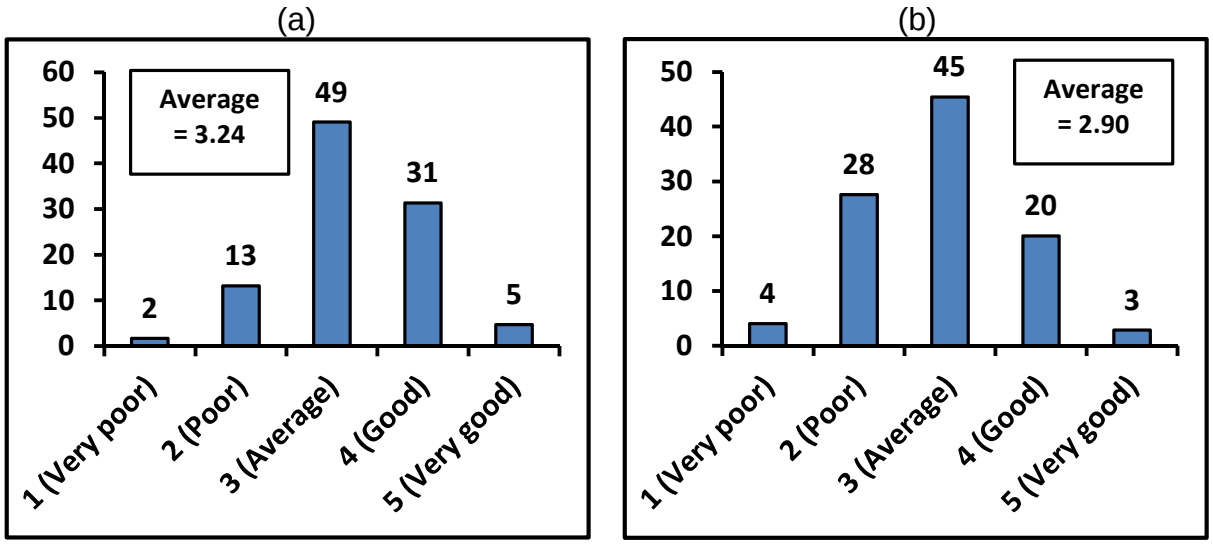


Figure III(i): Percentage of respondents expressing the extent that the fresh local graduates have
(a) knowledge in Mathematics, Science, and Engineering;
(b) the ability to apply engineering fundamentals in solving engineering problems.

ii. Attributes associated with analytical skills yielded averages of 2.73 and 2.80. However, the distributions are skewed towards the lower end. This suggests that the graduates had not been sufficiently exposed to think critically about problems posed, and how best to solve them.

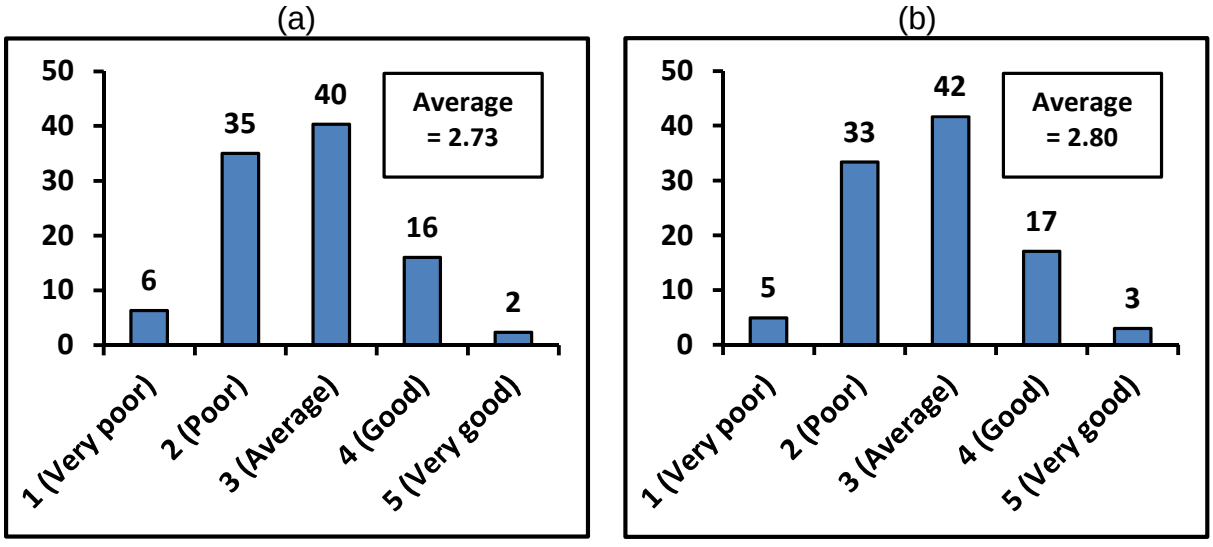


Figure III: Percentage of respondents expressing the extent that the fresh local graduates have
(a) the ability to identify and investigate problems as well as propose solutions;
(b) the ability to seek ways of doing things for better results.

iii. The lowest average scores arise from English communication skills. Barely 20% of the young graduate engineers are deemed above average in all three categories. As most local engineering programmes have been conducted in English, the results suggest that the deficiency originated in the lower educational institutions rather than in the universities.

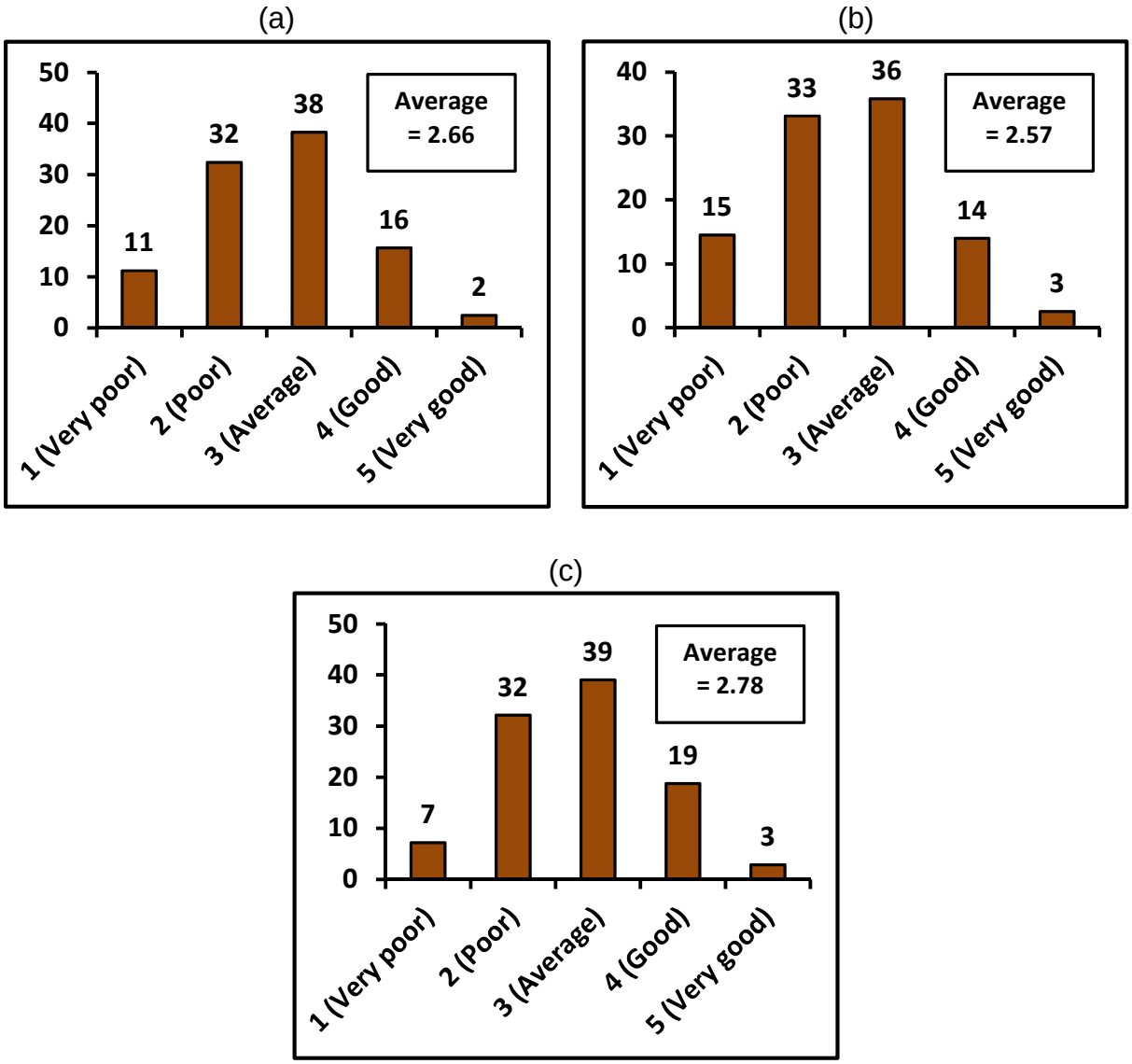


Figure III(iii): Percentage of respondents expressing the extent that the fresh local graduates have
(a) proficiency in spoken English;
(b) proficiency in written English;
(c) the ability to prepare and deliver presentations.

iv. The scores for questions based on team work were more encouraging with averages ranging from 3.11 – 3.40 and skewed towards the higher end. The increase in group work in the educational system seems to have helped. Nevertheless, the weakest attribute amongst these is basic interpersonal skills, with only 3 out of 10 respondents thinking that the young graduate engineers are above average.

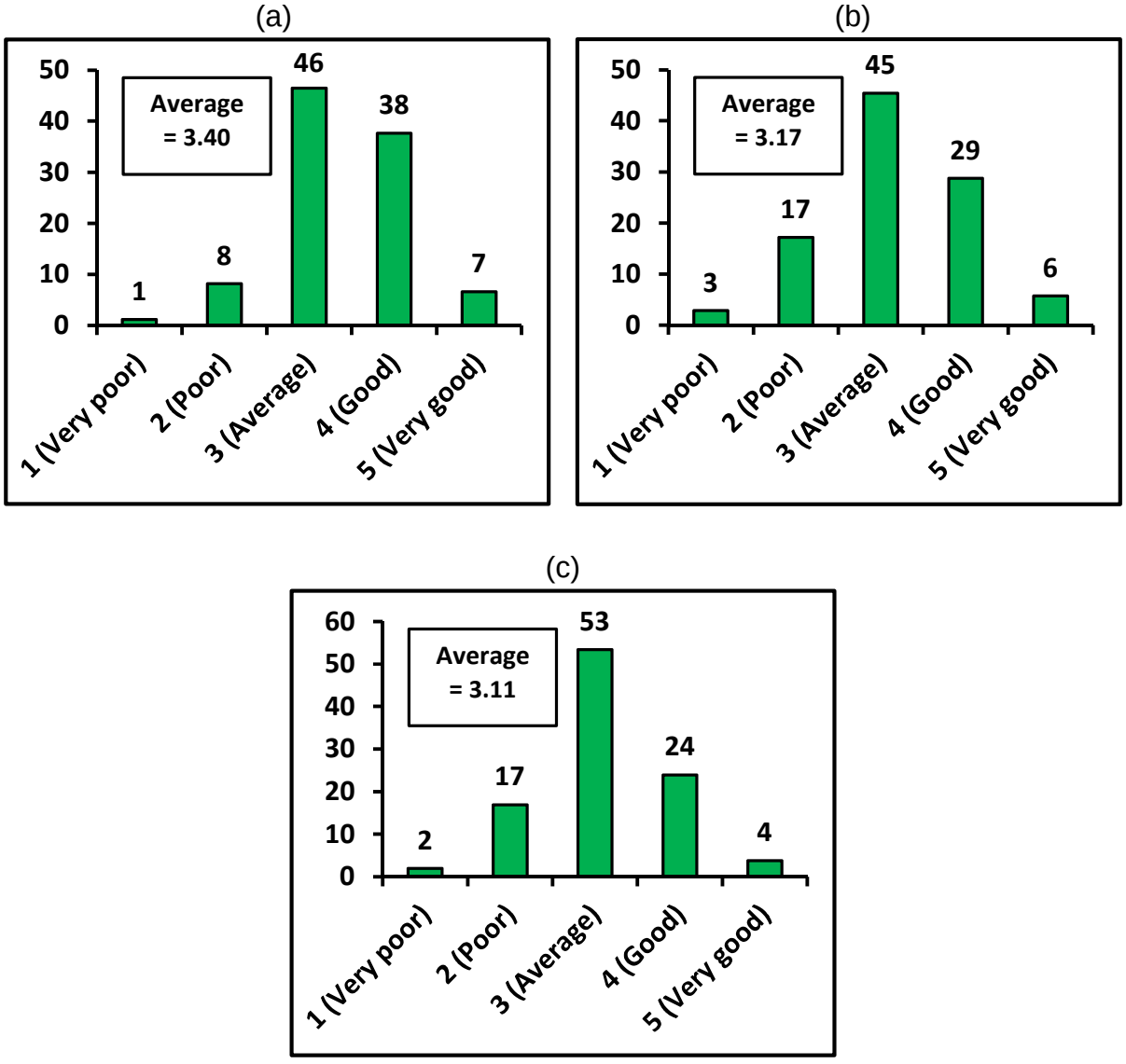


Figure III(iv): Percentage of respondents expressing the extent that the fresh local graduates have
(a) the ability to work with others in a team;
(b) willingness to share ideas;
(c) basic interpersonal skills.

v. The responses based on character had averages ranging 3.19 – 3.47 and were skewed towards the higher end. It was assuring that nearly half of the respondents perceived that the fresh graduate engineers conform above average to organization and professional rules; in fact only 9% perceived this aspect to be below average. The results paint a picture of eager, proud and willing engineers.

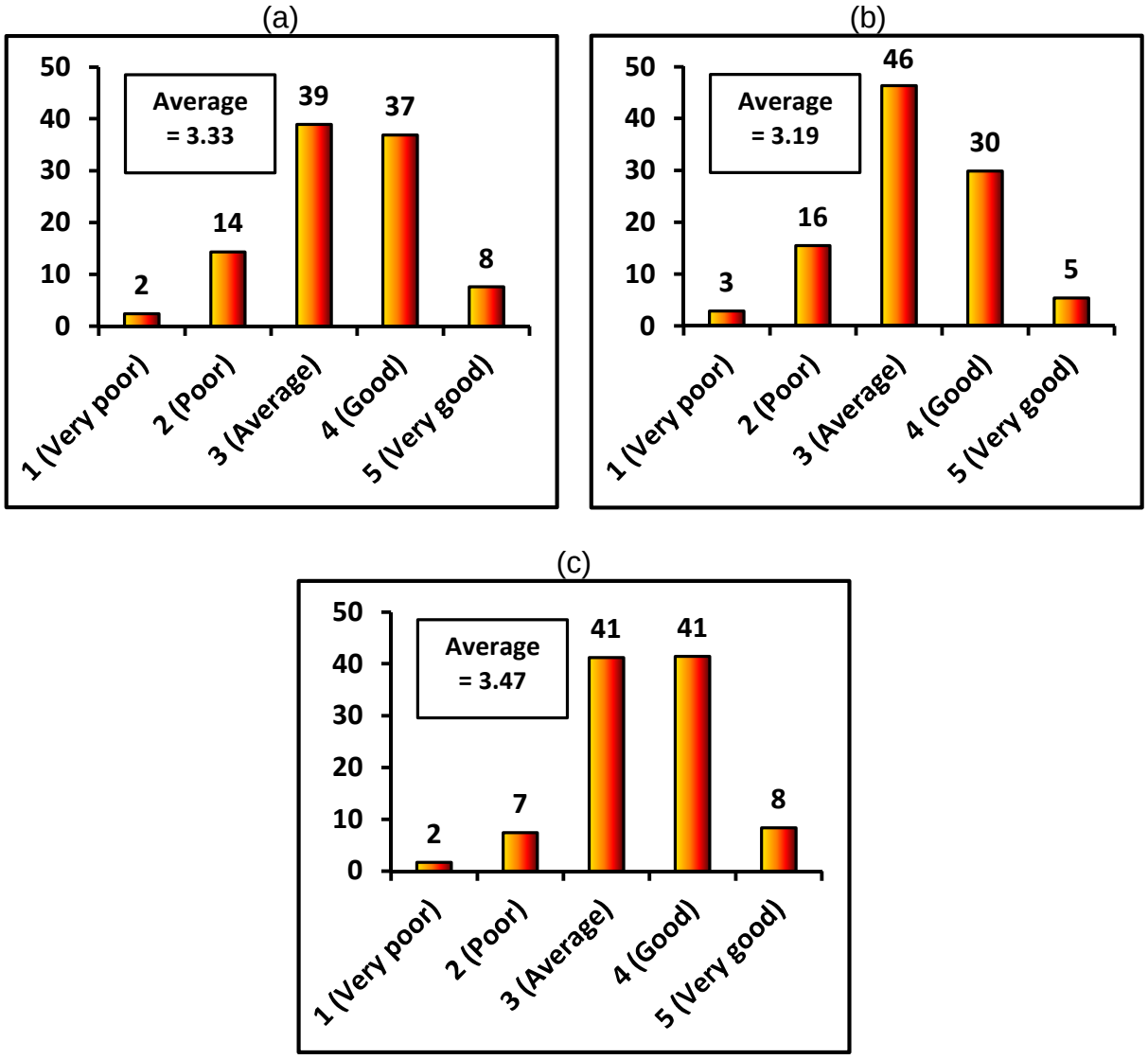


Figure III(v): Percentage of respondents expressing the extent that the fresh local graduates have the following attributes:
(a) willingness to learn and improve technical abilities;
(b) enthusiastic and take pride in work and
(c) willingness to follow organizational and professional rules

vi. The fresh local graduates are deemed average in their sense of numbers, concern for safety and environment, their ability to meet customer expectations, and their ability to do things right. Certainly there is room for improvement. In particular, the ability to meet customer expectations had the largest percentage below average, suggesting that the young engineers might not have honed such skills adequately, for example, to read between the lines.

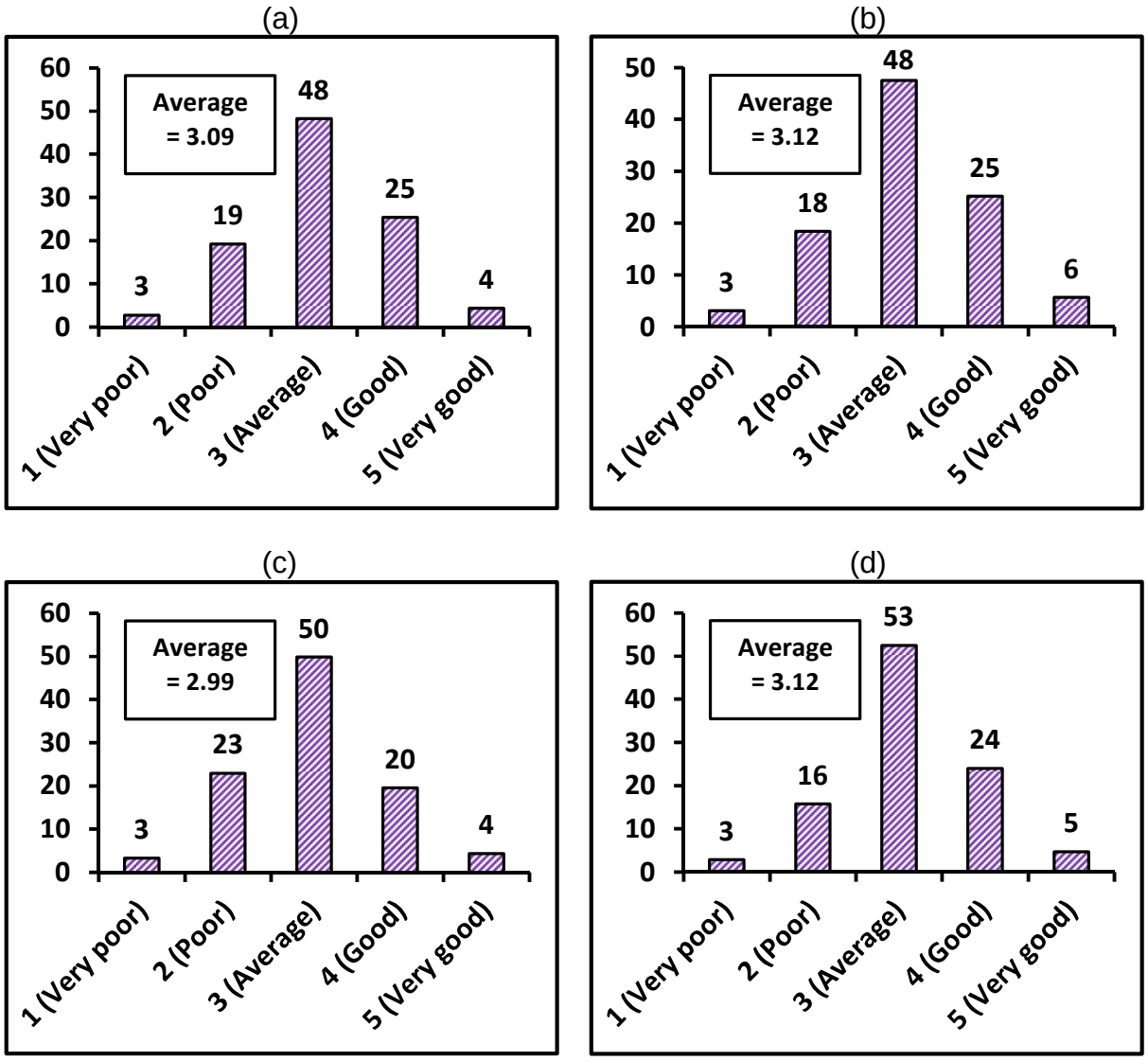


Figure III(vi): Percentage of respondents expressing the extent that the fresh local graduates have the following attributes:
(a) Have a sense of numbers and dimensions;
(b) Show concerns for safety, quality and environmental protection;
(c) Ability to understand and meet internal as well as external customers' expectations
(d) Ability to do things right.